Housing and Wealth Accumulation in Urban China, Before and After the 1994 Housing Reform*

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Abstract

We empirically document large increases in financial wealth and housing wealth/income ratios of urban Chinese households between 1995 and 2002. We analyze the drivers behind these trends with the help of a quantitative model that features coexistence of public and private housing sectors. Our focus is on the supply change, the preference shock and the institutional changes that the urban housing market experienced following the 1994 housing reform, in particular the introduction of mortgage markets and the introduction of a large private housing market replacing the allocation of housing through state-owned enterprises. We find that the supply change, the preference shock as well as the introduction of private housing markets are important, the latter by resolving misallocation that is present in the pre-reform allocation of dwellings, which distorts households' optimal choices. The introduction of the mortgage markets has a limited impact. We conclude that housing related factors including institutional changes affect Chinese households' saving behavior and can explain a significant part of the data trends.

Key words: Housing Reform in Urban China, Saving Behavior of Urban Chinese Households, Housing, House Prices

JEL classification: D14, D52, R21

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1 Introduction

In this project, we analyze the impact of housing related factors, including institutional changes in the urban Chinese housing market, on households' wealth holdings and house prices. Using micro data, we empirically document that between 1995 and 2002, the wealth/income ratio of urban Chinese households almost doubled from 2.51 to 4.78. At the same time, the housing wealth/income ratio more than doubled from 1.35 to 3.16, whereas the financial wealth/income ratio rose by only 30 percent, from 1.16 to 1.62. This suggests that the rise in aggregate wealth is mainly driven by housing wealth. Dwelling prices remained roughly at a constant level, relative to income.

The massive increase in wealth/income ratios is puzzling. Given high growth rates of about 10 percent per year that the Chinese economy experienced at the end of the 1990s, one would expect that households de-cumulate wealth in anticipation of their higher income in the future. The fact that house prices did not increase at the same time makes the rise in the housing wealth/income ratio even more puzzling, since it rules out that the latter is driven by capital gains in the housing market.

We argue that these trends can only be understood if housing related factors, including the housing reform that took place between 1994 and 1998, are taken into account. During this reform, housing units owned by state-owned enterprises were sold to their employees. As a consequence, the home ownership rate increased from about 20 percent in the pre-reform period to 80 percent in the post-reform period. Moreover, the supply of high quality housing increased from 30% to 60% during this period.

Housing is important for consumption and saving decisions because of its dual role as a consumption good and as an asset. We therefore expect that such a large scale reform as the 1994 housing reform also has impact on aggregate trends in wealth/income ratios.

The housing reform could influence wealth/income ratios through the following channels. Firstly, to the extent that homeowners save more than renters, the sharp increase in the homeownership rate could have contributed to the rise in wealth/income ratios in general. Secondly, homeowners are forced to save more than others if there are credit market frictions and transaction costs that prevent them from using their home equity to insure their non-housing consumption against bad income shocks. Thirdly, even if the credit market frictions are alleviated, households will save more

if housing as a consumption good becomes more expensive due to supply or preference change during the reform. A major feature of the housing market reform is that credit market frictions were substantially alleviated during the reform, as the Chinese government also introduced a mortgage financing system in order to help households to purchase housing property. Mortgages were completely absent in the pre-reform period, at least officially.

Fourthly, an additional important aspect of the housing reform is that it removed the "misallocation" that was present in the pre-reform allocation of dwellings, see Wang (2011). Misallocation arose because the allocation of housing units within state-owned enterprises was not based on the willingness of households to pay. Instead, apartments were allocated according to 'soft' criteria, such as seniority and status within the firm, among others. Households that were unsatisfied with their allocated apartment were left with the option of purchasing a dwelling on the small private market, which required considerable wealth on their side, given that mortgage markets were absent. By entering the private market, these households also drove up prices there. Hence, we would expect that the degree of misallocation is an important determinant of the wealth/income ratios and the dwelling prices in pre-reform urban China.

In this paper, we develop a quantitative framework that allows us to understand how these features of housing supply, housing preference and the housing reform have contributed to the trends that we observe in the data. More specifically, we study two models, one for the pre-reform economy and one for the post-reform economy. Both economies are dynamic general equilibrium models that endogenously generate dwelling prices, as in Ríos-Rull and Sánchez-Marcos (2008). Again following Ríos-Rull and Sánchez-Marcos (2008), we also assume that markets are incomplete and that households are subject to uninsurable earnings shocks, a feature that might have important consequences for the dwelling and saving decisions of households. Our framework is therefore general enough to study the importance of other changes besides the housing reform that could have contributed to the facts that we observe in the data, e.g. the increase in earnings uncertainty documented by Chamon and Prasad (2007). We will use our model to qualitatively judge the plausibility of the various channels, to analyze their interaction, and to quantitatively evaluate their relevance.

The pre-reform economy is designed to feature the important characteristics of the housing market in urban China prior to 1994, such as the co-existence of a large

public housing sector where dwellings are allocated randomly and a private housing sector, where dwellings are bought and sold by households. Housing in the public sector is subsidized. Secondly, dwelling exists in different types. For simplicity, we assume that there are only two types of dwellings, high- and low-quality. This allows us to capture the relative supply change of different quality housing as well as the existence of "misallocation" in the public sector, i.e. the fact that some households in the public sector are forced to live in a different type of dwelling than they would have chosen if they were in the private sector. And thirdly, there was no (official) mortgage system during the pre-reform period. In the post-reform period, there is only a private market. Moreover, we assume that households can use mortgages to finance the purchase of their dwelling.

We calibrate the parameters of our model economies such that the pre-reform economy is consistent with the wealth/income ratios as well as the dwelling prices relative to income for the pre-reform period in urban China. Using these parameters, we can then compare the changes between pre-reform and the post-reform economy. With the help of our post-reform economy, we can quantitatively evaluate the relevance of the specific channels outlined above.

Our results are as follows. Firstly, we find that misallocation is an important determinant of households' saving and dwelling choices in the pre-reform period. Without misallocation - i.e. in an environment where a free market structure is incorporated into the pre-reform economy - households' net worth /income ratio and the housing wealth/income ratio would have been much higher than the one we actually observed in the data (2.25 instead of 1.35 for the housing wealth/income ratio and 3.28 instead of 2.51 for the net worth/income ratio). The financial wealth/income ratio would have been roughly the same (1.03 instead of 1.16). These results indicate that households, in the absence of distortions introduced by the public housing system, would have accumulated more housing wealth in the pre-reform period.

It is interesting to compare our findings with the approach by Wang (2011). Using household level data from the pre-reform period, Wang (2011) compares the rental values of dwellings in the private and in the public housing sector for households with the same characteristics. She concludes that households in the private sector consume housing worth 15 percent more than households in the public housing sector. In line with our results, this suggests that households' consumption of housing increases if misallocation is removed. An important contribution of our project is that we are able to analyze the counterfactual pre-reform economy and to quantify to what extent

misallocation is important for wealth/income ratios and the prices of dwellings.

By applying her procedure to the data generated by our model, we can also compare the "strength" of misallocation implied by the model to her empirical findings. In our pre-reform model, households in the private housing market consume about 8 percent more housing than households in the public sector. This indicates that the strength of misallocation in our model economy is smaller than the one in the data. We therefore conclude that the results of our counterfactual experiment should be seen as a lower bound. The actual impact of misallocation on household decisions and the resulting wealth/income ratios and dwelling prices is likely to be even larger.

Secondly, our results show that alleviations of credit constraints has a positive effect on households' saving. Bussière et al. (2013) find that higher housing prices increased the saving rates of young Chinese households in the presence of borrowing constraints. This is because housing as an asset offers a higher return than financial assets, which makes it promising for the young generation to save for house purchase. This role of housing as an asset, its price effect and the effect of the alleviation of borrowing constraints on households' saving behavior are also recognized and measured in this paper. However, we investigate further the interaction between two mechanisms with housing functioning both as a consumption good and as an asset. The results of our experiment show that the alleviation of credit constraint and the resulting increased house price on the one hand make housing assets holding appealing while on the other hand less so because the housing consumption becomes more expensive. The aggregate effects lead to an increase in financial wealth accumulation.

Our results also contribute to the growing literature that analyzes the high saving rate of urban households in China through other economic determinants. Chamon and Prasad (2007) argue that the observable increase in earnings uncertainty raised the desire of Chinese households to accumulate precautionary saving. Indeed, we also find that higher uncertainty helps to generate the empirically observable increase in the financial wealth/income ratio in the model. However, the model also predicts that the housing wealth/income ratio should have fallen at the same time, since higher uncertainty makes ownership less attractive, given the various frictions associated with it. Hence, we conclude that rising earnings uncertainty alone cannot explain our empirical findings.

We find that the increase in the housing wealth/income ratio can be best explained by an increase in the preference for housing, a decrease in relative supply of housing and an increase in relative supply of high quality housing over time. This

preference shift can be rationalized by a fiercer competition in the marriage market, where more and more men are trying to increase their chances for finding a spouse among a shrinking pool of women. It is quite plausible that owning a large apartment gives men an advantage relative to their competitors. This finding is related to Wei and Zhang (2011), who argue that competition in the marriage market is the key for understanding wealth accumulation of urban Chinese households. Urbanization and migration are important features of China's general market reform. Housing is in short supply as rural workers migrate to the city. However, with the progress of the reform, there are more high quality housing, which, combined with the force of increasing housing preference, induce the households to save more for housing. Thus housing wealth is accumulated.

Whereas we are interested in understanding the impact of the 1994 housing reform for wealth accumulation of urban Chinese households, Choukhmane et al. (2013) analyze the impact of the one-child policy. They find that the one-child policy increased the saving rate since parents need to save more for their retirement, because they can expect less support from their children. Rosenzweig and Zhang (2014) are mainly interested in the high saving rate of young households. They find that the saving rate of the young is driven by high housing costs and the prevalence of intergenerational shared housing. Song and Yang (2010), instead, argue that the saving behavior of young households is mainly driven by expectations about changes in the age-earnings profile that are the result of a structural change in the fast-growing Chinese economy.

The remainder of this paper is structured as follows. In section 2, we give a brief overview of the (institutional) features of the housing market in urban China, before and after the housing reform. We discuss the data and present our empirical findings of households' wealth holdings and house prices as well as main features in different housing sectors before and after the housing reform in section 3. Section 4 develops the stationary model illustrating the pre-reform and the post-reform economies, while section 5 outlines the calibration of the models' parameters. Finally, we present our results and discusses implications of various channels in section 6. Section 7 concludes.

2 The Development of Housing Markets in Urban China

2.1 Prior to 1994 Housing Reform

Misallocation of dwellings and lack of mortgage financing are the two major institutional deficiencies in housing of pre-reform China. Moreover, low degree of urbanization and low supply of high quality housing are also important characteristics of the urban housing. The existence of misallocation is closely related to the pre-reform institution of government allocation of housing. Work-unit-owned public housing is a key feature of the pre-reform welfare system of China after 1949. While some households that previously possessed private ownership of houses were allowed to retain the ownership of their residences, in the urban areas, all the new housing stock and some originally private houses were registered however with public ownership, which altogether, by 1994 constituted about 80% of the total housing stock according to the Urban Household Survey (UHS) 1993. The distribution of this large public housing stock was managed by the nationwide work units, i.e., the state-owned and collective enterprises, to their employees, the population of which by 1994 was 99.3% (UHS 1993).[1]

Low rents, co-residence and acceptance of poor housing are common with such arrangement. The rents charged by the work units were highly subsidized (Zhou and Logan (1996), Fu and Tse (2000)). Together with the lack of resources, housing entitlement was determined by factors such as official status and work experience rather than according to the characteristics of the family (Wang and Murie (2000)). The housing units sometimes had to be shared by more than one household and the households had to bear poor living conditions as a price for the low rent(Li (2000)). Thus misallocation was generated as a consequence of mismatch between households' willingness to pay and the actual housing condition they accepted from the government's arrangement.

The remaining 20% private housing stock formed a small private market for trading, which was affected by the inefficiency in housing distribution administered

[1]We distinguish between housing of public ownership and employees of the public sector. In the following of the paper, "housing in the public sector", which is exactly housing of public ownership, sometimes appears as opposed to "housing in the private market" which is registered with private ownership and can be traded in the private market. A public sector employee can still possess and purchase "housing in the private market" while most likely he is entitled to "housing in the public sector".

largely by the government through work units. Besides, there was no official mortgage financing system in the pre-reform period which rendered trading in the private market mostly costly.

In both housing sectors, the quality of the housing is relatively low.[2] Only 27.83% of the public housing and 45.11% of the private housing are of high quality.

2.2 China's 1994 Housing Reform and Post-reform Housing Market

China's 1994 housing reform was initiated as a part of China's market reform, and in terms of expectation, practically the first comprehensive nationwide reform for the sitting tenants in the public housing sector. To address the serious problems in the state provision of housing, such as shortages, poor management and corruption in the distribution (Wang and Murie (1999)), major experiments and key policies were introduced between 1994 and 1998, a full account of which can be found in Wang and Murie (2000). "The decision on Deepening the Urban Housing Reform" published by the state council in 1994 launched the important housing reform following a series of reform programmes and experiments throughout the 1980s.

Sale of public sector housing and establishment of a mortgage financing system constitute the two main dimensions of the 1994 housing reform. Firstly, to steadily sell the old state-owned housing at a large discount to the sitting tenants who would then become private home-owners allows for welfare improvement through free trading according to willingness to buy instead of reluctant acceptance of government's housing distribution in exchange for low rent. During the reform period, to speed up the process of housing commercialization in urban areas, material distribution of public housing to urban employees was completely stopped as a decision by the central government in 1998. Secondly, the set-up of a mortgage financing system further facilitated trading of housing by loosening the restrictions on loans and alleviated households' burdens of saving for purchase.

Rapidly increased private home ownership and a gradually developing mortgage system made possible an active large-scale private housing market in the post-reform economy of China. With the successful implementation of these policies, the 1994 housing reform ended in the beginning of 2000s with home ownership rate rising to about 85% in the economy according to the 2002 Chinese Household Income Projects

[2]For the quality standard, see Section §3.1.

(CHIP). The development of the mortgage financing system was slow but on the track by the time the housing reform ended (Chamon and Prasad (2007)).

As for the general supply of the housing, the government outsourced the repairing and other services to external professional companies and build "economically-affordable-houses" for low income population (Comfortable Housing Project). Basically, the government encouraged the people to buy and build more private-owned houses of high quality. Generally, it can be stated that some factors such as education and health care are far better in urban area than in rural area in China. Because only by receiving city-"hukou" (the household permit/identity for living legally in the city) the household can profit from the basic social security and have access to better school (Wu 2004). Lots of rural household swarm into the city and put more pressure on housing supply.

3 Empirical Evidence on Housing and Wealth

3.1 Data Sources

CHIP, UHS and CHNS

Our primary data sources are the 1995 and 2002 household-level surveys from the Chinese Household Income Projects (CHIP) organized by Chinese and international researchers, with assistance from the National Bureau of Statistics (NBS). Other than the Census, the three most widely accepted and used micro-datasets of China are the CHIP, UHS and China Health and Nutrition Survey (CHNS). As is declared by the main investigators of the CHIP in Li and Yue (2008), the CHIP surveys are closely related to the NBS household surveys, the UHS, which covers six geographical regions (Northeast, North, East, Center, Northwest, and Southwest) and altogether 10 provinces.

The UHS and the CHNS do not contain sufficient information on housing. Although to track the dynamics of housing market development in China, the year 1993 seems to best stand for the pre-reform period and the CHIP has conducted only four waves of household surveys in 1988, 1995, 2002, and lastly 2007, we choose not to employ datasets from the UHS and the CHNS which do cover the year 1993 because neither of them contains information on house prices and household wealth.

Despite similar sampling methods, the representativeness of the CHIP data in

Table 1: Share of Ownership of Urban Housing Stock in Different Datasets

Dataset	Public Ownership	Private Ownership
UHS1992	81.5%	18.5%
UHS1993	78.0%	22.0%
UHS1994	70.0%	30.0%
UHS1995	67.7%	32.3%
UHS1996	63.4%	36.6%
UHS1997	51.1%	48.9%
CHIP1995	67.3%	32.7%

Notes: This table summarizes the share of urban housing stock registered with public/private ownership in the UHS from 1992 to 1997 and in the CHIP 1995 wave. UHS questionnaires categorize the home ownership into 4 types: 1. public housing; 2. house rented from private owner private house; 3. private house; 4. other. CHIP 1995 questionnaires categorize ownership into 7 types: 1. public housing owned by work unit; 2. other public housing; 3. inherited old private house; 4. self-built private house; 5. self-purchased private house (including house bought on private market or from unit or government as part of housing reform); 6. house rented from private owner; 7. other. All of them are grouped into either public or private ownership.

comparison with data from other sources such as the census is not clear. The CHIP investigators provide only two indicators of the urban sample to check with parallel statistics obtained from the NBS data: the ratio of females to males and the average number of household members. The former is 102.6, relatively higher than 98.8 from the NBS data while the latter is 3.23, close to 3.13 of the corresponding national statistics published by the NBS.

The CHIP 1995 and 2002 datasets are representative of the pre- and post-reform stages. One concern is that the official starting point of China's housing reform is year 1994 so the CHIP 1995 data are inclusive of the effects from the reform that has partly materialized. In Table 1 is listed the home ownership rates in different years in the UHS and of 1995 in the CHIP. These two dataset reveal similar distribution of public and private home ownership in 1995 and it is clear that the private home ownership rate did rise from 1994 to 1995. However, most of the increment in the private ownership after the reform begins still comes from after 1995, which validates our choice of the CHIP 1995.

Moreover, both the CHIP and the UHS use identical categorization of types of houses which makes it possible to distinguish between low quality and high quality dwellings consistently across different databases. We define high quality housing as apartments with independent toilet and kitchen. Those apartments without or with

Table 2: Share of Different Types of Housing in Different Datasets

	Public Ownership		Private Ownership	
Dataset	Low Quality	High Quality	Low Quality	High Quality
UHS1992	73.9%	26.1%	81.0%	19.0%
UHS1993	76.5%	23.5%	64.5%	35.5%
UHS1994	76.0%	24.0%	56.0%	44.0%
UHS1995	73.0%	27.0%	49.2%	50.8%
UHS1996	71.0%	29.0%	48.0%	52.0%
UHS1997	73.8%	26.2%	52.5%	47.5%
CHIP1995	72.2%	27.8%	54.9%	45.1%

Notes: This table summarizes the share of dwellings of different quality (High/Low) in the UHS and the CHIP and reveals similar structure for both types in both sectors around the year 1995. The UHS and the CHIP employ identical housing type categorization: 1. single family unit with auxiliary rooms; 2. one bedroom apartment; 3. two bedroom apartment; 4. three bedroom apartment; 5 four bedroom apartment; 6. ordinary apartment unit, i.e., without or with shared kitchen and toilet; 7. single storey house, or rooms therein, without auxiliary rooms. We further categorize them into high and low quality housing conditioning on whether the dwelling is equipped with independent kitchen and toilet.

shared toilet and kitchen are thus by definition of low quality. Respectively from now on we will sometimes refer to them briefly as "House" (high quality) and "Flat" (low quality). The share of different types of housing in the reform period is listed in 2 and both datasets exhibit, even under different quality housing types, similar homeownership rate structure in 1995, which further substantiates our attempts to use data from the CHIP 1995.

3.2 Statistics on Wealth/Income ratio and Dwelling Prices

Financial wealth and housing wealth, as components of the net worth of a household's wealth, change along with the economic environment from pre-reform to post-reform period. Definitions of those concepts related and measures of corresponding indicators in the dataset are provided.

Definition of Variables

We distinguish the households who are entitled for public housing from the home ownership of public housing. The definition of a household, which is the primary economic unit of the CHIP, can be adopted partly from Rodríguez et al. (2002) to be

"a person or a couple of people who live together and all the other people who live in the same household who are financially dependent on them". And "a financially independent person who lives in the same dwelling, such as a roommate or a brother-in-law, is not considered to be a member of the same economic unit." (Appendix pp. 14) However, unlike their specifications about inclusion of children and the elderly in this unit as financially dependent, we only take underage (below 22 years old) children as dependents but those who are old aged and in most cases retired not. This approach takes into account that retired people as a group still counts as eligible for public housing before their retirement according to pre-reform housing allocation practice (Wang and Murie (1999)). Therefore, if there are more than four people in one apartment and the fourth member is above the age of 22, we will treat this case as one containing 2 households in one apartment. The UHS 1992, UHS 1993 and CHIP 1995 all have a similar share of households under this definition in the sample, approximately 0.1, that live together in the apartment with the "prime" household who is considered as the household head and claims home ownership of this apartment in the surveys. Hence, with measure one of home ownership, the size of the aggregate households is roughly 1.1. Co-residence is an important feature of the pre-reform economy and several researches value this feature as crucial in explaining Chinese household's saving profile, for example, Choukhmane et al. (2013) and Rosenzweig and Zhang (2014).

The codebook of the CHIP1995 offers a relatively complete definition of urban household income as the disposable after-tax income which includes: cash income of the working members; income of the retired members; income from private/individual enterprises; income from property; miscellaneous income (including private transfer and special income); subsidies less taxes (except housing subsidy) and income in housing subsidy. However, in the main table of CHIP2002, only an item called "Total Income" is used which corresponds to only a part of the disposable after-tax income of 1995, which is rather the labor income: the wage including bonus, allowances and subsidies, overtime and special wages. (In its appendix, other income items are also offered but inconsistent with the main table, which we choose to discard.) To keep our measures consistent, we also only adopt the labor income measure in CHIP1995. (Note that for the retired people, their income from pension etc is also included as labor income so we do not find using this measure questionable.)

We define wealth as the net worth of the households which includes the value of financial assets of all kinds plus housing assets net of various kinds of debts (including

the housing loan).[3] Specifically, the housing wealth is housing assets net of housing loan and the financial wealth is the value of financial assets of all kinds net of various kinds of debts, where the financial assets that we include are the following: deposits in fixed term savings accounts; deposits in currents accounts; stocks and bonds; money lent out; production funds for family production/operations and investments in other enterprises (excluding stocks and bonds).

Indicators and Research Questions

There are five critical indicators: house price/flat price ratio, flat price/income ratio, net worth/income ratio, housing wealth/income ratio and financial wealth/income ratio that exhibit variations along with and capture changes in the institutions before and after the housing reform. We document the changes in those indicators both on the aggregate level and on the housing sectoral level.

Both the housing wealth/income ratio and the financial wealth/income ratio increased after the housing reform. As can be obtained from CHIP 1995 and CHIP 2002 (Table 3), the net worth/income ratio of the Chinese households in the pre-reform econom4.78 after the housing reform. In 1995, the housing wealth/income ratio is 1.35 and financial wealth/income ratio is 1.16, which increased to 3.16 for housing wealth/income ratio and to 1.62 for financial wealth/income ratio. This suggests that the rise in aggregate wealth is mainly driven by housing wealth. Increase in housing wealth/income ratio between pre- and post-reform period at the aggregate level appears to be driven by former renters coming from the public housing sector given the huge increase in home ownership mentioned above, which hints to the importance of the housing reform.

Dwelling prices[4] relative to income, declined between pre- and post-reform period, which seems puzzling given that after the housing reform misallocation is resolved (Wang (2011)) and mortgage financing is made possible.

The massive increase in wealth/income ratios is also puzzling. Given high growth

[3]Our definition is slightly particular in that it does not involve durables and other productive fixed assets as a part of the wealth because financial wealth from saving and housing wealth are the major concerns of our study and suffice for modeling.

[4]Regarding the dwelling price, in the CHIP 1995 questionnaire, for private housing, two related prices are required to be reported: 1. the estimated market value of the current housing; 2. the historical market price paid for the housing. In the CHIP 2002, a third related price is also asked to be reported: at what price would you sell for the current housing. We use the estimated market value of the current housing as representative of the house/flat price since this measure is used in calculating households' wealth and reflects the current market price.

Table 3: Variations in Wealth/Income and Price/Income Ratios from Pre- to Post-reform Period

	Pre-reform (CHIP1995)	Post-reform (CHIP2002)
House price/Flat price	1.37	1.56
Flat price/Household income	3.6	3.33
Financial wealth/Income	1.16	1.62
Housing wealth/Income	1.35	3.16
Net worth/Income	2.51	4.78

Notes: This table lists the five major indicators related with housing in both pre- and post-reform periods. The CHIP 1995/2002 data are employed to obtain statistics for the corresponding periods. The price/income ratio fell on the aggregate level while wealth/income ratios all increased.

rates of about 10 percent per year that the Chinese economy experienced at the end of the 1990s, one would expect that households de-cumulate wealth in anticipation of their higher income in the future. The fact that house prices decreased at the same time makes the rise in the housing wealth/income ratio even more puzzling, since it rules out that the latter is driven by capital gains in the housing market.

Moreover, in Table 4 we document changes in these indicators on the housing sectoral level. Housing wealth/income ratio decreased for the private sector probably as a a result of the decrease in price/income ratio. However, financial wealth/income ratio increased between pre- and post-reform period. This suggests similar research questions in the literature that are related with household's saving behavior. In particular, we find that in the pre-reform economy, households who own a private dwelling public housing tenants do not save differently from households who own a private dwelling.

We argue that these trends can only be understood if the housing reform is taken into account. Housing is important for consumption and saving decisions because of its dual role as a consumption good and as an asset. We therefore expect that such a large scale reform as the 1994 housing reform also has impact on aggregate trends in wealth/income ratios and house prices.

4 The Stationary Model Economies

The economies in our paper are two dynamic models related with dwellings applied to both pre- and post-reform periods. We are only looking at stationary equilibria

Table 4: Variations on the Housing Sectoral Level from Pre- to Post-reform Period

	Pre-reform (CHIP1995)	Post-reform (CHIP2002)
Public sector financial wealth/Income	1.15	
Private sector financial wealth/Income	1.19	1.62
Private sector housing wealth/Income	3.97	3.16
Public sector net worth/Income	1.15	
Private sector net worth/Income	5.17	4.78

Notes: This table provides further information of the indicators on the housing sectoral level for both pre- and post-reform periods. The public sector accumulated financial wealth not so differently from the private sector in pre-reform economy while the private housing wealth decreased from pre- to post-reform period. This table excludes housing wealth reported from renters of the public administered housing, which is also excluded in acquiring the house/flat price ratio.

of respectively pre-reform economy, which features coexistence of both public and private sectors, and post-reform economy where only the private markect exists. Our modeling of the private market is based on Ríos-Rull and Sánchez-Marcos (2008) with dwellings introduced as both a consumption good and a type of assets.

Dwellings We model those features of dwellings that carry economic values related with institutions of environments of pre- and post-reform periods. The dwellings in our model are in fixed supply and are costly to purchase but can be used as collateral. They exist in different quality by which we categorize into two types: flats f and houses h. The existence of two types of dwellings allows us to generate the misallocation as a major feature of the pre-reform economy, i.e. the fact that tenants in the public housing sector would have a different dwelling type were they in a private market without government allocation. The set of dwelling choice contains three elements: $d = \{0, f, h\}$, where $d = 0$ is defined as having no homeownership. We assume that households own only 1 element of d to exclude multiple homeownership. In the pre-reform economy, as discussed in Section 3, there was co-residence in around 10% of the dwellings. We view this extra 10% households as owning the 0 element. While in the post-reform economy, this feature diminishes and the renting market develops correspondingly so we define the renters in the post-reform economy as in the subset of $d = 0$. We denote prices of dwellings in the private market by p_0, p_f and p_h where p_0 is set to 0.

Preferences and Shocks Typical households save for both life cycle reasons

and housing reasons. We assume a simple life cycle earning profile so that all households are born as poor and die stochastically. The population turnover rate is $1 - \pi$ where π is the average death rate. Other than the utility from consumption good, there is a utility gain from owning the dwelling the household lives in. Households' preferences are thus given by an adjusted CRRA utility function $u_d(c) = \frac{c^{1-\sigma}}{1-\sigma}\gamma^d$ such that $u_0(c) < u_f(c) < u_h(c)$. Households are ad hoc heterogeneous in their earnings ability, i.e. there is an idiosyncratic earnings shocks e. In the steady state, three different earnings classes exist in the economy. The earnings state of the households evolves according to a Markov process.

Asset Markets Incomplete markets seem to be a good approximation of the heavily regulated financial system in China. Thus with the financial asset market, the standard assumption in heterogeneous agent model is kept such that insurance markets against the idiosyncratic earnings shocks are absent. Households can only "self-insure" by saving in the risk-free bond with an exogenous interest rate r. Borrowing from the financial market is not allowed so that the lower bound of asset holdings is 0 and the possibility for the households to collateralize their dwellings for financing consumption is also excluded.

For the housing market, we assume the existence of annuity markets so that the assets and dwellings of households that die are redistributed to the surviving households. Survivors receive bonus $\frac{1-\pi}{\pi} > 0$ per unit of asset and dwelling as a bequest from the dead. Typically, a subset of these surviving households, after accumulating some assets, will put a down payment and buy a starter's flat or house. As time passes, some households upgrade to a higher quality house while households with houses may be subject to earnings shocks and have to eventually downgrade to a flat or even to no dwelling.

Collateralized borrowing is allowed for housing market. Therefore households can collateralize their current dwelling for financing their housing consumption, i.e. purchase of a new type of dwelling. Specifically, the households face a borrowing constraint which allows them to borrow up to (1-α) of the dwelling's value in purchase of dwellings. For the pre-reform economy, since there are no mortgage markets, α is set to 1. If the households decide not to trade for a different type of dwelling next period, they need only to pay for the interest of amortization but if they decide to upgrade or downgrade to a new dwelling type, there will also be a transaction cost δ for trading the dwelling which is imposed on the buyer, so the cost function ϕ in

these two cases can be written as:

$$\begin{aligned}\phi(d',d) &= r(1-\alpha)p_d \text{ if } d'=d,\\ \phi(d',d) &= \alpha(p_{d'}-p_d)+\delta p_{d'} \text{ if } d'\neq d.\end{aligned}$$

4.1 Model of the Pre-Reform Economy

Households in the pre-reform economy choose dwelling type, asset holdings if they are in the private market and were they in the public housing sector, they first choose whether to stay or leave for the private market then make saving decisions if they stayed. This setting characterized the pre-reform institutions: the SOEs offer indefinite lease of public stock of housing at zero cost to the households who are employed in the SOEs. Since the amount of public housing stock (80%) was smaller than the share of employees (99.3%) in the public sector, there naturally exist households who were allocated with no dwellings at all in the public housing sector. There were also households who were allocated with low quality flats while they prefer high quality house were they in the private market. Therefore, Households could choose to either stay in the public sector and accept the offer from their employers or if they were unsatisfied with the offer and had enough income and financial assets, they could choose to go to the private market that also existed in the pre-reform period. This is the households' problem in the public housing sector. We will first characterize the household's problem in the private market, which will then be part of the household's problem in the public housing sector.

Pre-reform: Households' Problem in Private Market The households in the private market can make saving and housing choices to maximize their lifetime utility in infinite periods. Function $V(a,d,e)$ denotes the value function of a household that has earnings shock e, dwelling d and financial saving a in the private market. If the household chooses to remain in the current dwelling, they only need to pay the interest. Therefore, the maximization problem of a household conditional on no dwelling adjustment next period, i.e. $d'=d$, is:

$$\begin{aligned}V^{d'}(a,d,e) &= \max_{a'}\left\{u_d(c)+\pi\beta E\left[V(a',d,e')|e\right]\right\} \text{ if } d'=d,\\ s.t. a'+c &= (1+r)a+e-\phi(d',d), a'\geq 0,\end{aligned}$$

where $\phi(d',d)$ is the interest payment from amortization.

Similarly, if the household chooses to change dwelling in the next period, their value function will appear as:

$$\begin{aligned} V^{d'}(a,d,e) &= \max_{a'} \{u_d(c) + \pi\beta E\left[V(a',d',e')|e\right]\} \text{ if } d' \neq d, \\ s.t. a' + c &= (1+r)a + e - \phi(d',d), a' \geq 0, \end{aligned}$$

where $\phi(d',d)$ is the transaction cost plus the price difference which allows for collateralizing.

The complete household's problem in the private market can be expressed as follows depending on whether they choose to adjust or not:

$$V(a,d,e) = \max_{d'}\{V^{d'}(a,d,e)\}. \tag{1}$$

Pre-reform: Households' Problem in Public Housing Sector In the public housing sector where households' dwellings are allocated by the SOEs, the households can choose either to accept that arrangement or leave for the private market and pay the prices of dwellings in the private market if they have a lower utility staying in the public sector. As discussed above, misallocation is generated when a poor household in the public housing sector is assigned to a high quality house or when a rich household is assigned to a low quality flat. For households rich enough, such mismatch is solved when they leave for free trade in the private market while poorer households will accept such an offer thanks to the low rent (zero in our model) charged by the SOEs even if they would choose a higher quality dwelling were they in the private market. If they decide to stay in the public housing sector and accept the offer either because its quality exceeds or equals their willingness to pay or because they are unwilling to pay an amount of money for a higher quality dwelling given their budget constraint and the attractive zero price of the dwelling in the public sector, the value function will appear as:

$$\begin{aligned} V_{pb}^{d'}(a,d,e) &= \max_{a'} \{u_d(c) + \pi\beta E\left[V_{pb}(a',d,e')|e\right]\}, \\ s.t. a' + c &= (1+r)a + e, \end{aligned}$$

where d is an indicator rather than a choice variable since households are no longer allowed the dwelling choice.

If some households decide to leave for the private market, the continued expected

value will be adopted from the household's problem in the private market:

$$\begin{aligned} V_{pb}^{d'}(a,d,e) &= \max_{a'} \{u_d(c) + \pi\beta E\left[V(a',d',e')|e\right]\} \text{ if } d' > d, \\ s.t. a' + c &= (1+r)a + e - \phi(d',d). \end{aligned}$$

Therefore, between the choices of staying and leaving, the households in the public housing sector choose the one that brings them higher value:

$$V_{pb}(a,d,e) = \max_{d'}\{V_{pb}^{d'}(a,d,e)\} = \max\{V_{pb}^{d'=d}(a,d,e), V^{d'>d}(a,d,e)\}. \tag{2}$$

Pre-reform Equlibrium Ours is a dynamic general equilibrium model where households' saving decisions, their housing choices, choice of staying in the public sector or leaving for the private sector as well as house prices are endogenous.

We describe the stationary equilibrium of the pre-reform model as: Given interest rate r, an allocation of aggregate stock of flats and houses in both public sector and private sector, there exists a distribution of households x^* in different states of financial wealth, earnings and dwelling together with a set of dwelling prices p_f^*, p_h^* such that

1. Private dwelling markets clear:

$$\int_{a,f,e} dx = \mu_f \ , \ \int_{a,h,e} dx = \mu_h;$$

2. Distribution x^* is stationary in the sense that the flow of households from the public sector to the private market is zero;

3. All dwellings in the public sector are occupied. The implication is that if there are households leaving the public sector although they are already provided with some shelter, their vacant positions will be fulfilled by those originally provided with no housing in the public sector.

4.2 Model of the Post-Reform Economy

The post-reform model captures the features of an established complete private market and an accompanying mortgage market. In the post-reform economy, after the

SOEs gradually sell the public housing stock to the sitting tenants, all housing stock is traded in the private market established after the housing reform. We model the establishment of the mortgage financing system by lowering the down payment ratio α. The households' problem can be set up exactly the same as the one of the pre-reform private market and we define the stationary equilibrium in post-reform economy as: Given r, there exists a distribution of households x^* in different states of financial wealth, earnings and dwelling together with a set of asset prices p_f^*, p_h^* such that

1. Housing markets are clear:

$$\int_{a,f,e} dx = \mu'_f \ , \ \int_{a,h,e} dx = \mu'_h.$$

2. Distribution x^* is stationary.

5 Parameterization and Calibration

We follow a procedure as follows to calibrate and verify the explanatory power of the models. We first calibrate the preference parameters and discount factor using stationary equilibrium of pre-reform economy, in the meantime we use both aggregate and sectoral level indicators from the CHIP 1995 to check the validity of the calibration. Then we incorporate these parameters into the pre-reform economy settings to compute its stationary equilibrium and compare the results generated of the post-reform model to the corresponding indicators from the CHIP 2002 data.

Some specifications of the model are independent of the equilibrium and can be set beforehand while some parameters should be endogenously generated to match targets of some statistics acquired from the data. As we discussed in detail in Section 3, the top choice of targets should come from the wealth/income and price/income ratios.

5.1 Parameters Set Independently

1. Markov process and earnings states: we target a Gini coefficient of 0.29 from the CHIP 1995 to acquire the Markov process and earnings states for the model. we refer to Fan et al. (2009) for the income process estimation in China. In

constrast with the U.S. data, income shocks for Chinese individuals are more volatile but less persistent : their estimation of the AR(1) income process results in parameters of persistence and variance respectively $\rho = 0.969, \sigma = 0.044$.[5]

2. Population turnover rate: We refer to Ríos-Rull and Sánchez-Marcos (2008) and set the turnover rate to be 0.985, implying 67 years of average adult life in the absence of population growth

3. Risk free interest rate: 0.03. According to China's National Bureau of Statistics (NBS), the nominal benchmark one year loan and deposit interest rate of year 1993 is 10.17% and 10.08% , however, at that period, the inflation rate is 14.7%. (In years from 1993 to 1995 the inflation was extremely severe.) So the real interest rate is negative. Without a properly chosen interest rate, given that in the pre-reform economy, the mortgage market is not yet developed and we still have a high down payment ratio set for trading of dwellings, the impact from the interest rate in the post-reform economy would be even greater with alleviated credit restrictions. In the model, the interest rate on the one side represents the return to financial asset holdings, on the other side is the mortgage interest rate. In order to find a consistent and representative interest rate, we take the real average one-year benchmark loan interest rate instead of the deposit interest rate. Avoiding the high inflation periods, we obtain 4.12% of this indicator by taking the average of the benchmark loan interest rates announced by the People's Bank of China during the period 1996-2012. The average one-year benchmark deposit interest rate from 1996-2012 is 0.89%, however, the average return to financial assets for urban household should be higher than this considering other forms of financial assets such as stocks and bonds and more importantly, urban financial wealth occupies a smaller portion in the total net worth than the housing wealth so we adopt an interest rate that leans more towards loaning activities of the economy. We further downgrade the 4.12% of loan interest rate by 30% as is allowed as the lower bound by the central bank[6] and obtain an interest rate of roughly 3%.

4. Transaction cost : 0.2. There are several types of taxes and fees that are imposed on the two parties of the housing transaction. According to Notice of the State

[5] According to them, with similar methods of GMM estimation, the US income process features $\rho = 0.982, \sigma = 0.024$ in Storesletten et al. (2004)

[6] Usually the central bank sets the floor of lending rate 10 percent below its benchmark rate, with an exception for the mortgage rate allowed to be 30% below the benchmark rate.

Table 5: Supply of Low and High Quailty Housing across Sectors in the Pre-reform Period

Total supply of dwellings (100%)	0.9
Dwellings in the public sector (67.29%)	0.61
-Flats in the public sector (72.17%)	0.437
-Houses in the public sector (27.83%)	0.169
Dwellings in the private market (32.71%)	0.29
-Flats in the private market (54.89%)	0.161
-Houses in the private market (45.11%)	0.133

Source: CHIP 1995

Administration of Taxation about Further Strengthening the Administration of Real Estate Taxes (State Administration of Taxation (2005)), altogether 8 types of taxes and fees for individual buyers exist in the purchase of a dwelling. Referring to "Provisional Regulations of the People's Republic of China on Title Deed Tax", "Provisional Regulations of the People's Republic of China on Stamp Tax", "Provisional Regulations of the People's Republic of China on Business Tax", "Regulations for the Implementation of the Individual Income Tax Law of the People's Republic of China", etc (State Administration of Taxation (2007)), the transaction cost in China's housing trade includes 1.5%-3% deed tax on the buyer, stamp tax 0.05% on both sides, business tax 5.55% on the seller ((local) education supplementary tax, city planning tax included), individual income tax 20% of the price difference on the seller (land value increment tax is exempted for individuals). Besides, there could be relevant lawyer and certifications fees 0.05% on both sides, agency fee 1% on the buyer, and some procedure fee based on the size of the dwelling, altogether it is around 20% of the total value of the dwelling considering all the tax burdens that could be transferred onto the buyer and the seller.

5. Exogenous supply of high/low quality dwellings in public and private housing sector: The population of households is normalized to 1. We set the supply of aggregate housing stock to be 0.9 for the reason of co-residence mentioned in section 3. Specifically in Table 5 we provide the exogenous supply of high/low quality dwellings (houses/flats) across the housing sectors in the pre-reform period.

6. Proportion of households eligible for public housing: 0.993

   In the pre-reform economy, we consider the whole population of public employ-

ees as eligible for public housing. According to UHS 1992, 1993, 1995 and CHIP 1995, only 0.7% of the total population works in the private economy. Therefore we set the proportion of household eligible for public housing to 99.3%.

7. Coefficient of relative risk aversion: a value in [1,3]. For the CRRA utility function form assumed, we set the coefficient of relative risk aversion equal to 2 as is the standard practice in literature.

8. Down payment ratio: in the pre-reform economy, there is no mortgage market and most of the transactions of private dwellings are carried out between individuals through the management of the housing administration office. Thus, we set the down payment ratio to 1. In 1999, the People's Bank of China issued "Several Opinions on Encouraging Consumption Mortgage", increasing the housing mortgage ratio to 80% of the total price. In 2005, "Notice of the People's Bank of China on Adjusting the Housing Credit Policy and Excess Reserve Interest Rate for Commercial Banks" was announced, indicating that "in cities or areas where the real estate prices have risen too fast, the minimum down payment for individual housing loans shall be raised from the current 20% to 30%" (People's Bank of China (2005)), and from 2006 on, it regulated in "Notice of the People's Bank of China on Relevant Matters concerning the Adjustment of Housing Credit Policies" that "From June 1, 2006, the down payment of the mortgage loans for individual houses shall be no less than 30%. But the provisions on the down payment of 20% for houses purchased for living with less than 90 square meters in the dwelling size shall still be followed (People's Bank of China (2006))." Therefore, for experimental design for the post-reform economy, we will test with the official announcement of downpayment ratio of 20%.

5.2 Calibration: Parameters Set Endogenously

1. Discount factor: we target the networth/income ratio of 2.52 in the pre-reform economy to obtain the discount factor which is closely related with household's saving behavior, thus affecting wealth accumulation.

2. Utility shifters: By targeting house price/flat price ratio 1.38 and housing wealth/income ratio 1.33 to catch both relative and aggregate effects from dwelling prices, we acquire the two utility shifters for flats and houses. The

Table 6: Description and Source of Parameters Set Independently

Moments to Match	Source
Gini coefficient of income: 0.29	CHIP(1995)
Networth (of wealth)/Income ratio: 2.51	CHIP(1995)
Risk free interest rate: 0.03	People's bank of China
Transaction cost : 0.2	State Administration of Taxation, etc
Exogenous supply of low/high quality apartments in public and private sector:$\mu^f_{pb} = 0.437, \mu^h_{pb} = 0.169, \mu^f_{pt} = 0.161, \mu^h_{pt} = 0.133$	CHIP(1995)
Proportion of households eligible/NOT eligible for public housing: 0.9/0.1	CHIP(1995)
Turnover rate: 0.985 (67 years of average adult life)	Rios-Rull, Sanchez-Marcos (2006)
House price/Flat price ratio: 1.37	CHIP(1995)
Housing wealth/Income ratio: 1.35	CHIP(1995)
Coefficient of relative risk aversion:2	value in [1,3]
Down payment ratio: 1	mortgage markets are non-existing

Notes: This table lists all the parameters set exogenously for calibrating the pre-reform economy.

utility shifters reflect different preferences of households for flats and houses, which will be an important driver of the demand for each type of dwellings and hence of the price levels. [7]

The complete list of targets of our pre-reform model and their sources is provided in Table 6 and Table 7. In Table 7, the values of the parameters endogenously generated are provided together with the comparison of the related targets matched by the model to the data.

[7]Since we also target networth/income ratio , financial wealth/income ratio is also matched in this way.

Table 7: Results of Endogenous Parameters & Comparison with Related Targets from Data

	Targets from Data	Value	Our Model's Value	Parameters' Value
Utility Shifters γ^d	Housing Wealth/Income	1.35	1.28	[0.16 0.146]
	House Price/Flat Price	1.37	1.37	
Discount Factor	Networth/Income	2.44	2.44	0.9227

Notes: The utility shifter for flat γ^f is 0.16. Given that the coefficient of risk aversion is 2, a larger utility shifter represents a lower level of preference.

6 Calibration and Experiment Results

6.1 Calibration of the Pre-reform Economy

Following the experimental procedure discussed above, we first obtain the calibration results from the pre-reform economy. It turns out that not only values for the utility shifters and the discount factor can be acquired by matching the wealth/income ratios and price levels of different types of dwellings, but also that the calibration does a good job in matching most of the other pre-reform economy wealth/income ratios across housing sectors that are originally not our targets.

In Table 8 are listed all the wealth/income ratios and price information of pre-reform economy on the sectoral as well as on the aggregate level obtained from both our model and the data. Most of the results of the indicators generated by the pre-reform model with two housing sectors match the statistics of the data.

The reason that this model fits the data almost perfectly is because it has well explained the saving incentives of the households in different sectors. The saving incentives are three-dimensional in characterizing the households' wealth accumulation. Firstly, there is the precautionary saving incentive for households to save in the form of financial wealth and self-insure against the idiosyncratic risks. Secondly, in our model, housing acts both as a consumption good and an investment good. As a consumption good, housing consumption provides an extra saving incentive for purchase of a dwelling. While as an investment good, households can accumulate housing wealth as a substitute for financial wealth, which on the contrary offsets the incentive to save in the form of financial wealth. Last but not the least, misallocation, as an important feature of the pre-reform economy, indicates that households who accept the mismatch between their willingness to pay and the actual offer in the pre-reform economy in the public sector are discouraged to go to the private market and thus

Table 8: Summary of Calibration Results of the Pre-reform Model

	Model	Data	Target or Not
Gini coefficient of income	0.30	0.29	Yes
Public sector financial wealth/income	1.16	1.15	No
Private sector financial wealth/income	1.16	1.19	No
Financial wealth/income	1.16	1.16	Yes
Private sector housing wealth/income	3.87	3.97	No
Housing wealth/income	1.28	1.35	Yes
Public sector net worth/income	1.16	1.15	No
Private sector net worth/income	5.03	5.17	No
Net worth/income	2.44	2.51	Yes
House price/flat price	1.37	1.37	Yes
Flat price/income	3.6	3.6	Yes

Notes: This table provides the summary of the calibration results and in the final column is indicated whether this outcome is targeted or not. As can be seen, other than the targets to match, several other results generated by the pre-reform model also fit the data well. The data come from the CHIP 1995.

unable to accumulate wealth in the form of housing wealth. This explains why for the public sector both our model and data reveal practically higher wealth/income ratios than for the private sector. The extent to which misallocation affects household's saving decision and wealth accumulation will be further investigated in the following experiment part.

Misallocation With the calibration results, it is possible then to measure quantitatively misallocation in China's pre-reform economy. More specifically, it needs to be calculated how much on average would a household who stays in public housing prior to the reform consume of housing if they were in the private market and how is that compared to their actual housing consumption. Wang (2011) proposes a measure of misallocation in her empirical paper. After controlling for certain household characteristics, she finds that on average the households in the pre-reform public sector were consuming 15 percent less housing consumption than if they were in the private market. Since we have established this model of pre-reform economy, we could calculate with our model the measure of misallocation in terms of housing wealth following the same definition proposed by Wang. With our model settings, this approach will be modified to account for the heterogeneity of households in asset holdings, dwelling states and income level.

Controlling for the economic and housing characteristics, our model generates an 8.7 percent less housing consumption in households who have chosen to stay in

public housing than what they would have chosen to consume in the private market. Although Wang's argument of the existence of misallocation is proved and quantified, our measure of misallocation is smaller which indicates that the strength of misallocation in our model economy is smaller than the one in the data. We therefore conclude that our results should be seen as a lower bound. The actual impact of misallocation on household decisions and the resulting wealth/income ratios and dwelling prices is likely to be even larger.

The good performance of our model in charactering the pre-reform economy justifies the validity of our parameters acquired through calibration and the implementation of them into the post-reform economy a trustworthy practice.

6.2 Experiments on the Post-reform Economy

We use the parameters calibrated for the pre-reform economy in our post-reform economy to implement the changes and document the effects of the housing reform. The features that should come along after the housing reform are that firstly, the mortgage financing system is established and secondly, that there is no longer government intervention in the housing market and all the housing stock is available for free trade. These features are embodied in the post-reform model with a decreased down payment ratio and characterization of only a private market.

We not only compare the post-reform model's results with the data but also try to answer several related questions: firstly, whether "privatization" drives up dwelling prices as also argued by Wang (2011). And secondly, to our knowledge, the mortgage market in the post reform economy is not fully developed and we would want to see to what extent the mortgage market is liberalized after the housing market reform. Thirdly, if there are differences between the results generated by our model and the data, possible explanations should be proposed and tested to verify missing mechanisms during the housing reform that the model might fail to capture with incorporation of mere changes in institutions of the housing market. One of the possible example could be the argument of Chamon and Prasad (2007) that an increase in earnings uncertainty can help account for the increase in wealth/income ratios. We also incorporate supply changes and preference shocks into the calibration exercise to study their separate and combing with other forces, the overall effects on households' saving behavior and thus wealth and housing accumulation.

The Effects of Privatization We first investigate the effects of privatization

by incorporating the pre-reform economy feature of misallocation into the post-reform economy in a counter-factual experiment. This could further answer to the question of the strength of misallocation. Besides, in Wang (2011), she suggests that "privatization" alone would cause the price of the dwellings to rise due to the theoretical increase in demand, which outweighs the theoretical increase in supply after the reform. The validity of this claim could also be checked by our model.

We increase the down payment ratio to 1 in this experiment to isolate the first effect of mortgage market liberalization and only investigate the influence of the second feature of privatization in the post-reform economy. As can be seen from Table 9, the effect of privatization is contrary to what Wang (2011) expected. The reason is that after the housing reform, the supply of the dwellings exceeds the demand generated from the market liberalization, causing dwelling prices actually to decrease.

Another major result from this experiment is that the existence of misallocation in pre-reform China is strong enough to cause the households to change saving behavior and hold financial and housing wealth in proportions significantly different from if they were in an economy without this misallocation. From Table 8 we know that households in public sector and private sector do not differ much in their financial wealth holdings in the economy with misallocation. Therefore the decrease in financial wealth and increase in housing wealth when misallocation is removed indicates that first, misallocation distorts saving behavior of households from both sectors and second, once ownership is assume without misallocation, housing wealth will increase along even if prices are not increasing. The mechanism behind the change of saving behavior is that housing an asset cannot be recognized as a part of wealth for households in the public sector while for households in the private market, the small size of the market together with the credit market constraint of no mortgage financing make it inconvenient to use housing as an equity against income shocks. This distortion makes saving in the form of financial wealth more appealing.

Aggregate Effects of the Housing Reform With the effect of privatization incorporated, we further take into account the effect from the development of the mortgage market to account for the aggregate effects of the housing reform. By decreasing the down payment ratio we could check the effects of implementing the mortgage market. From the huge increase in the price level reported in Table 10 after we implement the official down payment ratio of 0.2 into the economy, which is contrary to the actual decline of price/income ratio in the data, we could conclude that the our experiment overstates the degree of development in the mortgage market.

Table 9: The Effects of Privatization

	Economy with Misallocation Implemented	Economy without Misallocation
Financial wealth/Income	1.16	1.03
Housing wealth/Income	1.28	2.25
Net worth/Income	2.44	3.28
House price/Flat Price	1.37	1.89
Flat price/Income	3.6	1.94

Notes: This table provides the changes in indicators from the effects of privatization by incorporating misallocation into the post-reform economy and compare it with the free market economy. Notice that this "economy with misallocation implemented" is in fact the pre-reform economy since the down payment ratio is still set at 1. And the "economy without misallocation" is the post-reform economy without the effect of credit market development. Naturally, the results of the economy with misallocation are adopted from the calibration of the pre-reform period.

The existence of refinancing options and no credit spread could be the explanation for the underdevelopment of mortgage markets in post-reform China. For the record, Chamon and Prasad (2007) also reports that the proportion of households that have used mortgage financing and are repaying a home loan is still low, standing at only 5 percent in 2005.

Nevertheless, Table 10 offers another perspective into the effects of alleviation of credit constraint on household's saving behavior. We argue that there are two mechanisms in this experiment. On the one hand, with less trade frictions from credit constrain, housing as an asset is more appealing, which will lead to an increase in its value and share in the households' wealth. On the other hand, however, given that housing as a consumption good is cheaper to acquire with the mortgage financing opportunities, the price of housing will be driven up by the demand to an extent that housing consumption becomes less appealing. This channel will reduce the wealth accumulated in the form of housing. The results in Table 10 show that financial wealth significantly increases after down payment ratio decreases. The implication is clear that the effect of mortgage market development through housing as a consumption good outweighs its effect through housing's as an asset.

Increase in Income Inequality We now look at the channel of increase in income inequality together with misallocation for explaining financial and housing wealth increase. [8]We calibrate the income process so that a post-reform GINI of

[8]Chamon and Prasad (2007) explain the high saving rate of Chinese households by the increasing

Table 10: Aggegate Effects of the Housing Reform

	Economy without Mortgage Market	Economy with Mortgage Market
Financial wealth/Income	1.03	1.51
Housing wealth/Income	2.25	1.83
Net worth/Income	3.28	3.34
House price/Flat price	1.89	1.49
Flat price/Income	1.94	8.7

Notes: The second column of this table is an economy without a mortgage market but privatization is realized, which fundamentally is the same economy in the third column of Table 9. The third column is an economy with both mortgage market and privatization, which therefore is our post-reform economy. The down payment ratio is decreased to the official level of 0.2.

Table 11: Effects of Increase in Income Inequality in the Post-reform Economy

	Model of Post-reform Economy ($dp = 1$)	Data of Post-reform Economy
Financial wealth/Income	1.2	1.62
Housing wealth/Income	2.27	3.16
Net worth/Income	3.47	4.78
House price/Flat price	2.08	1.48
Flat price/Income	1.88	3.33

Notes: This table shows the effect of rising income inequality in the post-reform model in the second column. Data of post-reform economy are from the CHIP 2002.

0.32 is matched in Table 11. The financial wealth/income ratio increases due to the incentive to self-insure as states are more persistent and income inequality is higher.

However, there are still discrepancies between the wealth/income ratios generated by the model and by the data. Since during the housing reform, supply of housing and relative supply of high quality housing has changed dramatically, we now incorporate those changes additionally.

Decrease in Housing Supply and Increase in Relative Supply of High Quality Housing

We now look at the channel through housing supply. In Table 12, the relative supplies of different quality housing are listed. After the housing reform, public

idiosyncratic risks in earnings. Chamon et al. (2013) also by studying the income process of the Chinese households find that there is a trend of a rising variance during the period of housing reform, with the point estimates steadily rising from 0.012 in 1991 to 0.04 by 2004.

Table 12: Supply of Low and High Quality Housing across Sectors in the Post-reform Period

Total supply of dwellings (100%)	0.9
Dwellings in the public sector (16.67%)	0.15
-Flats in the public sector (68.61%)	0.1
-Houses in the public sector (31.39%)	0.05
Dwellings in the private market (83.33%)	0.75
-Flats in the private market (39.41%)	0.3
-Houses in the private market (60.59%)	0.45

Source: CHIP 2002

Table 13: Effects of Changes in Housing Supply in the Post-reform Economy

	Model of Post-reform Economy ($dp = 1$)	Data of Post-reform Economy
Financial wealth/Income	1.28	1.62
Housing wealth/Income	3.21	3.16
Net worth/Income	4.49	4.78
House price/Flat price	1.39	1.48
Flat price/Income	3.44	3.33

Notes: This table shows the effect of changing housing supply in the post-reform model in the second column. Data of post-reform economy are from the CHIP 2002.

tenants are renters who live in the economically affordable housing supplied by the government or renters who do not choose to exercise ownership right since they are not eager to trading housing because of economic constraint or other reasons. This group becomes the extra renters $d = 0$. The large group 83% of the economy is established as a private market and in particular, the high quality housing in this market has risen significantly compared with the pre-reform market.

We incorporate the changes in misallocation, income inequality and supply together and report the results in Table 13. As we can see, after we have introduced those changes, other than the financial wealth/income ratio, the other indicators all match the data well.

Increase in Discount Factor The increase in financial wealth/income ratio can be traced to different sources. Literature has centered on various mechanisms to explain Chinese households' saving behavior. We now look at the channel through the discount factor. In Table 14, financial wealth and housing wealth both increase because of a higher discount factor because future non-housing consumption and

Table 14: Effects of Changes in Discount Factor in the Post-reform Economy

	Model of Post-reform Economy ($dp = 1$)	Data of Post-reform Economy
Financial wealth/Income	1.52	1.62
Housing wealth/Income	3.34	3.16
Net worth/Income	4.86	4.78
House price/Flat price	1.8	1.48
Flat price/Income	3.58	3.33

Notes: This table shows the effect of discount factor β in the post-reform model in the second column. Data of post-reform economy are from the CHIP 2002.

Table 15: Effects of Increase in Utility Gain of Housing in the Post-reform Economy

	Model of Post-reform Economy ($\gamma^d = [0.12\ 0.11]$)	Data of Post-reform Economy
Financial wealth/Income	1.29	1.62
Housing wealth/Income	3.26	3.16
Net worth/Income	4.55	4.78
House price/Flat price	1.35	1.48
Flat price/Income	3.55	3.33

Notes: This table shows the effect of rising preferences for housing in the post-reform model in the second column. Data of post-reform economy are from the CHIP 2002.

housing consumption are value more.

With the above results. We can see that if misallocation is solved, households' saving will actually decrease, and increase in inequality and changes in housing supply do not affect households' saving behavior much.

Increase in Utility Gain of Housing We could check how preference change would affect the financial wealth and housing wealth/income ratios. As is argued by Wei and Zhang (2011), there seems to be an increasing value attached to housing assets of a household due to a fiercer competition in the marriage market of China. Thus, we adjust with the assumption that the utility gain from the dwellings for the households has increased over the years. We decrease both of the utility shifters and report the results in Table 15. The increase in both financial wealth and housing wealth/income ratios after the adjustment confirms this channel.

7 Conclusion

We empirically documented large increases in financial wealth and housing wealth/income ratio of urban Chinese households between 1995 and 2002. We analyzed the drivers behind these trends with the help of a quantitative model. Our focus was on the institutional changes that the urban housing market experienced following the 1994 housing market reform, in particular the introduction of mortgage markets and the introduction of a large private housing market replacing the allocation of housing through state-owned enterprises. We found that the introduction of mortgages is not as important as the introduction of private housing markets. The introduction of private housing markets resolved misallocation that was present in the pre-reform allocation of dwellings and recovered households' optimal choices. We concluded that the interaction between institutional changes and an increase in earnings uncertainty can only partly explain the data trends. The large rise in the housing wealth/income ratio can be either driven by urbanization and migration which reduce the relative housing supply or it can be driven by an increasing preference for the housing. The large rise in financial wealth/income ratio can be driven by increasing preference for housing or income uncertainty or other drivers that affects the discount factor.

Our research will further incorporate documentation and analysis of micro-level changes in wealth/income ratios of households from different social groups in the pre-reform economy. Those households from the group which rent a better quality house in their favor due to factors such as social status which are unrelated with family characteristics and economic situations will continue to benefit from the sale of public housing directly to sitting tenants. Therefore the concerns such as reinforced inequalities after the housing reform (Wang and Murie (2000)) will be addressed under our framework.

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