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HOUSEHOLD FINANCE IN CHINA

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ABSTRACT

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Household Finance in China*

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Abstract

This paper uses a lifecycle model to study household finance in China, focusing on the high savings rate, the low stock market participation rate and the low share of stocks in wealth. We control for important regime changes in China in the estimation of structural parameters, and examine their impacts on household finance patterns. Relative to the US, the distinctive financial choices of households in China are driven by institutional factors, such as labor market risks and costs of asset market participation, as well as by differences in preferences. Specifically, large stock market participation and adjustment costs along with high stock market volatility in China lead to the relatively low stock market participation rate and the low share of stocks in wealth conditional on participation, but they contribute little to the high savings rate. The high savings rate in China is driven mainly by high labor market risks and the patience of households. Given the estimated differences between China and the US in preferences, the model predicts that households in China would continue to save more than their US counterparts even if institutional differences disappear.

1 Introduction

As is well documented, the household savings rate in China is high, compared to most developed economies such as the US. The average wealth-to-income ratio is about 14.67 in China compared with 4.46 in the US.[1] This high savings rate has drawn considerable attention as it impacts trade flows, international financial flows, the demand for US Treasuries, the level of world economic activity, etc.

This paper extends the literature on the high savings rate in China in two ways. First, it enriches the standard household intertemporal optimization problem to include the interaction between savings, asset (stock) market

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[1]The wealth-to-income ratio is defined as total wealth (including housing equity) divided by family income. It is calculated from the 2011 wave of China Household Finance Survey, and the seven waves of the Survey of Consumer Finance in the US between 1989-2007. In the calculation households with zero income are excluded. The high wealth-to-income ratio in China reflects the high savings rate in China as studied in, e.g., Chamon and Prasad (2010) and Chamon, Liu, and Prasad (2013).

participation and portfolio composition. This adds an extensive margin to the standard model, allowing us to study the extent to which the high savings rate comes from asset market participation decisions rather than just a high savings rate by market participants. Further, the expanded model includes a portfolio choice dimension which potentially interacts with wealth accumulation.

Second, the paper looks forward and asks: what will the household savings look like in China as the country further develops its financial market and labor market? Specifically, we take the US as the economy to which China will eventually approach and study how household financial choices will evolve. This is an important exercise for evaluating whether the high savings rate, with its various implications for the rest of the world, will persist.

The analysis builds a lifecycle model to jointly study the following features of Chinese household financial choices: (i) the low stock market participation rate, (ii) the low share of wealth in stocks conditional on participation, and (iii) the high wealth-to-income ratio. We estimate the model parameters for both China and the US via Simulated Method of Moments (SMM hereafter), exploiting country-specific variations of household finance patterns by educational attainment and age. We distinguish preference parameters from institutional factors, including stock market participation and adjustment costs as well as the exogenous processes for labor income and stock returns, since we expect the latter to change as China further develops while the former may evolve slowly if at all.

The structural estimation uncovers three key differences between the US and China. First, households in China are more patient than those in the US.[2] Second, the costs of stock market participation and portfolio adjustment are larger in China. Third, the consumption floor which captures a country's social safety net is lower in China. These differences, along with the differences in labor income processes and in stock return process, are the main drivers of the observed between-country disparity in savings rate and portfolio choice.

Estimation of the model is challenging due to cohort effects in the data moments which may bias our estimation and predictions. These cohort effects stem from the significant regime changes experienced by the Chinese households at different stages in their lives.[3] The traditional approach to address this issue uses cohort dummies and long repeated cross sectional data to purge the data of cohort effects. This approach is infeasible in our setting as there is only one cross section of data publicly available in China with enough details and coverage to study the financial choices of households – the 2011 wave of China Household Finance Survey (CHFS hereafter).[4] Instead, our innovative approach is to incorporate cohort effects into the model rather than to purge them from the data. We solve the lifecycle optimization problems of different cohorts in the 2011 CHFS, taking the regime changes that occurred at cohort-specific ages explicitly into account. Thus the resulting optimal decision rules reflect the cohort-specific impacts of regime changes. We pool the simulated data for various cohorts together to calculate the household finance moments in 2011 that are comparable to the moments calculated from the 2011 CHFS.

This estimation strategy allows us to study the impacts of historical regime changes on household finance patterns in China. We show that both housing reform and labor market reform have led to higher wealth-to-

[2]Given the long agricultural tradition in China, the low time preference and high savings rate seem consistent with Galor and Ozak (2016).

[3]For example, the cohort aged 40 in a 2011 survey should be strongly affected by the housing reform around 2000 when they were 30, while the cohort aged 65 in 2011 should be strongly affected by the re-opening of the stock market around 1990 when they were 45.

[4]CHFS conducted several follow-up surveys since 2011, but only the 2011 wave is publicly available.

income ratios. In the future, when the economy is unaffected by these regime changes, we predict that Chinese households will save even more, have much higher participation rates in the stock market, and have higher stock shares in total wealth.

Our analysis uncovers interactions between savings and portfolio composition that provides new insights into the financial choices of Chinese households and helps to predict future developments. On the one hand, the level of savings and thus wealth accumulation strongly affects portfolio composition: wealthier households have lower per unit costs of stock market participation and adjustment. On the other hand, some factors influence asset market participation and portfolio composition, but affect savings only marginally. For example, imposing the US stock return process on China significantly changes stock shares but has only a limited impact on the wealth-to-income ratio. Overall we find that asset market underdevelopment in China, as captured by the large stock market participation and adjustment costs and the low Sharpe ratios, does not contribute to the high savings rate.

We perform a series of counterfactual experiments in which China adopts the US institutions. We show that if China adopts the US labor market that features lower income uncertainty and a larger consumption floor, then Chinese households on average will lower their wealth-to-income ratio by more than 50%. Alternatively, if China adopts the US financial market but preserves its own labor market features, then about 90% of households will participate in the stock market due to the higher Sharpe ratio and lower stock market related costs which are further dwarfed by the large wealth accumulation. Further, if China converges to the US in terms of both the labor market and the financial market, then stock share in total wealth of the Chinese households will be close to the US data, and the wealth-to-income ratio will be lowered but is still significantly higher than in the US data. In other words, Chinese households will continue to save more than their US counterparts even after institutional differences completely disappear, unless their preferences change.

The rest of the paper is organized as follows. Section 2 presents data facts about household finance in China and compares them with US patterns. Section 3 introduces the structural model where the optimization problem of households and the key market frictions are laid out. Section 4 discusses the estimation strategy and reports estimation results, including the impacts of regime changes. Section 5 focuses on the interaction between wealth accumulation, asset market participation and portfolio composition. Section 6 discusses what drives the large US-China disparity in household finance patterns, and predicts the patterns in China as the country approaches the US in terms of its financial market and labor market. Section 7 concludes.

2 Motivating Facts

Facts about household finance patterns, for both China and the US, are reported in Table 1. The statistics are calculated from the 2011 wave of the CHFS for China, and from seven waves of the Survey of Consumer Finance (SCF) between 1989 and 2007 for the US, without any control for year or housing effects. More details on the data are provided in Appendix A, and more household finance patterns are provided in Appendix B.

For each country, the table presents the average values of household financial decisions for two educational

attainment levels: (i) high school and below (low-edu) and (ii) beyond high school (high-edu).[5]

Table 1: Household Finance Facts by Education

Country	Edu.	Part.	Share	W/I	Share(h)	$W(h)/I$
CN	low-edu	0.053	0.501	1.113	0.108	13.802
		(0.003)	(0.021)	(0.094)	(0.010)	(0.892)
	high-edu	0.252	0.512	1.604	0.131	16.189
		(0.009)	(0.012)	(0.109)	(0.007)	(1.370)
US	low-edu	0.188	0.488	1.362	0.247	3.845
		(0.008)	(0.015)	(0.084)	(0.016)	(0.231)
	high-edu	0.566	0.568	2.793	0.376	4.529
		(0.004)	(0.003)	(0.046)	(0.012)	(0.106)

This table reports the participation rate (Part.), the share of stocks in household portfolio for participants, the mean wealth-to-income ratio (W/I) for Chinese and US households by educational attainment. Data for China are from the CHFS (2011). Data for the US are from the SCF (1989-2007). Households whose heads have at least a high school diploma are defined as high education households In calculating Share(h) and $W(h)/I$ housing equity is included in wealth. Standard errors are reported in parentheses.

We focus on three dimensions of household financial decisions: (i) the stock market participation rate, (ii) the share of stocks in household portfolio conditional on participating in the stock market, and (iii) the wealth-to-income ratio. A household is considered a stock market participant if it holds stocks either directly or indirectly through mutual funds. Throughout the paper, calculation of the wealth-to-income ratio is based on total family income which includes the sum of family members' labor income and transfers from the government that are not needs-based.[6]

The table presents two measures of wealth: financial wealth and total wealth (the sum of financial wealth and net housing equity). Correspondingly, 'share(h)' is the stock share relative to the total wealth while 'share' is relative to financial wealth. Likewise, 'W(h)/I' is the ratio of total wealth relative to income, while 'W/I' is defined on the basis of financial wealth.

As shown in the table, the average wealth-to-income ratio is about 3-4 times larger in China than in the US when housing is included in wealth. Once housing is excluded from the wealth measure, the wealth-to-income ratios naturally are lower and the differences across countries are less pronounced. In both countries, more educated households have higher wealth-to-income ratios, and this education gradient of the wealth-to-income ratio is larger in the US than in China. It is also noteworthy that housing is a more important component of wealth for the less educated households in both countries.

The stock market participation rate is much lower in China. This is the case for both education groups. In both countries participation rises with educational attainment.

[5]Only 12.4% of the population is in the high education group in China based on the 2010 census data. The corresponding number is 58.9% in the US, as reported in `https://www.census.gov/content/dam/Census/library/publications/2016/demo/p20-578.pdf`. A finer breakdown by educational attainment is not feasible due to the limited observations of households with college or post-graduate education in the CHFS sample.

[6]Needs-based transfers are included in the "consumption floor" in our structural model. The wealth-to-income ratio is calculated based on after-tax income for China but before-tax income for the US. The CHFS reports after-tax income only, while the SCF reports only before-tax income.

For stock market participants, the stock share in total wealth in the US is 2-3 times larger than in China. Excluding housing, stock share in financial wealth is close to 50% in both countries. For both countries, the stock share rises with education.

3 Household Dynamic Optimization

To understand the above household finance patterns, we build a dynamic optimization model of saving and portfolio choice over the lifecycle. In the presentation of the model, 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 labor market and financial market conditions for that education and country pair. For simplicity of notation the cohort index of the Chinese households is also omitted.

3.1 Basic Assumptions

Households live up to T periods with some death probability in each period, and work for the first $T^r < T$ periods of life conditional on survival. During the working phase of life, households earn stochastic income. During retirement, households receive deterministic income, but face stochastic out-of-pocket medical expenses.[7] In our quantitative analysis, we assume households work for 40 years, between age 21-60 in China and 26-65 in the US, and assume households die with probability one by age 91.[8].

Households have access to two types of assets: bonds and stocks. Bonds are risk-free and perfectly liquid, but stocks are risky and illiquid in the sense that it is costly for households to enter the stock market and costly to adjust stock holdings. Thereby the model emphasizes two key discrete choices of households: stock market participation and portfolio adjustment.

Housing is bundled with the traditional risk-free and low-return assets such as bank deposits to form a composite asset, i.e. the bonds. Housing returns in China have a very low standard deviation which provides justification for this bundling.[9] The implied costless housing adjustment assumption is assessed in Appendix E.3 where we compare the bond change rates from the simulated data to the proportion of liquid asset in composite bond holdings found in the 2011 CHFS data, and show that the liquid proportion in the composite bond is generally sufficient for households to smooth their consumption against income and medical expense shocks.

Following Cagetti (2003), for both China and the US, we assume that nondurable consumption, $\hat{c}$ and housing services h are combined through a Cobb-Douglas function, $c = \hat{c}^{1-\phi} h^{\phi}$. In this way, housing services are included in the composite consumption c.[10]

[7] The importance of income uncertainty and medical expenses in explaining the high savings rate in China is explored in Chamon and Prasad (2010) and Chamon, Liu, and Prasad (2013).

[8] In the Chinese data the average probability of death is 19.1%, 21.7% and 45.4% for those aged between 90-94, 95-99 and over 100.

[9] The standard deviations of housing return and stock return in China are 0.075 and 0.515 respectively, according to Fang, Gu, Xiong, and Zhou (2015).

[10] We set $\phi = 0.24$ in the quantitative analysis and note that the value of this parameter is not important for our moments.

3.2 Participant

Let $\Omega = (y, m, A, R^s)$ represent the current state of the household where y and m denote income and medical expense respectively. $A = (A^b, A^s)$ summarizes the current holdings of bonds and stocks respectively and R^s is the return on stocks.

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

$$V_t(\Omega) = \max\{V_t^a(\Omega), V_t^n(\Omega), V_t^x(\Omega)\} \tag{1}$$

for all Ω. The subscript t in the value functions denotes the age of households. Value functions are age-dependent due to the finite horizon of households in the model. For both the state variables and control variables, we omit age subscripts but use primes to denote variables of the next period.

If the household adjusts its portfolio, it chooses the holdings of stocks and bonds to attain a value of:

$$V_t^a(\Omega) = \max_{A^{b\prime} \geq \underline{A}^b, A^{s\prime} \geq 0} \left\{ (1-\beta)c^{1-1/\theta} + \beta \left[(1-\nu_{t+1}) \left(E_t V_{t+1}(\Omega')^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}} \tag{2}$$

s.t.

$$c = y + TR - m + \textstyle\sum_{i=b,s} R^i A^i - \sum_{i=b,s} A^{i'} - F \tag{3}$$

$$TR = \max\{0, \underline{c} - (y + \textstyle\sum_{i=b,s} R^i A^i - m)\}. \tag{4}$$

where c is the current period consumption, ν_{t+1} is the death probability between age t and $t+1$. E_t denotes the expectation with respect to future income, medical expenses and stock returns. B_{t+1} is the bequest value if the household dies, and γ is the relative risk aversion. The household's future value is summarized by the term in the brackets which depends on the degree of uncertainty and risk aversion.

θ is the elasticity of inter-temporal substitution (EIS) that determines the substitutability between the current consumption the future consumption summarized in the future value. With this recursive representation following Epstein and Zin (1989) and Weil (1990), two key aspects of household choices, namely risk aversion and the EIS, are estimated independently.[11]

The bequest value as a function of state variables is given by:

$$B(R^b A^{b'} + R^{s'} A^{s'}) = L \times (R^b A^{b'} + R^{s'} A^{s'}). \tag{5}$$

where L determines the strength of bequest motives. This bequest value is stochastic because the stock return $R^{s'}$ is a random variable. The effect of risk aversion on bequest value appears in the parameter γ in equation (2).

In the choice set of equation (2), $\underline{A}^b$ is the lower-bound of bond holdings. In the quantitative analysis below, we find that treating $\underline{A}^b$ as an additional free parameter does not improve the fit of the model. Therefore $\underline{A}^b = 0$

[11] As reported in Cooper and Zhu (2016), this recursive utility formulation fits the moments for the US best.

is imposed.

The F in equation (3) represents the cost of stock adjustment, including fees paid as well as time costs incurred. In Bonaparte, Cooper, and Zhu (2012) and Cooper and Zhu (2016), this cost is used, in part, to match portfolio adjustment rates. Although no data exists on adjustment rates for Chinese stock market participants, the stock adjustment cost leads to lower stock market participation and lower stock share for participants, therefore is identifiable.

Equation (4) is the transfer to the household that is associated with the 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 (2016), this institutional feature is important for matching the wealth-to-income ratio of relatively poor households.

A household that participates in the stock market but chooses not to adjust its stock account is able to freely adjust its bond account. That is, if the household chooses not to adjust its portfolio, then the cost F is avoided and the value is:

$$V_t^n(\Omega) = \max_{A^{b\prime} \geq \underline{A}^b} \left\{ (1-\beta)c^{1-1/\theta} + \beta \left[(1-\nu_{t+1}) \left(E_t V_{t+1}(\Omega')^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}}$$

$s.t.$

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

where the return on stocks is automatically reinvested into the stock account, i.e. $A^{s\prime} = R^s A^s$. By assumption, bond adjustment is costless. Recall that bonds are defined as a composite of the low-return liquid assets (e.g. bank deposit) and housing asset. If the amount of bond adjustment is larger than the holdings of low-return liquid assets, then the adjustment involves housing transaction which is clearly not costless. As mentioned earlier, we assess this assumption in Section E.3.

A participant may also choose to exit the stock market. This is likely to be optimal when a large negative shock occurs, such as an adverse income shock or medical expense shock. In this case $A^{s'} = 0$, and the value is given by:

$$V_t^x(\Omega) = \max_{A^{b\prime} \geq \underline{A}^b} \left\{ (1-\beta)c^{1-1/\theta} + \beta \left[(1-\nu_{t+1}) \left(E_t W_{t+1}(\Omega')^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}}$$

$s.t.$

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

where $W_{t+1}(\Omega')$ is the value for non-participants discussed in the coming subsection.

3.3 Non-participant

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

$$W_t(\Omega) = \max\{W_t^n(\Omega), W_t^p(\Omega)\} \tag{6}$$

where $W_t^n(\Omega)$ is the value of remaining a non-participant and W_t^p is the value of becoming a participant.

The optimization problem of a non-participant who remains a non-participant is:

$$W_t^n(\Omega) = \max_{A^{b\prime} \geq \underline{A}^b} \left\{ (1-\beta)c^{1-1/\theta} + \beta \left[(1-\nu_{t+1}) \left(E_t W_{t+1}(\Omega')^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}}$$

s.t.

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

Though not holding stocks, the household can adjust its bond account to smooth consumption.

If a non-participant switches its status and decides to purchase stocks, it must pay a participation cost of Γ. There is no lag so that the household can instantly trade in the stock market. The value of participating for the first time is given by:

$$W_t^p(\Omega) = \max_{A^{b\prime} \geq \underline{A}^b, A^{s\prime} \geq 0} \left\{ (1-\beta)c^{1-1/\theta} + \beta \left[(1-\nu_{t+1}) \left(E_t V_{t+1}(\Omega')^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}}$$

s.t.

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

3.4 Preference Parameters and Institutional Parameters

Parameters in the model can be split into two groups. The first group characterizes financial market and labor market conditions, are hence called "institutional parameters". Financial market parameters are the stock market entry cost Γ, the adjustment cost F, the bond return R^b, and parameters related to the stock return process. Labor market parameters are parameters related to labor income process, medical expense process and the consumption floor $\underline{c}$.

The second group of parameters, called "preference parameters", includes the discount factor β, the coefficient of risk aversion γ, the EIS θ, and the bequest motives L.

In the quantitative analysis below, parameters related to the income and medical expenses processes, and return

processes, are estimated from the data directly. That is, they are estimated outside the household optimization problem. The remaining parameters are estimated via SMM, including the preference parameters, the consumption floor, the stock market entry cost and the adjustment cost.

4 Quantitative Analysis

For the SMM approach, the vector of parameters $\Theta \equiv (\beta_i, \Gamma, F, \gamma, \theta, \underline{c}, L)$, solves the following problem:

$$\pounds = min_{\Theta}(M^s(\Theta) - M^d)\mathcal{W}(M^s(\Theta) - M^d)' \tag{7}$$

where $\mathcal{W}$, the weighting matrix, is the inverse of the variance-covariance matrix of the moments. Note that the discount factor, β_i, is indexed by $i = 1, 2$ where $i = 1$ denotes the low education group and $i = 2$ denotes the high education group.[12] The simulated moments, $M^s(\Theta)$, are calculated from data created by simulating the decision rules derived from the household optimization problem.

In the presence of stock market participation costs, the status of being a participant itself has some value. Therefore the initial allocation of assets could be important. For the US model we take as an input the joint distribution of stocks and bonds for households aged between 25-30 in the SCF. For China neither of the two cohorts in the model has stock holdings when they enter the economy since the stock market became active only after 1990.

4.1 Regime Changes

In working with the Chinese data there is an important challenge: the available data have a time span that is too short to use the traditional dummy regression approach to control for cohort effects stemming from multiple regime changes in China. We consider two cohorts: a young cohort that is 35-45 years old in 2011 and an old cohort that is 60-70 in 2011. Obviously they have experienced each regime change at different ages, hence their households finance patterns are affected differently, which makes the inference from a single cross sectional data difficult.

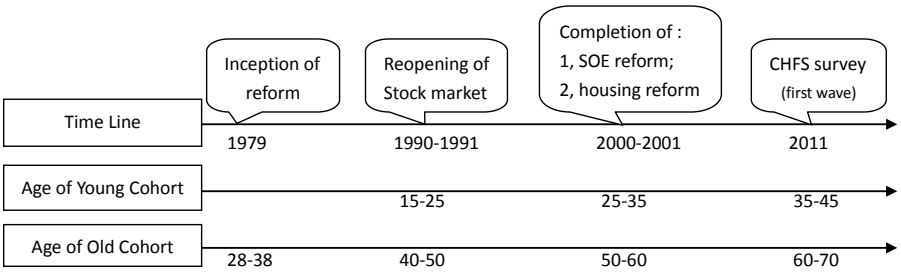
Figure 1 lists the key regime changes we consider and their timing. As the figure shows, the stock market in China re-opened in 1990.[13] Thus for the old cohort, stock market was simply not accessible until they were 40 years old. However the young cohort has had access to stock markets ever since they first entered the labor market.

Housing reform is another important regime change. Prior to housing reform there was no active residential housing market, instead houses were mostly allocated through employment. In 1998, the State Council in China issued the 23rd Decree which banned work units from developing new residential houses for their employees in any form. After 2000, house prices started to take off, and the average real growth rates of house prices in many cities

[12] In experiments where, in addition to the difference in the discount factor, we also allow difference in either the participation cost or the adjustment cost, the estimation results indicate that these additional differences are statistically insignificant.

[13] The Shanghai Stock Exchange re-opened on December 19, 1990 after being closed for forty years since 1950. The Shenzhen Stock Exchange also started to operate on December 1, 1990.

Figure 1: Regime Changes and Cohort Effects



This chart shows two cohorts in the 2011 CHFS and the major regime changes they experienced at different ages. These regime changes lead to cohort effects in household finance patterns observed in the 2011 survey.

have exceeded 10% per year since 2005. We will return to this point in Section 4.2.3 when we calibrate the return processes for stocks and bonds.

The changes in the 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 as shown in He, Huang, Liu, and Zhu (2014). By the beginning of 2000s, the SOEs had mostly been transformed into so-called "modern enterprises" that essentially maximize profits, with the freedom to set wages and layoff workers.

An obvious effect of labor market reform in China is the gradual rise of the college premium which is shown in Figure 4 in Appendix A.3. This point is also evident in Figure 2 where we plot the age profiles of income estimated from the China Health and Nutrition Survey (CHNS) between 1989-2011: the income gap between the two education groups is clearly larger in the post-2000 era. The figure also shows a significant change in the shapes of income profiles.

The stochastic process of income has also changed dramatically in China. Section 4.2.1 describes how we model and estimate the process, and reports the related parameters in Table 2. Compared to the pre-2000 era, income shocks are both larger and more persistent after 2000. This is especially true for the more educated group. Similar changes about income risks are documented in He, Huang, Liu, and Zhu (2014).

Our approach to estimation is to include the cohort effects from these changes in our model, rather than remove them from the data. For each education group we solve the dynamic optimization problem, taking each regime change as a surprise. Using access to the stock market as an example, we assume that prior to 1990 various cohorts make financial decisions based on the expectation of no stock market in their lifetime. In 1990 the stock market re-opened and households re-solved their lifetime optimization problem given the new opportunity, assuming the new regime is to last forever. Clearly this re-optimization is cohort-specific.

Thus our optimal decision rules incorporate regime changes, and the household finance moments calculated from the simulated data are comparable to those from the 2011 CHFS data. By matching these model moments with the data moments, we obtain unbiased estimates of the structural parameters.

4.2 Exogenous Processes

As presented in this section, households in China and the US differ in exogenous income processes, medical expenses processes and mortality rates. In addition, the asset return processes in the two countries differ, with a significantly lower Sharpe ratio in China. These country-specific processes are taken as exogenous inputs in the estimation of the model. In section 6.1 we further study the mapping between these exogenous differences and the between-country disparity in household finance patterns.

4.2.1 Income

Income processes for the Chinese households are estimated using the panel data of CHNS 1989-2011. Appendix A.3 provides more details about the data. Household income is decomposed into a deterministic component and a stochastic component. For each education group, we regress the logarithm of household income on a constant, age, age-squared, year dummies (to remove aggregate shocks and growth) and a set of demographic variables. The deterministic component is the income predicted using the coefficients on age and age-squared. The stochastic component is estimated based on the regression residuals.

Deterministic Income Profiles: The deterministic component of income over the lifecycle is shown in Figure 2. Income levels are re-scaled so that the average of the two education groups is one.

For China, the rising education premium is apparent.[14] On average income of the high education group is 18% higher than the low education group in pre-2000 data, but the number becomes 54% in post-2000 period. In the US the corresponding number is 78% in our PSID sample between 1989-2009. Therefore despite the fact that education premium has risen considerably in China, it is still small relative to the US.

Compared with the pre-2000 income profile, the hump shape is less pronounced in the post-2000 regime in China. Relative to the US data, the hump shapes in post-2000 China are also much less pronounced. This would, all else the same, lead to less savings in China.

Stochastic Processes: Letting $\tilde{y}_{i,t}$ denote the residual from the income regression for household i in period t, we further decompose it into transitory and persistent shocks:

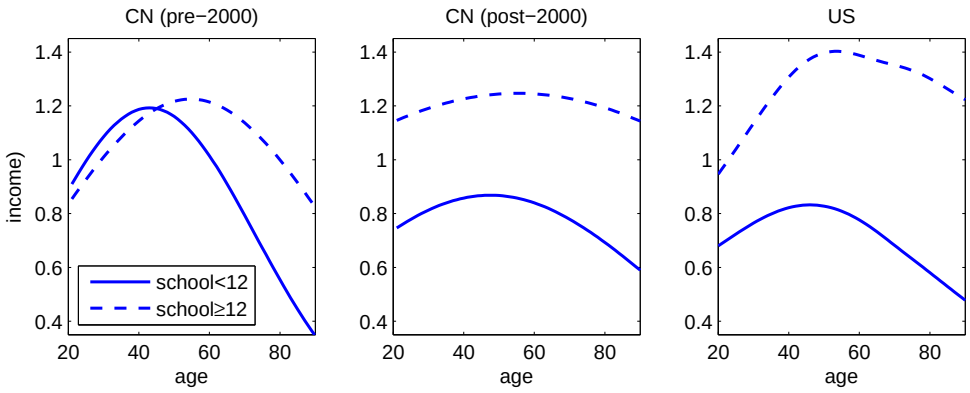
$$\begin{aligned} \tilde{y}_{i,t} &= z_{i,t} + \epsilon_{i,t} \\ z_{i,t} &= \rho z_{i,t-1} + \eta_{i,t} \end{aligned} \tag{8}$$

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

The stochastic income process is summarized in the education-specific parameters $\{\rho, \sigma_\eta^2, \sigma_\epsilon^2\}$. We estimate them by matching the variances and serial correlations of income implied by the above two equations with those

[14] Note this is not the college premium, but the difference in income between the high education group with at least a high school diploma and the low education group without.

Figure 2: Age Profiles of Income



The figure shows the average profiles of income by educational attainment, controlling for year effect, region of residence, gender of household, and the urban dummy. Income levels are re-scaled so that in each panel the average of the two education groups is one.

calculated from the data, as detailed in Yu and Zhu (2013). Table 2 reports the estimates for both China based on the CNHS and the US based on the PSID.

Table 2: Stochastic Income Processes

	China pre-2000			China post-2000			US		
Schooling	ρ	σ_η^2	σ_ϵ^2	ρ	σ_η^2	σ_ϵ^2	ρ	σ_η^2	σ_ϵ^2
<12	0.736	0.124	0.382	0.844	0.134	0.329	0.962	0.017	0.108
	(0.022)	(0.023)	(0.034)	(0.011)	(0.015)	(0.031)	(0.008)	(0.003)	(0.022)
≥12	0.708	0.059	0.235	0.832	0.076	0.204	0.955	0.023	0.052
	(0.043)	(0.028)	(0.048)	(0.018)	(0.012)	(0.026)	(0.004)	(0.003)	(0.010)

The table reports stochastic income processes based on the CHNS (1989-2011) for China and the PSID (1989-2009) for the US.

After labor market reform in China, income shocks are more persistent and the variances of persistent shocks are larger, which is evident in Table 2. There are two notable between-country differences. First, the variances of both persistent and transitory income shocks are much larger in China than in the US. Second, income shocks are less persistent in China relative to the US. Overall households in China face much riskier income than in the US.[15]

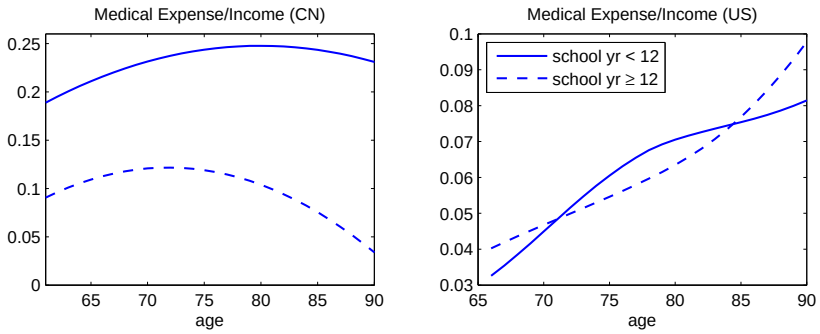
4.2.2 Medical Expenses and Mortality

For China, data on out-of-pocket medical expenses are extracted from the China Health and Retirement Longitudinal Study (CHARLS). We use the 2011 and 2013 waves of the survey to estimate the deterministic and stochastic medical expense processes. More details about the data and sample selection are provided in Appendix A.3.

For each education group, we regress the ratio of out-of-pocket medical expenses to income on a quadratic

[15]The persistent component of income shocks ($z_{i,t}$) is more variable in China in terms of the unconditional variance of $z_{i,t}$ which is $\sigma_z^2 = \frac{1}{(1-\rho)^2}\sigma_\eta^2$. For the less educated group, values of ρ and σ_η^2 in Table 2 imply unconditional variances of 0.68 in China and 0.48 in the US. For the more educated group, the unconditional variances are about the same: 0.50 for China and 0.51 for the US.

Figure 3: Post-Retirement Medical Expenses Relative to Income



The figure shows the average post-retirement profiles of out-of-pocket medical expenses relative to income by educational attainment, based on CHARLS (2011 and 2013) for China and HRS (1996-2008) for the US.

Table 3: Stochastic Medical Expense Processes

	China			US		
	ρ	var(η)	var(ϵ)	ρ	var(η)	var(ϵ)
Overall	0.978	0.077	1.875	0.922	0.0503	0.665
	(0.034)	(0.053)	(0.133)			
Schooling<12	0.987	0.058	1.904			
	(0.029)	(0.038)	(0.134)			
Schooling≥12	0.954	0.107	1.825			
	(0.086)	(0.141)	(0.281)			

The table shows the stochastic processes of out-of-pocket medical expenses, based on CHARLS (2011 and 2013) for China and HRS (1996-2008) for the US.

function of age. The left panel of Figure 3 shows the predicted profiles for China. Clearly, relative to their income, less educated households are subject to higher out-of-pocket medical expenses in China, which is in sharp contrast with the US profiles based on the Health and Retirement Study (HRS) between 1996-2008, shown in the right panel. Also compared with the US households, the out-of-pocket medical expense in China has much flatter age profiles, but the average levels are higher, especially for the less educated group.

The stochastic process of out-of-pocket medical expense is estimated with the same procedure used for the income process. These results are presented in Table 3. 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.

Another exogenous input in the structural model is the age-dependent death probability. For China the death probability is obtained from the mortality table based on the 2010 census, available at `http://www.stats.gov.cn/tjsj/pcsj/rkpc/6rp/html/A0604a.htm`. For the US it is estimated from the HRS with the same estimation procedure as in DeNardi, French, and Jones (2010). The between-country difference is small, which is partly reflected in the average life expectancy of 76.1 in China and 79.3 in the US as calculated by the World Health

Organization. We use the same death probability for different education group in each country.[16]

4.2.3 Asset Returns

Returns on stocks and bonds, both in real terms, are calculated directly from the data. Details on data sources and calculation methods are presented in Appendix A.3.1.

Real stock returns include dividends and capital gains. The mean stock return in China is 10.07% with a standard deviation of 0.47. The high mean return and high standard deviation are consistent with the findings in Fang, Gu, Xiong, and Zhou (2015) that reports the mean and standard deviation of stock return to be 7.3% and 0.515 respectively between 2003-2013.

Bonds in our model are a composite of housing and the traditional low-risk liquid assets such as bank deposits and treasury bills. Housing is bond-like as an asset since its return has a very small standard deviation.[17] The real return on the traditional low-risk assets is 1.8%, and the average return on housing is 6.28%. In our 2011 CHFS sample, housing accounts for 81.5% of the sum of housing and the traditional low-risk assets. Therefore we put a weight of 0.815 on housing and a weight of 0.185 on the traditional low-risk assets to reach a return of 5.45% for the composite bond.

In comparison, in the US the average stock return is 6.33% and the standard deviation is 0.155 based on Robert Shiller's online data on the $S\&P500$ for the 1947-2007 period. As discussed in Cooper and Zhu (2016), in the US the return on similarly defined composite bond is 4.08%. The Sharpe ratio based on our definition of riskfree composite bond is 0.145 in the US and 0.091 in China.[18] Therefore the risk-adjusted return is much higher in the US stock market.

Since there is no active housing market prior to the regime change in 2000, we set the return on the composite bond to 1.8% which is the return on the traditional low-risk assets.

4.3 Moments

China: Data moments for China are summarized in the top panel of Table 4. The "young cohort" and "old cohort" refer to the two cohorts aged 35-45 and 60-70 in the 2011 CHFS as illustrated in Figure 1. The moments are obtained by regressing the elements of household financial decisions on the dummies of the following four cohort-education pairs: young with low education, young with high education, old with low education, and old with high education, controlling for housing effects.[19] The omitted group represents households of any educational attainment in neither the 35-45 or 60-70 cohort. Using the simulated data which also contain cohort effects, we run the same regression to obtain the model moments.

[16] Using a similar model Cooper and Zhu (2016) finds that education-specific mortality has only marginal effects on household finance moments.

[17] Fang, Gu, Xiong, and Zhou (2015) reports a standard deviation of housing return of 0.075 for smaller and median-sized cities between 2003-2013.

[18] Excluding housing from the bond return, the Sharpe ratio is about 0.30 for the US and 0.16 for China.

[19] The presence of an unmarried son is also a significant regressor and its effect on wealth accumulation is consistent with Wei and Zhang (2011)), but it does not influence the moments we match.

Table 4: Data and Model Moments for China

		Young Cohort		Old Cohort	
	const.	low-edu	high-edu	low-edu	high-edu
Data					
part.	0.120	−0.059	0.206	−0.059	0.100
	(0.022)	(0.010)	(0.012)	(0.011)	(0.021)
share(h)	0.124	−0.002	0.009	−0.038	0.048
	(0.023)	(0.023)	(0.014)	(0.026)	(0.025)
W/I(h)	12.478	−1.869	4.444	1.967	5.285
	(2.146)	(1.109)	(1.307)	(1.200)	(2.212)
Model					
part.	0.118	-0.064	0.204	-0.080	0.088
share(h)	0.094	-0.001	-0.022	-0.029	-0.009
W/I(h)	6.949	0.377	1.600	2.769	4.777

Data moments (with standard errors) and model moments. Housing is included as part of the risk-free bond.

Our optimization model does not include a home ownership choice although it influences portfolio decisions as shown in Cocco (2005) and Yao and Zhang (2005). Therefore in obtaining the moments related to stock market participation, we include in the regression two housing related variables: a home ownership dummy and the logarithm of home equity value. By controlling for these variables the data moments are purged of their effects, hence are comparable with the model moments. The effects of home ownership and home equity on participation are reported in Table 10 in Appendix A.2 for both China (based on CHFS) and the US (based on SCF).[20] The role of housing as a component of wealth is captured in the moments related to stock share and wealth-to-income ratio, since we include housing wealth in the composite bond.

US: Following Cooper and Zhu (2016), we regress each of the three household financial decisions on a constant, age, age-squared, an education dummy, and year dummies.[21] For the participation decision, the regression also includes a home ownership dummy and the logarithm of housing equity. Table 5 summarizes the data moments obtained from the regressions and used in the estimation of the parameters for the US economy.

4.4 Estimation Results

Table 6 presents parameter estimates for both China and the US. For China, the estimated discount factor of 0.877 for the low education group is considerably lower than 0.959 for the high education group. For the US the discount factor is also higher for the high education group, though this difference is not statistically significant. Importantly, the discount factors for China are much higher than for the US.

The estimated risk aversion is $\gamma = 7.395$ for China which is higher than γ=6.469 for the US, though the difference

[20] For both countries, home ownership is negatively correlated with stock market participation, but home equity is positively correlated with it. The effects of home ownership and home equity on stock share in total wealth are statistically insignificant. These results are consistent with Chetty, Sndor, and Szeidl (2017).

[21] Figure 5 in Appendix A.4 plots the predicted lifecycle profiles by educational attainment for the US households.

Table 5: Data and Model Moments for the US

		const.	*age*	age^2	*edu*	
part.	**data**	-0.116	0.016	-0.00015	0.267	
	(s.e.)	(0.073)	(0.001)	(0.00001)	(0.010)	
	model	-0.312	0.015	-0.00016	0.274	
share(h)	**data**	-0.113	0.013	-0.0001	0.115	
	(s.e.)	(0.074)	(0.001)	(0.00001)	(0.015)	
	model	0.044	0.011	-0.0001	0.118	
		const.	*age*	age^2	$age \times edu$	$age^2 \times edu$
W/I(h)	**data**	1.733	-0.045	0.00088	-0.01	0.00038
	(s.e.)	(0.407)	(0.008)	(0.00008)	(0.004)	(0.00007)
	model	0.379	-0.045	0.00094	0.002	0.00027

This table reports US household finance moments (regression coefficients) from the data and the model. "edu" stands for the dummy for high education households. For the regression of wealth-to-income ratio, the education dummy is interacted with age and age-squared.

is not statistically significant due to the relative large standard errors of the two estimates.[22] For neither country is $1/\gamma$ close to θ, so the traditional CRRA preference specification is rejected. The estimated bequest motives for China and the US are fairly close to each other.[23]

The estimated EIS for China is $\theta = 0.493$, significantly lower than the $\theta = 0.893$ for the US. The small estimate for China is partly driven by the small gap in the wealth-to-income ratio between education groups. As shown in the counterfactual experiments reported in Table 8, imposing a larger EIS on China widens this gap by lowering ratios of the low education group and raising ratios of the high education group. Intuitively, income of the low education group falls quickly after middle age, and given a higher EIS, they care less about low consumption in the old age hence accumulate less wealth. On the other hand, for the high education households who have a larger β and a relatively steeper income profile, a larger EIS induces them to sacrifice more consumption in the young age and accumulate more wealth.

The consumption floor is reported as a fraction of average household income in a country. The estimated floor is 7.9 percent in China or about 736 Yuan. The estimated consumption floor in the US is 26.4 percent, about 3.3 time larger than that in China. Considering the income disparity between China and the US, the gap in consumption floors is even larger in dollar value.

The estimated cost of stock market participation is very high in China: 25.5% of the average income. The high entry cost is needed to match the relatively low stock market participation rate in China. The cost is considerably higher than the US estimate of 0.028, i.e. 2.8% of the average US household income. Using an average disposable household income of \$85 thousand for the US and \$9.3 thousand in China, the participation cost is estimated at \$2,380 in the US and \$2,375 in China, hence the costs are about the same in terms of dollar values.[24] The estimated

[22]The estimates of γ of the two countries can be assumed to be independently and normally distributed, thus their difference has a standard deviation of $\sqrt{0.654^2 + 0.241^2} = 0.697$, and the t-stat of the difference is $(7.395 - 6.469)/0.697 = 1.33$.

[23]The bequest motive is identified through the size of wealth at old age which could be driven by purely altruism or selfish preferences. Horioka (2014) finds that bequests of the US households appear to be more consistent with altruistic preferences while those of the Chinese households appear to be more consistent with selfish preferences.

[24]The average household income in China is calculated from our sample of the 2011 CHFS which is 58,021 RMB, or about 9,313 USD using the exchange rate at the end of 2011. For the US, the 2010 wave of SCF shows that the mean and the median family income are

adjustment cost of 0.051 in China is also significantly higher than the cost of 0.016 in the US, but it is actually smaller in dollar terms.

Table 14 in Appendix C reports the elasticities of the simulated moments with respect to parameter values. Obviously moments associated with stock market participation and stock share are very sensitive to stock adjustment cost F, which explains why F is estimated precisely with a small standard error. The wealth-to-income ratio moments are sensitive to the discount factors and the consumption floor.

Table 6: Parameter Estimates

	β_1	β_2	Γ	F	γ	θ	$\underline{c}$	L	$\pounds$
China	0.877	0.959	0.255	0.051	7.395	0.493	0.079	1.877	32.46
	(0.017)	(0.004)	(0.040)	(0.009)	(0.654)	(0.019)	(0.032)	(0.459)	
US	0.824	0.842	0.028	0.016	6.469	0.893	0.264	1.960	43.98
	(0.007)	(0.004)	(0.008)	(0.003)	(0.241)	(0.058)	(0.063)	(0.563)	

Estimated parameter values for China and the US. β_i for $i = 1, 2$ refers to the low and high education groups. $\pounds$ is the difference between model moments and data moments as described in equation (7).

The simulated moments for China are reported in Table 4. The model matches the participation moments quite well, capturing both the effects of education and cohort. The dependence of stock share on both cohort and education is relatively small in the data, and so is in the model. The model is unable to adequately capture the level of the wealth-to-income ratio which is the constant term in the regression, partly because this data moment has a large standard error so the minimization procedure puts less weight on it. The model does succeed in matching the higher wealth-to-income ratio for both the older and more educated households.

The simulated moments for the US are reported in Table 5. The estimated model captures the effects of age and education on participation, share and wealth-to-income ratio fairly well. The constants from the regressions are less well-fit, again because these moments have large standard errors.

4.5 Impact of Regime Changes

Since we incorporate regime changes into the structural model, we are able to quantitatively examine the effects of regime changes on household finance patterns. Table 7 compares household finance moments from the baseline model with moments from the counterfactual experiment in which each household lives in the completely new regime without experiencing the regime changes illustrated in Figure 1. Differences in moments are precisely the cohort effects caused by these regime changes.

Overall the impacts of regimes changes are economically significant. As shown in the table, without these regimes changes households in China would have higher stock market participation rates, higher stock shares and higher wealth-to-income ratios. This is true for each age and education group, but the older and more educated households are subject to stronger cohort effects. For example, their participation rate would be 50.7% in the absence of cohort effects, compared with 20.5% in the presence of cohort effects. The higher wealth-to-income ratios indicate that households would have even higher savings rate in the completely new regime.

about $80 thousand and $50 thousand respectively.

Table 7: Regime Changes and Household Finance

	Young Cohort		Old Cohort		Distance (w.r.t. baseline)	p-value	Total Distance
	low-edu	high-edu	low-edu	high-edu			
Baseline Model (with cohort effect)							
part.	0.054	0.321	0.037	0.205			
share	0.093	0.071	0.065	0.085			
W/I	7.326	8.549	9.718	11.72			
Completely New Regime (w/o cohort effects)							
part.	0.088	0.329	0.071	0.507	228	(0.00)	259
share	0.097	0.135	0.080	0.121	23.3	(0.00)	(p=0.00)
W/I	7.961	11.43	10.41	15.07	7.77	(0.10)	

This table compares moments from the baseline model with cohort effects with moments from the counterfactual experiment without cohort effects. The distance is calculated using equation (9). The total distance is the sum of distances in participation, stock share, and W/I. The p-value shows the probability that the realized distance is even larger than the calculated distance under the null that the counterfactual model is identical to the baseline model.

More details about how each individual regime change impacts household financial choices are reported in Appendix D. There it is clear that the higher wealth-to-income ratio in the new regime is mainly driven by the riskier income processes and the higher return on housing investment. In particular, the change of return on housing has a sizable effect. The higher wealth level after regime changes diminishes the per unit stock market entry and adjustment costs, leading to the higher participation rates and stock shares in total wealth.

Table 7 also reports the distances between the counterfactual moments and the baseline moments, pertaining to participation, stock share, wealth-to-income ratio, respectively. The distance is calculated as

$$Distance = \sum_{i=1}^{n} \left(\frac{M^i_{baseline} - M^i_{counterfactual}}{\sigma^i_M} \right)^2, \tag{9}$$

where $n = 4$ is total number of moments. $M^i_{baseline}$ is the i^{th} moment from the baseline model and $M^i_{counterfactual}$ is similarly defined, and σ^i_M is the standard error of this moment calculated from the data. "Total distance" in the last column is the simple sum of the three types of distance.

The p-values of the distances show the probability that the realized distances are even larger than these calculated distances under the null that the counterfactual model is identical to the baseline.[25] As they indicate, both stock market participation rates and stock shares are significantly impacted by the regimes changes statistically. The impacts on wealth-to-income are also statistically significant at 10% level.

Given the significant impacts of regimes changes, we refer to household finance moments from the completely new regime as "China benchmark moments" in the counterfactual experiments presented below. The China benchmark moments are purged of the cohort effects, thus are more comparable with moments in the US, and more relevant to our analysis of how China may evolve in terms of household finance patterns.

[25] Under the null that the difference $M^i_{baseline} - M^i_{counterfactual}$ follows a normal distribution with a zero mean, then the distance in (9) is a random variable (denoted x) that follows a Chi-square distribution with n degrees of freedom. This allows us to calculate the p-values defined as $Pr(x > Distance)$ which is the probability that the realization of x is even larger than the reported distance.

4.6 Robustness

The estimation results above for China are quite robust to alternative specifications. We re-estimate the model using the identity weighting matrix, alternative stock return processes, alternative bond return, and alternative deterministic income. The resulting parameter estimates are quantitatively similarly to those from the baseline estimation, and the model moments all exhibit the same patterns as in the data. Details on these alternative specifications and results are reported in Appendix E.

Thus far the estimation has exploited variations in household financial choices by educational attainment. Household finance patterns in China also differ by sector of employment (i.e. state versus non-state sectors) and by rural-urban status as shown in Table 13 in Appendix B. We also re-estimate the model using these variations and report results in Appendix E. Since there is a strong correlation between educational attainment and sector of employment or rural-urban status which is shown in Table 12, it is not surprising to see that parameter estimates are all very close to the baseline estimation.

Finally our analysis assumes there is no cost of adjusting the composite bond which includes housing. In reality households frequently adjust their liquid assets due to various random shocks (e.g. income shocks and medical expense shocks) on the one hand, and they only adjust the holdings of housing asset occasionally on the other hand. Our assumption of costless bond adjustment could be too restrictive if the model-implied bond adjustment exceeds the holdings of liquid assets observed in the actual data. As we show in Appendix E, since the holdings of liquid asset in the CHFS data are sufficient for households in the model to buffer against income and medical expense shocks, the model assumption that bonds can be adjusted without costs is not restrictive in the savings decisions.

5 Interaction Between Wealth and Portfolio Composition

One contribution of our analysis is to go beyond the traditional focus on the Chinese savings rate to highlight the role of stock market participation and portfolio composition. Here we demonstrate the richness of their interaction as it helps to understand the factors leading to the high savings rate in China.

Our approach is to sequentially change model parameters and examine the simulated moments. From this we gain insights into the interaction between savings decision and portfolio choice. Given our emphasis on China vs the US, we impose parameters from the US economy for the exogenous changes. Results with more significant changes in moments are presented in Table 8. Full results for each parameter appear in Appendix F.

Our experiments demonstrate that the level of savings and thus wealth accumulation strongly affects portfolio composition. This is seen as we change the discount factors. As the table shows, imposing the smaller US discount factors cause the wealth-to-income ratios to fall by 33-66% for different groups of households. Stock market participation rates become near zero, and stock share in wealth falls tremendously for those who remain in the market. The reason is intuitive: wealthier households have lower per unit costs of stock market participation and adjustment.

Table 8: US Parameters on Chinese Households (Without Cohort Effect)

		Young		Old		Distance	$Total_{distance}$	Distance	$Total_{distance}$
	edu	low	high	low	high	(w.r.t. CN)		(w.r.t. US data)	
US Data	part.	0.164	0.518	0.230	0.705				
	share	0.240	0.376	0.221	0.371				
	W/I	0.919	1.839	4.028	8.053				
CN Benchmark	part.	0.088	0.329	0.071	0.507	0	0	603	1198
(w/o cohort effect)	share	0.097	0.135	0.080	0.121	0	(1.0)	463	(0.0)
	W/I	7.961	11.43	10.41	15.07	0		132	
US parameter		CN Simulation							
β (discount)	part.	0.011	0.001	0.020	0.006	1399	1501	3563	4311
	share	0.083	0.077	0.060	0.032	31.06	(0.0)	725	(0.0)
	W/I	5.269	3.749	6.438	5.091	71.43		23	
θ (EIS)	part.	0.035	0.527	0.032	0.932	721	741	607	1162
	share	0.090	0.146	0.073	0.195	9.55	(0.0)	394	(0.0)
	W/I	6.565	13.860	9.742	19.750	9.82		161	
Γ (entry cost)	part.	0.412	0.820	0.113	0.626	2775	2792	1381	2158
	share	0.049	0.087	0.083	0.104	16.93	(0.0)	638	(0.0)
	W/I	8.090	11.772	10.537	15.202	0.10		139	
F (adj. cost)	part.	0.110	0.355	0.168	0.870	387	391	306	971
	share	0.087	0.128	0.049	0.086	3.78	(0.0)	352	(0.0)
	W/I	7.976	11.458	10.489	15.184	0.008		133	
Stock Return	part.	0.085	0.354	0.114	0.736	138.3	247	361	660
	share	0.196	0.228	0.198	0.241	106.2	(0.0)	143	(0.0)
	W/I	8.054	12.094	10.964	18.040	2.28		156	
$\underline{c}$ (cons. floor)	part.	0.071	0.319	0.036	0.473	16.33	25	1347	1900
	share	0.098	0.136	0.097	0.119	0.41	(0.01)	457	(0.0)
	W/I	6.830	11.238	7.291	14.715	7.78		96	
Stochastic Income	part.	0.000	0.247	0.001	0.305	256	326	1570	2058
	share	0.000	0.160	0.054	0.165	24.91	(0.0)	455	(0.0)
	W/I	2.616	8.213	5.905	12.189	44.79		32	

This table reports counterfactuals from imposing US parameters (one at a time) on the Chinese model, controlling for cohort effects. The CN benchmark are simulated from the completely new regime. The US data moments are taken from the SCF data between 1989-2007. The distance is calculated using equation (9). The total distance is the sum of distances in participation, stock share, and W/I. The p-value shows the probability that the realized distance is even larger than the calculated distance.

Similarly, when the US θ is imposed on the Chinese economy, wealth-to-income ratios are lowered for the less educated households but raised for the more educated. Consequently, the former allocates less wealth to the stock market while the latter chooses to have more stock investment. Note that with the larger θ, households are more willing to substitute inter-temporally, hence the lifecycle profile of wealth track income more closely. For the more educated Chinese, the decline of income occurs later and to a less extent as shown in Figure 2, hence their wealth-to-income ratio is raised by a larger θ. Conversely, wealth-to-income ratio of the less educated are lowered by the larger θ.

Our results also highlight a situation where some factors impact asset market participation and portfolio composition with relatively little affect on savings and wealth accumulation. Reducing the stock market entry cost Γ to the US level, participation rates rise by 23-369%, but this institutional improvement generates only a 1-3% increase

in wealth-to-income ratios. Lowering the stock adjustment cost F to the US level also leads to significantly higher participation rates, but it causes only a 0.2-0.8% increase in wealth-to-income ratios.[26] Imposing the US stock return process causes participants to hold significantly higher stock shares, but this again generates only modestly higher wealth-to-income ratios.

The underdevelopment of asset market in China is partially captured in our model by the high costs associated with stock market participation and stock adjustment, as well as the high variability of stock returns. The above experiments indicate that they lead to less (not more) wealth accumulation, and the effects are quite small, thus they do not contribute to the high savings rate in China.[27]

6 China vs the US: How May China Evolve?

This section turns to one of the central questions of the paper: how will household finance patterns in China evolve as the country further develops? Our model neatly distinguishes institutions, i.e. labor and financial markets, from preferences and thus provides an ideal framework to answer this question. As China develops, it is natural to think that institutions will evolve to be similar to those in the US. But differences in preferences are less likely to change over time. Thus we conduct experiments in which China adopts the US institutions partially or fully, and compare the simulated moments with the US data moments as well as the China benchmark moments.[28]

6.1 China-US Disparity

We have discussed the large between-country differences in parameters pertaining to both preferences and institutions. This subsection studies the mapping between these differences and the disparity in household finance patterns. This is done by checking the distance between the US data moments and the simulated moments in China, as reported in the last two columns of Table 8.

As shown in the table, the benchmark distance, i.e. the total distance between China benchmark moments and the US data moments, is 1198. Imposing the US stock return process, the total distance is lowered to 660. Thus a large portion of the US-China disparity is attributable to the high risks and the low Sharpe ratio in the Chinese stock market. Imposing the US stock adjustment cost also lowers the total distance, from 1198 to 971. A closer look at the breakdowns of total distances reveals that these two experiments bring the portfolio composition in China significantly closer to the US, but they barely change the disparity in wealth-to-income ratios.

Imposing the US stock market entry cost increases the overall US-China disparity in household finance moments: the total distance is 2158 which is much larger than the benchmark distance. The larger overall distance is mainly because of the larger distance pertaining to participation rates. The low US entry cost along with the massive

[26] As shown in Table 8, lowering adjustment cost does not necessarily increase stock share conditional on participation, because it causes the participation of relatively poor households who keep a low stock share.

[27] Recall that we impose $\underline{A}_b = 0$ in the model. Chamon and Prasad (2010) shows that borrowing constraint, a form of financial underdevelopment, contributes to the high savings rate in China.

[28] As we emphasized in Section 4.5, the China benchmark moments are simulated from an environment without regime changes.

wealth accumulation in China causes the stock market participation rate in China to be even higher than in the US on average.

The much higher wealth-to-income ratio in China relative to the US is attributable to the risky labor income and the more patience of Chinese households. Imposing the US stochastic labor income processes or the US discounter factors, the distance of wealth-to-income ratio falls from 132 to 32 and 23, respectively. But stock market participation rate is also lowered, which widens the overall distance between China and the US. Similarly, imposing the more generous US consumption floor on China, wealth-to-income ratio in China falls and becomes closer to the US ratio, but the between-country gap in stock market participation rate is widened.

From these experiments we draw two conclusions. First, the China-US disparity in portfolio composition is largely driven by the larger stock adjustment cost and the lower Sharpe ratio in China. Second, the disparity in wealth accumulation is mainly driven by the larger discount factors, the riskier income processes and the lower consumption floor in China.

6.2 Looking Forward

Over time, we expect some convergence of China towards the US. This is likely to happen in the labor and financial markets but not in preferences. Here we explore the implications of this convergence on household finance patterns.

6.2.1 The US Labor Market

Suppose China develops a labor market identical to the one in the US, including the labor income processes, the medical expense processes, and the social insurance as captured by the consumption floor.[29] The resulting simulated moments are reported in the block labeled "US labor MKT" of Table 9.

Comparing these new moments with the China benchmark moments labeled "CN Benchmark" in the table, it is clear that this institutional change dramatically reduces stock market participation rates, stock shares in total wealth and wealth-to-income ratios in China. Intuitive the results come from the reduced labor market risks as captured by the less variable income and medical expenses, and the larger consumption floor.

Next, the new moments in China are compared with household finance patterns found in the SCF data in the US shown in the top block of the table. Obviously wealth-income ratios in China is still higher than in the US, indicating higher savings rate in China. The last column of Table 9 reports the distance between the simulated moments in China and the US data moments. As shown in the table, the benchmark distance pertaining to wealth-to-income ratio is 132. Adopting the US labor market, the distance is reduced to 13. However, with the US labor market in China, the distance pertaining to participation rises from 603 (benchmark) to 2279, and the distance of stock share also rises significantly.

In conclusion, with the adoption of the US labor market, Chinese households are predicted to save less, but the savings rate is still significantly higher than their US counterparts. In addition, they will allocate less savings to

[29] This is equivalent to the situation where a Chinese household work full time in the US but invest its savings in the Chinese financial market.

Table 9: China-US Comparison

	Pre-retirement		Post-retirement		Distance
	low-edu	high-edu	low-edu	high-edu	(to US data)
	US Data				
part	0.164	0.518	0.230	0.705	
share	0.240	0.376	0.221	0.371	
W/I	0.919	1.839	4.028	8.053	
	China Simulation				
CN Benchmark, w/o cohort effect					
part	0.088	0.329	0.071	0.507	603
share	0.097	0.135	0.080	0.121	463
W/I	7.961	11.43	10.41	15.07	132
Imposing US Institutions					
	US labor MKT				
part	0.000	0.137	0.000	0.206	2,279
share	0.000	0.103	0.000	0.134	649
W/I	1.750	6.265	3.140	9.992	13
	US financial MKT				
part	0.913	1.000	0.709	0.995	9,316
share	0.253	0.267	0.172	0.192	116
W/I	7.629	12.05	10.04	16.18	136
	US financial and labor MKTs				
part	0.446	0.940	0.268	0.941	2,173
share	0.411	0.358	0.199	0.203	103
W/I	1.456	6.239	2.593	10.43	14
Imposing US preferences					
part	0.000	0.000	0.000	0.001	3,692
share	0.000	0.000	0.000	0.035	1,083
W/I	3.333	2.418	3.278	4.276	8

This table reports the US data moments and simulated moments in China. The distance is calculated based on equation (9) using the US data moments as the baseline. Preference parameters include discount factors (β's), risk aversion (γ), EIS (θ), and bequest motive (L). The financial market is characterized by its stock market entry cost (Γ), stock adjustment cost (F), return on bond, and the stochastic process of stock return. The labor market is characterized by its consumption floor ($\underline{c}$), income processes and medical expense processes.

the stock market, hence further lower the stock market participation rate and stock share in total wealth.

6.2.2 The US Financial Market

Now suppose China develops a financial market identical to the one in the US, featuring low stock market entry and adjustment costs and a high Sharpe Ratio, which is equivalent to the situation of Chinese households investing in the US financial market while working in China. Here we assume the stock market entry and adjustment costs are relative to the average income in China rather than in the US since we interpret them as time costs.[30]

As shown in Table 9, the stock market participation rates are close to 100% for the more educated households.

[30]The literature generally interprets the costs as information and time costs rather than direct monetary costs. See Bonaparte, Cooper, and Zhu (2012) and Vissing-Jorgensen (2002) for examples.

The participation rates are considerably higher than in the US. The wealth-to-income ratios in China are also much higher than in the US, especially for the young households. Intuitively, households accumulate massive wealth because of their large discount factors and strong precautionary motives caused by the highly variable income and the small consumption floor. Such wealth levels make the low costs in the US financial market negligible, leading to the extremely high participation rates. Stock shares conditional on participation are still lower in China than in the US, but they are much higher than the shares observed in the China benchmark moments.

Compared with the China benchmark moments, the adoption of US financial market brings the distance pertaining to stock shares from 463 down to 116. However, the distance pertaining to participation rises from 603 to 9316. This mis-fit is largely due to the excessively high participation rate. The distance of wealth-to-income ratio is changed only marginally.

6.2.3 The US Labor Market and Financial Market

Suppose China develops the US institutions in terms of both the financial market and the labor market, the resulting household finance patterns are reported in the block labeled "US financial and labor MKTs". The stock market participation rate and wealth-to-income ratio are again significantly higher than in the US. But they are lower than the case where China only adopts the US financial market. This is because households in the latter case are subject to more labor market uncertainty and face a low consumption floor, hence need more precautionary savings.

Given the full institutional convergence assumed in this experiment, we have much smaller distances pertaining to wealth-to-income ratio and to stock share in total wealth. In particular the stock share in China on average becomes fairly close to the US data. However since households in China participate in the stock market much more than the US households, the distance pertaining to participation is still very large, actually much larger than in the China benchmark model.

Overall the disparity in moments remains fairly large, even with the full convergence in institutions. This reflects differences in preferences. In particular, as we have shown earlier, the large discount factors in China are a major contributor of the high savings rate.

6.3 Preferences

To gauge the importance of preferences, we conduct the experiment of imposing US preference parameters (i.e. β's, γ, θ and L) on China without changing the Chinese institutions. The simulated moments are reported in the last block of Table 9. Wealth-to-income ratios become much closer to the US data, with the distance lowered from 132 to 8. So indeed preferences explain a large portion of the US-China disparity in savings and wealth accumulation. Not surprisingly, stock market participation rate and stock share are near zero in this case, due to the low level of wealth, the large labor market risks, and the underdeveloped asset market.

7 Conclusions

This paper studies the savings and portfolio choice of the Chinese households by estimating and simulating a lifecycle optimization model. The estimation controls for cohort effects by explicitly taking regime changes in China into the structural model. The model is able to quantitatively capture key household finance patterns in China, as well as in the US to which we assume China may converge institutionally.

The joint study of savings and portfolio choice uncovers interesting interactions. On one hand, a higher wealth level is associated with more stock investment since the cost per unit of participation and adjustment are lower for wealthier households. On the other hand, exogenous changes to asset market conditions do not significantly change wealth-to-income ratios, despite their huge impacts on portfolio composition.

The paper shows that history matters, and the major regime changes in China have impacted household savings and portfolio choice. The impacts are more pronounced for the older and more educated households. Without the regime changes, the Chinese households would have even higher wealth-to-income ratios, and the stock market participation rates and stock shares would also be significantly higher.

An important point of the analysis is to understand why household finance patterns differ between China and the US. For both countries, we identify both preference parameters and institutional parameters. We find that households in China are significantly more patient, which contributes to the higher wealth-to-income ratio in China. Institutional differences are also important. Labor market in China features more variable income and a low consumption floor, leading to stronger precautionary saving motives hence the high wealth-to-income ratio. Asset market in China features a low Sharpe ratio and high costs associated with stock investment, which leads to the low stock market participation rate and low stock share in total wealth in China.

Looking forward, if China adopts the US labor market, the average wealth-to-income ratio will be lowered by more than 50% due to the reduced labor market risks. Alternatively, if China adopts the US financial market but preserves its own labor market features, then households still keeps a massive stock of precautionary savings. In addition, about 90% of the households will participate in the stock market, and the stock share will rise significantly. Further, if China converges to the US in terms of both the labor market and the financial market, then the stock share in China will be fairly close to the US data. The wealth-to-income ratio will be lowered, but still 73% higher than in the US data. Thus, even with the US institutions, the high savings rate in China is likely to continue unless the preferences change.

As it stands, the study omits 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 the 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.

Finally, the effects of home ownership status and home equity are clearly present, as seen in Table 10. These effects have not been the focus of our analysis. An extended model that includes the choice of home ownership and equity with appropriate transaction costs is an obvious next step.

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Appendices

A Data Appendix

A.1 CHFS data

Household finance patterns in China come from the 2011 wave of China Household Financial Survey (CHFS). The CHFS is conducted by the Survey and Research Center of China Household Finance, Southwestern University

of Finance and Economics, Chengdu, China. Detailed information about the CHFS is available at `http://www.chfsdata.org/`. Gan, Yin, Jia, Xu, Ma, and Zheng (2013) provides a comprehensive description of the survey and some key statistics found in the survey.

For each household in the sample, the CHFS identifies a respondent which is defined as the member who knows the best about a household's financial situation. For 86.22% of the households in the survey, the respondents and their spouses make decisions regarding stock market investment according to question [D3112]. A household is considered a stock market participant if it holds stocks either directly or indirectly through mutual funds that invest mainly in the equity market. Direct stockholding information is provided in questions [D3101] and [D3103]. Indirect holding information is obtained in answers to questions [D5104] and [D5107].

The data have some information about transfers. About 5% of the respondents live in a house that is bequeathed or transferred, although the survey does not specify where the transfers are from. The survey also has questions about two types of financial transfers: government transfer which is mainly needs-based and private transfer from parents, relatives, friends and others. These transfers are not regular income, and not included in our income measure. Among households who receive transfers, the average government transfer is 1582 Yuan and the average private transfer is 4298 Yuan.

A.2 Housing and Portfolio Choice

Table 10 shows that housing has statistically significant effects on stock market participation and stock share in financial wealth in both China and the US.

Table 10: Effects of Home Ownership and Home Equity on portfolio choice

China		Young Cohort		Old Cohort		**Homeowner**	**Home Equity**
	const.	low-edu	high-edu	low-edu	high-edu		(*logarithm*)
part.	0.120	-0.059	0.206	-0.059	0.100	-0.113	0.010
(s.e.)	(0.022)	(0.010)	(0.012)	(0.011)	(0.021)	(0.014)	(0.001)
share	0.503	-0.041	0.024	0.029	0.036	-0.013	0.003
(s.e.)	(0.047)	(0.039)	(0.024)	(0.046)	(0.043)	(0.034)	(0.002)
US	const.	age	age^2	high-edu			
part.	-0.116	0.0161	-0.00015	0.267		-2.276	0.112
(s.e.)	(0.073)	(0.0012)	(0.00001)	(0.010)		(0.057)	(0.002)
share	0.275	0.0093	-0.00009	0.056		-0.144	0.007
(s.e.)	(0.071)	(0.0013)	(0.00001)	(0.014)		(0.052)	(0.002)

This table reports coefficients from regressing portfolio decisions on age and education dummies, the home ownership dummy and logarithm of home equity, based on the CHFS 2011 for China and the SCF between 1989-2007 for the US. Here "share" is the share of stocks in financial wealth.

A.3 Data for Exogenous Processes in China

A.3.1 Stock and Bond Returns

Stock Returns: Stock return process 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. We calculate the real returns based on quarterly data, then compound them into annual returns. Between March 1994 - March 2016, the annualized mean return is 10.07% with a standard deviation of 0.47. These statistics are used in the baseline model. 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% with a standard deviation of 0.492. Consistent with findings in the US market, we cannot reject the hypothesis that annual stock return follows an i.i.d. process in China.

Bond Returns: We combine the traditional low-risk asset and housing, and call the composite asset bond. We categorize housing as a low-risk asset since the standard deviation of housing return is only 0.075 for smaller and median-sized cities according to Fang, Gu, Xiong, and Zhou (2015). The traditional low-risk assets include cash, current deposits (checking account), fixed deposits (CDs), WMPs, treasury bills, corporate bonds, investment trust, non-RMB asset, and cash lent to friends and relatives.

Consistent with our definition of bond, bond return is the weighted average of housing return and return on traditional low-rick assets. The average annual return on 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 an real annual return of 1.75% using the data from St. Louis Fed(`https://research.stlouisfed.org/fred2`). Thus we take return on low-risk non-housing asset to be 1.8%.[31]

Wu, Gyourko, and Deng (2016) reports an average real growth rate of house prices of 6.5% per year in 35 major cities. Including an annual rental return of 2%, the real urban housing return is about 8.5%.[32] In the rural area, housing transactions are limited and real house prices rarely appreciate, thus we assume a housing return of 2.5%. In the 2011 CHFS 63% of the households are urban residents. Using this as a weight the average housing return is $8.5\% \times 0.63 + 2.5\% \times (1 - 0.63) = 6.28\%$.

In our CHFS sample, housing accounts for 81.5% of the sum of housing and the traditional low-risk assets. This ratio is 81.1% for the low education group and 80.7% for the high education group. Therefore we put a weight

[31] Another class of low-risk asset is 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%. The WMPs require a minimum level of fund so the access is limited. Perry and Weltewitz (2015) provides a nice description of WMPs in China.

[32] This low rental return is consistent with Wu, Gyourko, and Deng (2012) and Wu, Gyourko, and Deng (2016). Rent-to-price ratios are generally between 2-5%. The actual rental return is even lower once vacancies and maintenance costs are taken into account.

of 0.815 on housing and a weight of 0.185 on the traditional low-risk assets to reach a return of 5.45% for the composite bond in the baseline model.

In the robustness analysis we also consider a housing return of 11% which is the real return on housing asset in the third-tier cities in China reported in Fang, Gu, Xiong, and Zhou (2015).[33] The corresponding composite bond has a weighted average return of 9.3%. This is an artificially high return because it does not take the low housing return in the rural area into account. Nevertheless we use it to gain insights into how a lower Sharpe ratio impacts household finance moments.

A.3.2 Income Data

Income processes in this paper are estimated based on nine waves of China Health and Nutrition Survey (CHNS). CHNS is an ongoing international collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill and the Chinese Center for Disease Control and Prevention. The CHNS conducts surveys over a 3-day period using a multistage, random cluster process to draw a sample of about 4400 households with a total of 26000 individuals for each wave. The first wave of survey was conducted in 1989, followed by 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011 waves during which surveyed households were revisited.

CHNS provides detailed income information as well as a rich set of demographic variables of household members, including age, educational attainment, occupation, region of residence and sector of employment. We use these demographic variables to filter out predictable component of income. The survey consistently constructs nine categories of income for each household in each wave of survey – business, farming, fishing, gardening, livestock, non-retirement wages, retirement income, subsidies, and other income.[34] We estimate household income processes based on the sum of the nine income categories.

We select households that have valid information on income, rural-urban status, as well as the following information for household heads: age, gender, educational attainment, region of residence and sector of employment. The following are excluded: (i) households that report zero income; (ii) households whose income grow by more than 2000% between any two surveys; (iii) households whose income drop by more than 2000% between any two surveys.

An obvious effect of labor market reform in China is the gradual rise of the college premium, as shown in Figure 4 which uses the CHNS data between 1989-2011.

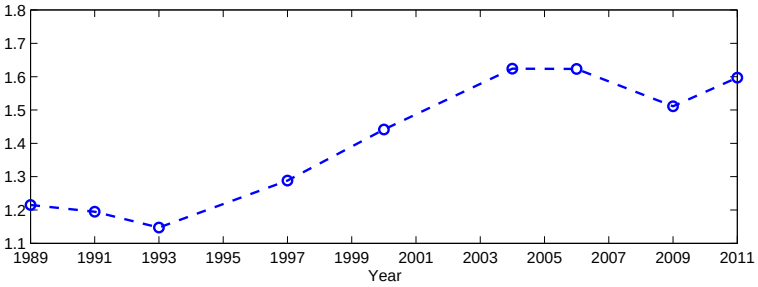
A.3.3 Medical Expense Data

For the medical expense processes, we use the 2011 and 2013 waves of the China Health and Retirement Longitudinal Study (CHARLS), available at `charls.pku.edu.cn/`. CHARLS is a longitudinal survey conducted by the National

[33] There are 85 third-tier cities in Fang, Gu, Xiong, and Zhou (2015) that are economically and politically important in their respective provinces but are not considered either first-tier (Beijing, Shanghai, Shenzhen and Guangzhou) or second-tier (autonomous municipalities, provincial capitals, or vital industrial/commercial centers). These top three-tier cities have significantly higher returns on housing.

[34] Detailed information about these household income categories are available at `http://www.cpc.unc.edu/projects/china/data/datasets/Household\%20Income\%20Variable\%20Construction.pdf`.

Figure 4: College Premium in China



The figure shows the college premium defined as the ratio of the average labor income of individuals with college education to those without college education. Data source: the China Health and Nutrition Survey between 1989-2011.

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Since 2011 the survey collects a representative sample of Chinese age 45 and older every two years. The survey data contain information on household demographics, health status, health care expenses, health insurance coverage, employment, income, consumption and assets. Similar to French and Jones (2004) which uses the Health and Retirement Study (HRS) data, total out-of-pocket medical expense is the sum of insurance premium, outpatient expense, hospitalization expense and self-treatment expense. Since CHARLS is designed on the models of HRS, These two data sources and hence the definitions of out-of-pocket medical expenses are highly comparable.

We select survey respondents that provide valid information in both waves regarding the following variables: out-of-pocket insurance premium (variable EA006), total outpatient expense (variable ED006), self-paid outpatient expense (ED007), transportation cost to medical facilities (ED015 and EE015), total treatment and medication cost (ED023), self-paid treatment and medication cost (ED024), total hospitalization cost (EE005) and the self-paid part (EE006), total self-treatment cost (EF002) and the self-paid part (EF003), total cost of dental care (EH003) and the self-paid part (EH004). We drop respondents without valid information on age, educational attainment, gender, rural versus urban status, and sector of employment.

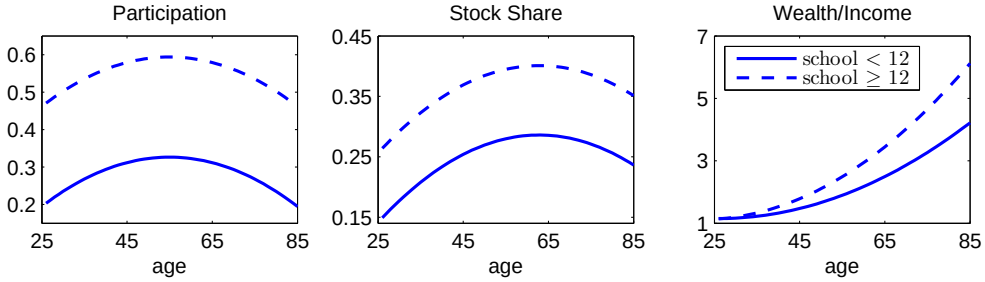
A.4 US Data

We estimate the US household finance patterns based on seven wave of Survey of Consumer Finance between 1989-2007. Definition of stock holdings are the same as in CHFS 2011. We use the same sample selection criteria as in Cooper and Zhu (2016) which studies US household finance patterns by a finer breakdown of educational attainment.

The US income processes and medical expense processes are estimated based on the Panel Study of Income Dynamics (1989-2009) and the Heath and Retirement Study (waves of 1996, 1998, 2000, 2002, 2004, 2006 and 2008). Details on these processes as well as stock return, bond return and housing return are provided in Cooper and Zhu (2016).

The predicted lifecycle profiles by educational attainment are shown in Figure 5. The wealth-to-income ratios

Figure 5: US Household Finance Profiles



These profiles show the age dependence of household financial decisions, estimated from the SCF data between 1989-2007. The stock share and wealth-to-income ratio are calculated on the basis of the broad measure of wealth that includes financial wealth and housing equity.

exhibit a rising trend even after retirement, consistent with DeNardi, French, and Jones (2010).

B Other Household Finance Patterns

Table 11 shows the difference in household finance patterns between US and China by age and educational attainment which supplements Table 1. It's noteworthy that wealth-to-income ratio rises more sharply in old age in the US than in China.

Table 11: Household Finance Facts by Education and Age

Age	25-34		35-45		46-59		60-70		71-80	
Edu	low	high	low	high	low	high	low	high	low	high
China										
part.	0.075	0.272	0.057	0.333	0.052	0.191	0.051	0.228	0.031	0.164
	(0.015)	(0.019)	(0.007)	(0.017)	(0.006)	(0.013)	(0.007)	(0.027)	(0.009)	(0.033)
share	0.368	0.453	0.460	0.525	0.542	0.534	0.534	0.538	0.502	0.505
	(0.072)	(0.025)	(0.039)	(0.019)	(0.035)	(0.022)	(0.047)	(0.040)	(0.093)	(0.056)
share(h)	0.138	0.134	0.119	0.130	0.098	0.116	0.083	0.169	0.103	0.132
	(0.041)	(0.017)	(0.020)	(0.012)	(0.017)	(0.010)	(0.013)	(0.028)	(0.043)	(0.043)
W/I	1.919	1.330	1.229	1.806	0.944	1.394	0.999	2.257	1.178	1.334
	(0.615)	(0.191)	(0.179)	(0.221)	(0.051)	(0.112)	(0.117)	(0.392)	(0.242)	(0.165)
W/I(h)	15.30	10.17	10.43	19.80	12.95	16.24	17.67	17.58	16.46	14.86
	3.454)	(1.070)	(0.831)	(1.716)	(0.501)	(0.734)	(1.389)	(1.860)	(1.900)	(2.030)
US										
part.	0.081	0.361	0.164	0.518	0.213	0.665	0.230	0.705	0.215	0.634
	(0.017)	(0.009)	(0.020)	(0.007)	(0.018)	(0.006)	(0.019)	(0.009)	(0.020)	(0.013)
share	0.509	0.515	0.564	0.567	0.522	0.586	0.471	0.580	0.439	0.542
	(0.071)	(0.010)	(0.044)	(0.006)	(0.031)	(0.005)	(0.031)	(0.007)	(0.032)	(0.010)
share(h)	0.351	0.341	0.240	0.376	0.263	0.389	0.221	0.371	0.229	0.361
	(0.076)	(0.024)	(0.086)	(0.035)	(0.025)	(0.022)	(0.022)	(0.008)	(0.024)	(0.009)
W/I	0.120	0.586	0.322	1.155	0.582	2.753	1.400	5.128	2.577	7.541
	(0.022)	(0.044)	(0.053)	(0.047)	(0.054)	(0.076)	(0.174)	(0.148)	(0.243)	(0.287)
W/I(h)	0.297	0.874	0.919	1.839	2.233	4.536	4.028	8.053	6.988	12.49
	(0.108)	(0.133)	(0.114)	(0.300)	(0.193)	(0.110)	(0.347)	(0.217)	(0.624)	(0.638)

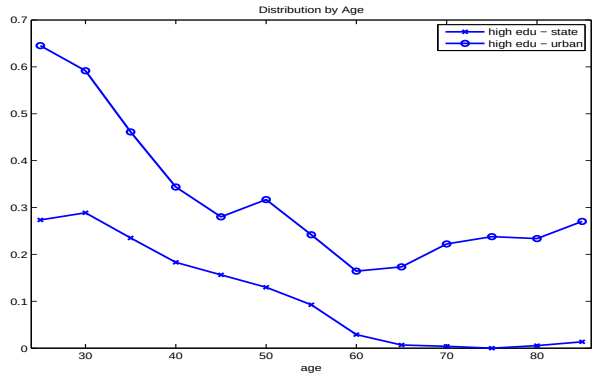
This table reports the participation rate, the share of stocks in household portfolio (for participants), the mean wealth-to-income ratio (W/I) for Chinese and US households by age and educational attainment. Data for China are from the CHFS (2011). Data for the US are from the SCF (1989-2007). Households whose heads have at least a high school diploma are defined as high education households In calculating share(h) and W/I(h) housing equity is included in wealth.

Table 12: Joint Distribution of Households in 2011 CHFS

	Rural	Urban		Non-state	State	N.A.		Pre-retirement	Post-retirement
Low-edu	2312	2229	Low-edu	548	230	3763	Low-edu	3138	1403
High-edu	389	2214	High-edu	374	889	1340	High-edu	2201	402

This table reports the joint distribution of households in 2011 CHFS by education, rural-urban status, sector of employment and age. N.A. denotes households without valid information on sector of employment. Pre-retirement households are those with house-heads aged below 60.

Figure 6: Fraction of high education Urban/State-Sector Employees



This figure plots the fraction of high education households that live in the urban area or are employed by the state sector in the 2011 CHFS.

We split the CHFS sample in alternative ways based on region of residence (rural versus urban) and sector of employment (non-state versus state). The state sector households include those employed by the governments, the SOEs and the collectively-owned enterprises. The joint distribution of households is reported in Table 12. Clearly, urban and state sector households are more educated.

Figure 6 plots the fraction of high education urban households and the fraction of high education state sector employees against age. These fractions are clearly larger among the young.

The top panel of Table 13 shows household finance patterns for the state and the non-state sector workers based on 28.6% of respondents in the 2011 CHFS sample with valid information on the sector of employment. The state sector workers have a significantly higher participation rate, wealth-to-income ratio and home ownership rate on average. These patterns are similar to the difference between low and high education groups, which is not surprising given that the state sector has a much higher percentage of high education workers as shown in Table 12 below. The stock share is not significantly different between the two sectors.

The bottom panel of Table 13 summarizes household finance moments by region in China. The participation rate and wealth-to-income ratio are much higher in the urban region. The difference in stock share is small, which is likely caused by the selection effect: only wealthy or high education rural households select to participate in the stock market. The home ownership rate is higher in the rural region where house prices are lower.

Table 13: Household Finance in China by Sector and Region

	Part.	Share	W/I	Share(h)	W/I(h)	Home Ownership Rate	Age
Non-state	0.145	0.498	0.76	0.124	10.03	0.76	41.73
	(0.011)	(0.009)	(0.05)	(0.006)	(0.56)	(0.01)	(0.3)
State	0.316	0.514	1.22	0.129	11.17	0.86	42.25
	(0.014)	(0.01)	(0.09)	(0.006)	(0.57)	(0.01)	(0.29)
Rural	0.027	0.468	0.72	0.118	9.43	0.94	52.25
	(0.003)	(0.006)	(0.04)	(0.003)	(1.03)	(0.004)	(0.23)
Urban	0.185	0.512	1.64	0.125	19.02	0.81	49.10
	(0.006)	(0.005)	(0.11)	(0.003)	(1.06)	(0.01)	(0.21)

This table reports household finance moments by sector of employment and region of residence. The state sector includes employees of governments, state-owned enterprises and collectively owned firms. The non-state sector includes farmers, workers in private firms, foreign firms and firms of joint ownership with foreigners. Among the 7144 households in our sample, 5103 of them do not have valid information on sector of employment. These households are dropped when we calculate the moments by sector of employment.

C Elasticity of Moments to Parameters

Table 14 reports the elasticities of simulated moments from the baseline model with respect to the estimated parameters.

D Impacts of Regime Changes

This appendix provides more details about experiments that show how the regime changes in China have impacted household finance patterns observed in 2011. A summary of results here are reported in Section 4.5 of the main text.

For each experiment, we calculate the averages of household finance moments for the four groups in the 2011 cross section of the simulated data. The results are shown in Table 15.

The first experiment imposes the pre-2000 old income processes, including both deterministic and stochastic components of income, on both the young and old cohorts throughout their lifetimes. This results in significantly lower wealth-to-income ratios for the young cohort, clearly due to the lower degree of income uncertainty in the old income process. In addition, for the more educated households, the deterministic income profile in the old regime falls much more quickly after retirement, which motivates them to save more for retirement, leading to a slightly higher wealth-to-income ratio.

With the old income processes, both the participation rate and stock share are lower for each of the four groups of households. On the one hand, a lower degree of income uncertainty leads to more risk-taking hence more participation and higher stock share (the direct effect). On the other hand the lower wealth accumulation increase the per unit costs of entry and adjustment. The quick decline of income with age in the old regime also causes households to take less risk, creating lower participation rates and stock shares. Our quantitative results reveal

Table 14: Elasticity of Moments to Parameters

		Young Cohort		Old Cohort	
	const.	low-edu	high-edu	low-edu	high-edu
	Participation				
β_1	0.984	3.105	-0.984	-0.007	-0.984
β_2	4.751	-4.751	11.435	-4.751	13.628
Γ	-0.109	0.109	0.571	0.109	-1.368
F	-18.125	13.559	-19.437	15.814	-27.868
γ	-0.005	-0.002	0.016	0.007	-0.034
θ	-0.217	-1.332	0.867	0.110	-0.593
$\underline{c}$	-0.145	0.096	0.097	0.422	-0.050
L	-0.050	-0.077	-0.034	0.047	-0.113
	Share				
β_1	0.091	0.667	-0.091	-0.334	-0.091
β_2	0.168	-0.168	-0.218	-0.168	-0.609
Γ	0.010	-0.010	-0.035	-0.010	0.094
F	8.382	-5.784	-7.011	-5.868	-7.064
γ	0.010	0.000	-0.010	-0.013	-0.012
θ	0.337	-0.576	-0.271	-0.263	-0.377
$\underline{c}$	0.606	-0.594	-0.610	-0.449	-0.638
L	0.040	-0.111	-0.042	-0.038	-0.045
	W/I				
β_1	19.521	49.545	-19.521	42.241	-19.521
β_2	26.379	-26.379	31.747	-26.379	46.656
Γ	-0.119	0.119	0.206	0.119	-0.627
F	0.050	0.675	-5.878	0.964	-2.964
γ	0.308	1.095	-0.092	0.207	-0.175
θ	-0.187	-18.962	4.152	3.609	3.340
$\underline{c}$	-6.031	-3.327	5.029	-1.491	5.307
L	-0.968	-0.467	0.776	-3.167	0.645

Each row of the table reports the elasticities of simulated moments from the baseline model with respect to one estimated parameter.

that the latter two mechanisms dominate the direct effect.

The second experiment imposes the post-2000 new income process through the lifetimes of both cohorts. Compared with the baseline model, the effects are just the opposite of the first experiment: on average households accumulate more wealth, participate more, and have higher stock share in total wealth. One exception is that the less educated young cohort has slightly lower share, likely caused by the selection effect: participants have lower income on average as more households participate in the stock market. Another exception is that less educated old households have slightly lower wealth-to-income ratio, because they have much higher income in the new income regime as shown in Figure 2.

The third and fourth experiments change the housing return. Recall that in the baseline model, the housing return is switched from 1.8% to 6.28% in 2000 unexpectedly as a result of the housing return, leading to a return of 5.45% on the composite bond. For these two experiments, the housing return either stays at the pre-reform level throughout the lifetimes of both cohorts, "Old Housing Return" case, or is at its new level throughout, the "New

Table 15: Regime Changes and Household Finance

	Young Cohort		Old Cohort		Distance (w.r.t. baseline)	p-value	Total Distance
	low-edu	high-edu	low-edu	high-edu			
Baseline Model (with cohort effect)							
part.	0.054	0.321	0.037	0.205			
share	0.093	0.071	0.065	0.085			
W/I	7.326	8.549	9.718	11.72			
Old Income Process							
part.	0.048	0.254	0.031	0.116	50.2	0.00	58.77
share	0.090	0.044	0.049	0.077	4.42	0.35	(p=0.00)
W/I	5.647	6.793	9.703	12.12	4.12	0.39	
New Income Process							
part.	0.084	0.691	0.051	0.394	1041	0.00	1047
share	0.089	0.082	0.073	0.105	1.32	0.86	(p=0.00)
W/I	7.459	11.00	9.085	13.69	4.60	0.33	
Old Housing Return							
part.	0.066	0.686	0.024	0.152	935	0.00	954
share	0.096	0.110	0.067	0.067	8.22	0.08	(p=0.00)
W/I	5.518	7.210	6.886	8.912	10.8	0.03	
New Housing Return							
part.	0.054	0.144	0.055	0.321	251	0.00	266
share	0.100	0.121	0.072	0.096	12.9	0.01	(p=0.00)
W/I	7.752	9.005	11.006	13.15	1.82	0.77	
Stock Market Always Accessible							
part.	0.054	0.321	0.039	0.281	13.09	0.01	13.23
share	0.093	0.071	0.066	0.076	0.12	0.998	(p=0.35)
W/I	7.326	8.549	9.759	12.01	0.02	1.00	
Completely New Regime (w/o cohort effect)							
part.	0.088	0.329	0.071	0.507	228	0.00	259
share	0.097	0.135	0.080	0.121	23.3	0.00	(p=0.00)
W/I	7.961	11.43	10.41	15.07	7.77	0.10	

This table report moments from the baseline model and from the counterfactual experiments. The distance is calculated using equation (9). The total distance is the sum of distances in three categories. The "p-value" column shows the probability that the realized distance is even larger than the calculated distance.

Housing Return" case.

Keeping the old housing return significantly changes the moments. Relative to the baseline, the wealth-to-income ratio is much lower. The lower return on composite bond leads to a higher Sharpe ratio, thus the participation rate and the stock share are both higher for the young cohort, especially the more educated households who are subject to less income uncertainty. For the old cohort, the participation rate and stock share either decrease or remain at about the same level, thus the low wealth accumulation has a dominatingly negative effect on stock investment for the old age households, despite the higher Sharpe ratio.

Using the new housing return throughout, each group of households has a high wealth-to-income ratio due to the high return on the risk-free composite bond. Two conflicting effects arise: the lower Sharpe ratio makes stock investment less attractive, while the the larger wealth accumulation diminishes the stock market entry and

adjustment costs (wealth effect). The wealth effect is weaker for the young cohorts as shown in the mild increase in wealth-to-income ratios and the lower stock market participation. But the wealth effect is strong for the old cohorts, resulting in much higher wealth-to-income ratios and participation rates.

In the block labeled "Stock Market Always Accessible", we experiment with the case when both old and young cohorts have access to stock market throughout their lifetime. This treatment does not affect the decisions of the young cohort because even in the baseline model it always has access to the stock market. Among the old cohort, the less educated households are affected only slightly – with slightly higher participation rate, stock share and wealth-to-income ratio. The weak effect is partly because the stock market re-opens at a time when the old cohort is about ten years prior to retirement hence they are able to take advantage of the new opportunity in the baseline model to a large extent.

In the last experiment, we assume both the young and old cohorts live throughout their lifetimes in the new regime. The results are reported and discussed in the main text.

A comparison of the p-values reveals that most of the regime changes lead to significant differences as measured by the overall distances, with p-values near zero. The only exception is the re-opening of the stock market. Had the stock market always be accessible, stock participation rate would be significantly higher (p-value pertaining to the participation moments being 0.01), but other moments would have little changes. The wealth-to-income ratios appear to be less affected by the regime changes partly because of the low weights they receive.

Housing market reform significantly changed wealth accumulation: without the reform wealth-to-income ratios would be much lower for each group of households. Relative to the baseline, ratios are clearly larger in the completely new regime. The impacts of changes in income process on the wealth-to-income ratio of the more educated group is also significant.

E Robustness of Estimation Results

This subsection reports moments and parameter estimates from various alternative specifications and source of hetergeneity listed in Section 4.6 in the main text. We also examine how the assumption of costless housing adjustment affects the savings and portfolio decisions of households.

E.1 Alternative Specifications

We re-estimate a number of variants of the baseline model and present the results in Table 16 (moments) and Table 17 (parameters).

Weighting Matrix: The first exercise replaces the weighting matrix used in the baseline estimation, the inverse of the variance-covariance matrix, with an identify matrix. Both matrices, in theory, generate consistent estimates of the structural parameters. With the identity weighting matrix, moments pertaining to wealth-to-income ratio no longer receive lower weights than other moments. As a result, the wealth-to-income ratio moments are better

Table 16: Robustness: Model Moments for China

		Young Cohort		Old Cohort	
	const.	low-edu	high-edu	low-edu	high-edu
China Baseline					
part.	0.118	-0.064	0.204	-0.080	0.088
share	0.094	-0.001	-0.022	-0.029	-0.009
W/I	6.949	0.377	1.600	2.769	4.777
Identity Weight Matrix					
part.	0.098	-0.073	0.083	-0.091	0.134
share	0.096	-0.002	0.008	-0.031	0.004
W/I	7.166	0.029	2.491	1.167	5.894
Earlier Stock Return					
part.	0.114	-0.066	0.202	-0.077	0.070
share	0.097	-0.015	-0.023	-0.016	-0.010
W/I	6.735	-0.035	1.155	2.831	4.919
US Stock Return					
part.	0.095	-0.079	0.086	-0.085	0.071
share	0.231	-0.021	-0.030	-0.036	-0.017
W/I	7.476	1.439	3.004	1.308	4.319
Higher Housing Return					
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
CHFS Income					
part.	0.103	-0.061	0.185	-0.083	0.103
share	0.089	-0.016	-0.009	-0.045	-0.046
W/I	5.864	0.179	0.573	4.157	4.568

This table reports model moments from alternative estimations, along with the baseline moments. Housing is included as part of the risk-free assets in data moments.

matched, but the match of moments related to participation and stock share is slightly worse.

The main features of the baseline model are preserved. In particular, the large gap between the discount factors of the low and high education households are present, though the differences are slightly less. Further, the stock market participation cost is quite close. However, with the identify matrix, the adjustment cost is higher and not statistically significant. As in the baseline model, the estimated consumption floor and the EIS are both significantly smaller than their US counterparts.

Stock Return Process: Given the short history of stock market in China, it is difficult to precisely measure the *expected* return and volatility of stock investment. In the baseline estimation, the stock return is estimated using the realized return in the period between March 1994 and March 2016. It is likely that households form expectations about the Chinese stock market based on experiences in the developed countries like the US. It is also likely that respondents in the 2011 CHFS form expectations based on realizations prior to the survey.

The row labeled "Earlier Stock Return" uses the realized stock return of the Shanghai Stock Exchange Composite Index between March 1994 - March 2011. In this case, the mean return is 12.57% and the standard deviation is

Table 17: Robustness: Parameter Estimates

	β_1	β_2	Γ	F	γ	θ	$\underline{c}$	L	$\pounds$
China (Baseline)	0.877	0.959	0.255	0.051	7.395	0.493	0.079	1.877	32.46
	(0.017)	(0.004)	(0.040)	(0.009)	(0.654)	(0.019)	(0.032)	(0.459)	
Robustness									
Identity Weight Matrix	0.871	0.968	0.261	0.091	8.54	0.526	0.102	2.564	3.38
	(0.043)	(0.018)	(0.427)	(0.390)	(1.768)	(0.305)	(0.051)	(0.890)	
Earlier Stock Return	0.867	0.940	0.275	0.083	7.986	0.563	0.076	1.301	35.49
	(0.008)	(0.008)	(0.109)	(0.034)	(1.168)	(0.146)	(0.055)	(0.775)	
US Stock Return	0.874	0.975	0.387	0.272	12.412	0.426	0.081	3.488	159.21
	(0.006)	(0.004)	(0.052)	(0.017)	(0.004)	(0.019)	(0.025)	(0.387)	
Higher Housing Return	0.834	0.946	0.264	0.012	6.495	0.367	0.139	2.479	53.88
	(0.017)	(0.015)	(0.068)	(0.005)	(1.644)	(0.075)	(0.052)	(0.869)	
CHFS Income	0.907	0.954	0.234	0.029	4.727	0.542	0.088	3.753	51.75
	(0.004)	(0.007)	(0.045)	(0.004)	(1.223)	(0.037)	(0.016)	(0.428)	
Rural-Urban	0.838	0.961	0.192	0.076	7.315	0.573	0.084	1.722	70.06
	(0.033)	(0.009)	(0.117)	(0.046)	(2.653)	(0.148)	(0.032)	(0.079)	
Nonstate-State	0.854	0.962	0.300	0.041	5.827	0.351	0.074	1.337	37.51
	(0.009)	(0.032)	(0.177)	(0.005)	(0.842)	(0.023)	(0.054)	(0.663)	

This table reports parameter values from alternative estimations. The "US return" estimation imposes US stock return on the Chinese households. β_i for $i = 1, 2$ refers to the low and high education groups except that for the "Rural-urban" case β_1 refers to rural households, and for the "Nonstate-state" case β_1 refers to households in the non-state sector.

0.488. For this specification, the estimated value of adjustment cost is slightly higher, which is needed when stock return is higher in order to match the moments related to participation and stock share. Important features in China relative to the US, such as the large and highly differentiated β's, the high participation cost, the low consumption floor and the low EIS are all well preserved.

The experiment of "US return" replaces the stock return process in China with the US process. This leads to substantially larger participation cost, adjustment cost, and coefficient of risk aversion which are needed in order to match the moments since a higher Sharpe ratio is imposed. The fit of the model is almost five times worse than the baseline. Thus the Chinese households do not seem to form their expectation about the Chinese market on the basis of the US experiences.

Housing Return: The case of "Higher Housing Return" sets the return on housing at 11% annually based on Fang, Gu, Xiong, and Zhou (2015). This increases return on the composite bond to 9.3%. In this case, the Sharpe ratio is even lower and stock investment is even less attractive, so a lower adjustment cost and a lower coefficient of risk aversion are estimated to match the participation and share moments. The high bond return also generates smaller estimates of β's and a larger consumption floor. The model fit is much worse than the baseline model, indicating that an excessively high housing return is not consistent with the expectations of households on average.

CHFS Income: Income level in the 2011 CHFS and the 2011 CHNS differs as shown in Table 18. The mean income levels of the young cohort are only slightly higher than the old cohort in the CHNS. In the CHFS data,

income levels of the young cohort are significantly higher than the old cohort. The "young/old" rows show that in CHNS the young cohort has an income level that is 1.034 and 1.18 times larger than the old cohort for the low and high education households respectively. The corresponding numbers are 1.225 and 1.638 based on the CHFS data.

Table 18: Mean Households Income in 2011 in China

	Young Cohort		Old Cohort	
	low-edu	high-edu	low-edu	high-edu
CHNS (baseline)	39318	73583	38022	62377
(s.e.)	(2194)	(3435)	(1440)	(3291)
young/old	1.034	1.180		
CHFS (robustness)	43110	115880	35180	70750
(s.e.)	(2847)	(10682)	(2823)	(11854)
young/old	1.225	1.638		

This table reports the mean values of income and their standard errors for the young and old cohorts in 2011 from two different data sources in China: the CHFS and the CHNS.

The much lower income levels of the old cohort relative to the young have implications for household finance patterns. As demonstrated in Heaton and Lucas (1997) and Cooper and Zhu (2016), income substitutes for bond holdings in household's portfolio choice, and lower income of the old cohort implies a lower stock share. To see the robustness of our baseline results, we re-scale the income profile of each of the four groups (namely the low and high education groups in the young and old cohorts) to match their relative income observed in the 2011 CHFS, and re-estimate the model parameters.[35] The results are reported in the row labeled "CHFS Income" in Tables 16 and 17. Compared with the baseline results, now the old cohort has much lower stock share. In particular for the more educated groups that have a larger income gap between the young and old cohorts, the stock share is about 5% lower than the baseline. Most of the features of parameter estimates in the baseline, such as the large entry cost and small consumption floor, and the discount factor heterogeneity, are well preserved.

E.2 Other Sources of Heterogeneity

As shown in Section B, Chinese household finance patterns differ by sectors of employment and region of residence. We re-estimate the model based on these alternative dimensions of heterogeneity. For these alternatives, the moments are created by replacing the education dummy with either urban dummy or the state sector dummy. Table 19 reports the results. Comparing these results with Table 4 reveals the similarity in both data moments and model moments from different splits.

Parameter estimates are reported in the bottom rows of Table 17. Overall, they do not deviate significantly from the baseline estimates, and the contrast between China and the US remains. The estimated entry cost is

[35]Since we normalize the average income level to one in the economy, what matters is the relative income of different groups. To adjust the income profiles, we rotate the baseline income profiles of the young cohort, so that the profiles get steeper until the young and less educated cohort has an income that is 1.225 time larger than the old and less educated cohort, and the young and more educated cohort has an income that is 1.638 time larger than the old and more educated cohort.

Table 19: China: Moments by Region and Sector

Rural vs Urban			Young Cohort		Old Cohort	
		const.	rural	urban	rural	urban
part.	Data	0.117 (0.024)	−0.081 (0.014)	0.224 (0.013)	−0.085 (0.015)	0.134 (0.022)
	Model	0.107	-0.106	0.217	-0.106	0.116
share(h)	Data	0.121 (0.023)	−0.016 (0.047)	0.016 (0.013)	0.009 (0.067)	0.052 (0.025)
	Model	0.104	-0.019	-0.039	-0.058	-0.009
W/I(h)	Data	13.368 (2.286)	−6.792 (1.439)	4.161 (1.359)	−3.653 (1.559)	6.030 (2.334)
	Model	5.543	-0.766	1.589	0.266	6.062
State vs Non-state			Young Cohort		Old Cohort	
		const.	non-state	state	non-state	state
part.	Data	0.117 (0.058)	−0.015 (0.010)	0.247 (0.016)	−0.028 (0.011)	0.038 (0.058)
	Model	0.134	-0.017	0.245	-0.029	0.042
share(h)	Data	0.121 (0.079)	−0.001 (0.016)	0.014 (0.016)	0.008 (0.019)	−0.014 (0.079)
	Model	0.117	-0.029	-0.056	-0.030	-0.018
W/I(h)	Data	12.312 (6.052)	1.203 (1.016)	−1.151 (1.642)	2.602 (1.113)	3.755 (6.076)
	Model	6.981	-0.957	2.472	2.471	6.188

This table reports data moments from the 2011 CHFS and the model moments based on heterogeneity either in region of residence or in sector of employment.

smaller but the adjustment cost is larger. For the sector of employment split, the relative risk aversion and the EIS are smaller. The low EIS helps generate a relatively small gap in the wealth-to-income ratio between the non-state and state employees.

E.3 Costly Housing Adjustment

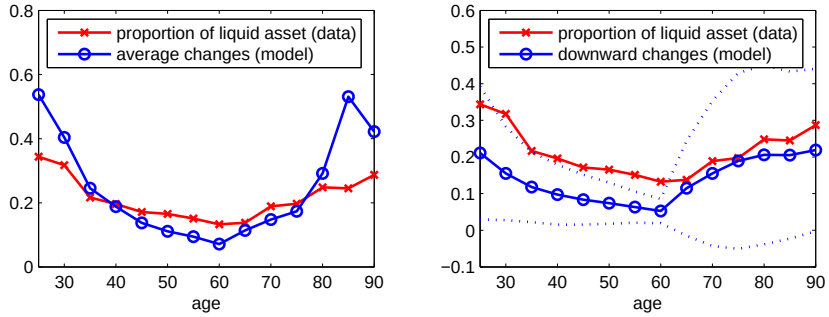
Our analysis assumes there is no cost of adjusting the composite bond which includes housing. In reality households frequently adjust their liquid assets due to various random shocks (e.g. income shocks and medical expense shocks) on the one hand, and they only adjust the holdings of housing asset occasionally on the other hand. Our assumption of costless adjustment could be too restrictive if the model-implied bond adjustment is large and exceeds the liquid assets observed in the actual data.

We estimate the proportion of liquid non-housing assets in the composite bond in the 2011 CHFS, and compare it with the rate of change in bond holdings in the simulated data, defined as $(A^{b\prime} - A^b)/A^b$. The purpose is to find out whether the traditional liquid asset in the data is sufficient for households in the model to buffer against shocks.

The left panel of Figure 7 shows the proportion of liquid non-housing asset in the composite bond in the 2011 CHFS by age, along with the bond change rate in the simulated data.[36] The latter is well below the former for households between ages 45 and 75, but it is well above the former before 40 and after 80.

[36]Since the proportion of liquid asset is calculated from one cross section of data, it is also contaminated by cohort effects.

Figure 7: Bond Change Rate Versus Liquid Asset in the Composite Bond



The figure shows the rate of change in bonds, $(A^{b\prime} - A^b)/A^b$, in the simulated data (the circled line) against the proportion of liquid non-housing asset in total composite bond in the 2011 CHFS (the starred line). The downward change rate of bond (right panel) is calculated from incidents $|(A^{b\prime} - A^b)/A^b| < 0$.

The right panel shows downward bond change rate in the simulated data which is the average calculated from the subset of data where $(A^{b\prime} - A^b)/A^b < 0$ at each age. The downward changes are all below the proportion of liquid assets. The right panel also shows the band of one standard deviation above and below the downward change rates (dotted lines). Before the retirement age of 60, the whole band is below the proportion of liquid asset. But after retirement, the band widens considerably and goes beyond the proportion of liquid asset.

Our main concern is whether the liquid proportion in the composite bond is sufficient to buffer against income or medical expense shocks. As shown in Bonaparte, Cooper, and Zhu (2012), a important reason for households to hold bonds despite the high equity premium is to use them to buffer against shocks and smooth consumption. The above analysis shows that liquid assets are sufficient to buffer against adverse shocks. For those aged below 40 or above 80, upward bond adjustments involve housing to some extent, but these adjustments are unlikely to be responses to income or medical expenses shocks. In summary, the assumption that bonds can be adjusted without costs is not restrictive as long as its role as a buffer against income and medical expense shocks are concerned.

F Counterfactuals of Imposing US Parameters on China

Table 20 reports results from imposing US parameters, one at a time, on the Chinese model without cohort effects. Part of the results here have been reported in Table 8 of the main text.

Table 20: US Parameters on Chinese Households (Without Cohort Effect)

		Young		Old		Young		Old	
	edu	low	high	low	high	low	high	low	high
		CN Benchmark				US Data			
	part.	0.088	0.329	0.071	0.507	0.164	0.518	0.230	0.705
	share	0.097	0.135	0.080	0.121	0.240	0.376	0.221	0.371
	W/I	7.961	11.425	10.413	15.067	0.919	1.839	4.028	8.053
Imposing						Distance	$Total_{distance}$	Distance	$Total_{distance}$
US Parameter						(w.r.t. CN)		(w.r.t. US)	
β	part.	0.011	0.001	0.020	0.006	1399	1501	3563	4311
	share	0.083	0.077	0.060	0.032	31.06	(0.0)	725	(0.0)
	W/I	5.269	3.749	6.438	5.091	71.43		23	
θ	part.	0.035	0.527	0.032	0.932	721	741	607	1162
	share	0.090	0.146	0.073	0.195	9.55	(0.0)	394	(0.0)
	W/I	6.565	13.860	9.742	19.750	9.82		161	
γ	part.	0.072	0.317	0.070	0.505	3.68	4.5	667	1235
	share	0.108	0.136	0.090	0.125	0.40	(0.97)	449	(0.0)
	W/I	7.469	11.121	9.968	14.923	0.39		117	
L	part.	0.086	0.326	0.066	0.496	0.57	0.6	637	1232
	share	0.097	0.135	0.080	0.118	0.01	(1.0)	465	(0.0)
	W/I	7.954	11.399	10.287	14.904	0.02		130	
Γ	part.	0.412	0.820	0.113	0.626	2775	2792	1381	2158
	share	0.049	0.087	0.083	0.104	16.93	(0.0)	638	(0.0)
	W/I	8.090	11.772	10.537	15.202	0.10		139	
F	part.	0.110	0.355	0.168	0.870	387	391	306	971
	share	0.087	0.128	0.049	0.086	3.78	(0.0)	352	(0.0)
	W/I	7.976	11.458	10.489	15.184	0.008		133	
Return	part.	0.085	0.354	0.114	0.736	138.31	247	361	660
(stock)	share	0.196	0.228	0.198	0.241	106.22	(0.0)	143	(0.0)
	W/I	8.054	12.094	10.964	18.040	2.28		156	
Return	part.	0.094	0.338	0.051	0.481	5.75	12	653	1299
(bond)	share	0.093	0.114	0.088	0.091	4.01	(0.45)	554	(0.0)
	W/I	7.293	10.703	9.156	13.157	2.50		102	
$\underline{c}$	part.	0.071	0.319	0.036	0.473	16.33	25	1347	1900
	share	0.098	0.136	0.097	0.119	0.41	(0.01)	457	(0.0)
	W/I	6.830	11.238	7.291	14.715	7.78		96	
Income	part.	0.018	0.139	0.030	0.446	322	330	1692	2376
(determinist.)	share	0.088	0.106	0.052	0.111	6.00	(0.0)	567	(0.0)
	W/I	7.735	9.850	10.804	15.060	1.60		117	
Income	part.	0.000	0.247	0.001	0.305	256	326	1570	2058
(stochastic)	share	0.000	0.160	0.054	0.165	24.91	(0.0)	455	(0.0)
	W/I	2.616	8.213	5.905	12.189	44.79		32	
Medical Exp	part.	0.082	0.323	0.019	0.482	23.87	29	810	1406
(determinist.)	share	0.097	0.135	0.052	0.112	1.30	(0.004)	484	(0.0)
	W/I	7.910	11.303	8.212	14.598	3.39		113	
Medical Exp	part.	0.082	0.315	0.017	0.404	50.24	58	936	1550
(stochastic)	share	0.097	0.133	0.046	0.093	2.93	(0.0)	507	(0.0)
	W/I	7.902	11.119	7.966	13.598	4.61		107	

This table reports counterfactuals from imposing US parameters (one at a time) on the Chinese model, controlling for cohort effects. The CN benchmark are simulated from the completely new regime using parameters from the baseline estimation. The US data moments are taken from the SCF data between 1989-2007. The columns labeled "Total" reports the sum of distances in participation, stock share and W/I.