A Quantitative Evaluation of the Housing Provident Fund Program in China

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Abstract

The Housing Provident Fund program is the largest public housing program in China. It was created in 1999 to enhance homeownership and to make housing more affordable. This program involves a mandatory savings scheme that requires participating workers to deposit a fraction of their income into the program. Past deposits are refunded when the worker purchases a house, or retires. The program provides mortgages at subsidized rates to facilitate these home purchases. Given the empirical challenges in evaluating the success of this program, I use a calibrated life-cycle model to quantify the effectiveness of these polices. My analysis shows that a housing program with these features is expected to increase the rate of homeownership by 4 percentage points in steady state. In addition, the average home size increases by 21% relative to the baseline model. These results are largely unaffected by the existence of employer contributions. I discuss the economic mechanisms by which these outcomes are achieved.

Keywords: Housing Provident Fund, Homeownership, Average home size.
JEL Codes: E2, E6, H3, R2, R3.

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1 Introduction

Governments around the world take measures to support homeownership. These actions are driven by the belief that housing, for most households, is both an important investment asset and a necessary consumption good, and that homeownership promotes social and economic stability. The U.S. government, for example, has fostered homeownership by encouraging subprime lending and expanding secondary mortgage markets (see, e.g., Mian and Sufi (2009) and Gabriel and Rosenthal (2010)). Arguably as a result, the U.S. homeownership rate reached 70% in 2004, compared to 60% in 1960 and 40% in 1940. Since the mortgage crisis of 2008, however, this rate has dropped back to 65%. Many Asian governments, in contrast, have adopted more centralized, mandatory savings plans that aim to fund households' housing needs. The Housing Provident Fund (HPF) in China is one such an example. Table 1 provides examples of similar programs in other countries.

The HPF was first enacted in 1999 and has been applied to an increasing number of regions of the country since then.[1] The policies stipulated by the HPF apply to all urban workers, regardless of the type of the enterprise they work for. There are two key features of this program. First, it is a mandatory savings scheme intended to fund housing purchases. Specifically, the government requires each worker to deposit a mandatory fraction of his or her salary to the program until the worker purchases his or her first house, at which point the government refunds the worker's past deposits. After the worker purchases the first house, the HPF still collects a fraction of the worker's salary every month, but refunds this amount to the worker usually within the same month. If the worker never purchases a house during his or her working life, the HPF returns all past deposits to the worker at the time he or she retires. Second, the program provides below-market rate mortgages to participants. The HPF is the largest public housing program in China, both in terms of the number of workers enrolled and of the funds deposited and distributed. According to the annual report published by the Ministry of Housing and Urban-Rural Development in China, in 2015, 124 million workers enrolled in the HPF (16% of the labor force), 1.5 trillion Yuan (2% of GDP) were deposited in the program, and 1.1 trillion Yuan were lent out for home purchases and building.

There has been much interest in the question of how effective this program has been at stimulating homeownership (see, e.g., Logan et al. (1999), Li (2000), Fu et al. (2000), Huang and Clark (2002), Buttimer et al. (2004), Meng et al. (2005), Yeung and Howes (2006), Xu (2016), and Tang and Coulson (2017)). Empirically evaluating the success of this program is

[1] For further details on the HPF and a review of the history of related Chinese housing policies, see Xu (2016).

not easy. There are several challenges. For example, at the micro level, workers may select when to join the program. If this decision depends on unobserved characteristics, regression estimates suffer from selection bias. Alternatively, one may exploit regional variation in the timing of the implementation of this program. To the extent that the adoption of this program is anticipated by households, however, the causal effect will not be identified. Finally, at the national level, the length of time for which these policies have been in effect is too short to estimate the impact of the program, even if a credible counterfactual could be constructed.

Given these empirical challenges, the current paper uses a calibrated life-cycle model to quantitatively evaluate the expected impact of the HPF program. The use of quantitative theory also helps understand the mechanisms by which these polices affect the housing market. I focus on the effect of the program on two outcome variables: the rate of homeownership and the average home size. The baseline model captures the consumption and savings behavior of Chinese households over their life cycle. Households can choose both the timing and the size of their home purchase. Within the same generation, households are heterogeneous in that each house purchase is associated with a randomly drawn transaction cost. As a result, homeownership and average home size vary over the life cycle and across households. I calibrate the model based on household survey data from the Chinese Household Income Project Series. The model produces a rate of homeownership that is increasing with age, and a roughly flat path of the avergage home size over the life cycle.

I then incorporate the two key features of the HPF program into this baseline model. First, the mandatory-savings feature is captured by a parameter that represents the fraction of income to be deposited into the program. Second, the mortgage subsidies are captured by the below-market mortgage rate. I set these parameters according to the values implemented by the HPF program in China. Finally, I compare the life-cycle path of the rate of homeownership and of the average home size with the corresponding paths in the baseline model.

My analysis shows that a housing program with these features is expected to increase the rate of homeownership by 4 percentage points in steady state, which is equivalent to a 10% increase in the homeownership rate relative to the baseline model. This increase is mainly due to the fact that many young households, who would otherwise buy a house later in life or who would simply choose never to buy a house, under this program choose to become homeowners. In addition, the average home size increases by 21% relative to the baseline model. This effect is mainly driven by middle-aged and old homebuyers.

To understand these results, I conduct two additional policy experiments. First, I consider a housing program that requires mandatory savings, but that does not offer mortgages at

below-market rates. Second, I consider a program that offers subsidized mortgages, but that does not require mandatory savings. I show that each of these alternative programs on its own raises the homeownership rate almost as much as both programs combined. The main benefit of combining both programs is an increase in the average house size.

The model provides some interesting insights into how these policies affect economic outcomes. For example, the mandatory savings program forcibly reallocates a fraction of the income of young households to later in their life, making it harder for young people, who are already liquidity constrained, to smooth consumption. Hence, many households choose to become a homeowner earlier in life to avoid additional forced savings. In contrast, the mortgages offered at a below-market rate create a wealth effect that allows households to borrow at a lower cost. This effect drives more households to purchase a house earlier in their life and to purchase a larger house.

The remainder of the paper is organized as follows. Section 2 describes the baseline model and discusses how to incorporate the key features of the HPF program into the baseline model. Section 3 outlines the model calibration. Section 4 presents the results from a series of policy experiments. Section 5 extends the model to incorporate employer contributions. Section 6 concludes.

2 Model

The baseline partial equilibrium life-cycle model is intended to capture households' decisions about non-housing consumption (henceforth referred to as consumption), the timing of purchasing one's first home, and the size of this home purchase.[2] The model has two important features. First, following Leahy and Zeira (2005), I make the simplifying assumption that households purchase a house, if at all, only once in their lives. Second, a house purchase is associated with a randomly drawn transaction cost. This assumption creates heterogeneity across households within the same generation. I then introduce the two key features of the HPF program, and embed these features into the baseline model.

2.1 Baseline Model

Time is discrete. The economy is populated with overlapping generations of households whose income and wealth differ across the life cycle. In each period, a mass of households is born and lives for J periods. In the first J_y periods of life, households work and earn labor

[2]The partial equilibrium consumption-choice framework, unlike a standard general equilibrium model of the housing market (see, e.g., Iacoviello and Neri (2010)), has the advantage of modeling more complicated household decisions, such as discrete purchases and heterogeneous household behavior (see, e.g., Ortalo-Magne and Rady (2006), Yang (2009), Iacoviello and Pavan (2013), and Berger et al. (2015)).

income. In the remaining $J - J_y$ periods, households retire and receive retirement income.

Households start their life without a house. In each period, households make decisions about consumption, about whether to become a homeowner if they are not already, about the size of the home they decide to buy, and about their savings for the next period. At the end of their life, households leave their total wealth as a bequest, consisting of savings and the value of their house.

A household maximizes expected lifetime utility,

$$E_0 \left\{ \sum_{j=0}^{J-1} \beta^j \left[u(c_j) + v(h_j) \right] + \beta^J \Phi(w_J) \right\}$$

where c and h denote consumption and the home size, respectively. I assume that the flow service generated by the house is proportional to the home size. The second term inside the expectation operator represents the discounted utility from leaving a bequest, specified by the bequest function Φ, the functional form of which is discussed in Section 3. w_J denotes the total wealth at the end of the household's life.

The household problem has a recursive form. The value at the end of the household's life, V_J, is given by the bequest function,

$$V_J(a, h) = \Phi \left((1 + r)a + ph \right)$$

where a denotes savings, p denotes the house price, and h denotes the home size. For lifetime period $j = 0, ..., J - 1$, the value V_j depends on whether the household owns a house at the beginning of the period. If the household owns a house of size h at the beginning of the period, the value is given by

$$\begin{aligned} V_j(a, h) = \max_{c, a'} \quad & u(c) + v(h) + \beta V_{j+1}(a', h) \\ s.t. \quad & c + a' = y + (1 + r)a \\ & -a' \leq \gamma p h. \end{aligned}$$

The first constraint is the budget constraint, where y denotes income and r denotes the interest rate. The second constraint is the collateral constraint. If the household borrows, the borrowing amount cannot exceed a fraction γ of the home value.

If the household does not own a house at the beginning of the period, V_j is the maximum of the value of purchasing a home, V_j^P, and of not purchasing a home, V_j^N, i.e.,

$$V_j(a, f) = \max \left\{ V_j^P(a, f), V_j^N(a) \right\}.$$

The value of purchasing a home is

$$V_j^P(a,f) = \max_{c,a',h'>0} \quad u(c) + \beta V_{j+1}(a', h')$$
$$s.t. \quad c + a' + ph' = y + (1+r)a - f$$
$$-a' \leq \gamma p h'$$

where f is a randomly drawn transaction cost from a continuous distribution F. The value of not purchasing a home is

$$V_j^N(a) = \max_{c,a'} \quad u(c) + \beta E\left[V_{j+1}(a', f')\right]$$
$$s.t. \quad c + a' = y + (1+r)a$$
$$a' \geq 0$$

where $E\left[V_{j+1}(a', f')\right] = \int_{-\infty}^{\infty} V_{j+1}(a', f')dF(f')$. The second constraint is the liquidity constraint, which requires liquid savings to be non-negative. The presence of the collateral constraint and the liquidity constraint jointly imply that any positive borrowing amount must be collateralized by a house.

2.2 Modeling Mandatory Savings

One important feature of the HPF program is a mandatory savings requirement for workers who are not homeowners. Specifically, the government requires each worker to deposit a mandatory fraction of his or her salary to the HPF until the worker purchases his or her first house, at which point the government refunds the worker for all past deposits. After the worker purchases the first house, the HPF still collects a fraction of the worker's salary every month, but refunds this amount to the worker usually within the same month. This is equivalent to not requiring any deposit to the HPF after the worker purchases the first house. Therefore, when modeling the mandatory savings requirement, I assume that existing homeowners are not affected by this requirement.

The mandatory-savings requirement affects the budget constraint of workers who choose not to purchase a house. After subtracting a fraction of their income, for $j = 0, ..., Jy - 1$,

$$V_j^N(a) = \max_{c,a'} \quad u(c) + \beta E\left[V_{j+1}(a', f')\right]$$
$$s.t. \quad c + a' = (1-\theta)y + (1+r)a$$
$$a' \geq 0$$

where θ is the fraction of a worker's income taken away by the program.

The HPF refunds the worker for all past deposits with interest if the worker purchases a

house. The value of purchasing a house at age $j = 1, ..., Jy$ becomes

$$V_j^P(a, f) = \max_{c,a',h'>0} \quad u(c) + \beta V_{j+1}(a', h')$$
$$s.t. \quad c + a' + ph' = y + (1 + r)a - f + \theta \sum_{k=0}^{j-1} y_k(1 + r)^{j-k}$$
$$-a' \leq \gamma ph'.$$

Finally, if the worker never purchases a house during his or her working life, the HPF returns all past deposits to the worker at the time he or she retires. This implies that the budget constraint for a non-homeowner at the retirement age has an extra income term, $\theta \sum_{k=0}^{J_y-1} y_k(1+r)^{J_y-k}$. Since the mandatory savings requirement does not apply to any retired workers, the household problem during the retirement is the same as in the baseline model.

2.3 Modeling Below-Market Rate Mortgages

In an effort to make housing more affordable, the HPF provides below-market rate mortgages. According to the People's Bank of China, the historical spread between the long-term market mortgage rate and the HPF's lending rate is about 2 percentage points. In modeling the mortgages provided by the HPF, I assume that households have two financial assets: liquid savings that earns a market interest rate, and a mortgage debt that is repaid at the rate specified by the HPF. I consider an interest-only repayment schedule that requires interest to be paid every period, but the principal to be paid when the mortgage contract terminates.[3]

Allowing two financial assets adds an additional state variable to the model, which greatly increases the computational cost of solving the model. The value V_J at the end of the household's life becomes

$$V_J(a, h, b) = \Phi\left((1 + r)a + ph - (1 + r^b)b\right)$$

where a denotes liquid savings, r denotes the market interest rate, b denotes the amount of mortgage debt, and r^b denotes the mortgage rate set by the HPF.

For lifetime period $j = 0, ..., J - 1$, the value V_j depends on whether the household owns a house and a mortgage at the beginning of the period,

$$V_j = \begin{cases} V_j(a, h, b), & if \quad h > 0 \\ V_j(a, f), & if \quad h = 0. \end{cases}$$

[3]I also considered an alternative, fully amortized repayment schedule that consists of equal repayments in all periods. The results are quantitatively similar.

where

$$V_j(a,h,b) = \max_{c,a'} \quad u(c) + v(h) + \beta V_{j+1}(a', h, b')$$
$$s.t. \quad c + a' = y + (1+r)a - M$$
$$a' \geq 0$$
$$b' = (1+r^b)b - M$$

where M is the periodic interest repayment. b' is the mortgage debt at the beginning of the next period. The liquidity constraint applies to liquid savings.

If the household does not own a house at the beginning of the period, V_j is the maximum between the value of purchasing a house V_j^P and not purchasing V_j^N. V_j^N is the same as in the baseline model, because a lower mortgage rate would not affect households who choose not to buy a home. V_j^P becomes

$$V_j^P(a,f) = \max_{c,a',h'>0,b'\geq 0} \quad u(c) + \beta V_{j+1}(a', h', b')$$
$$s.t. \quad c + a' + ph' = y + (1+r)a - f + b'$$
$$a' \geq 0$$
$$b' \leq \gamma p h'.$$

Given this analysis, it is straightforward to combine Sections 2.2 and 2.3 to model the two program features simultaneously.

3 Calibration

In order to quantify the impact of the HPF program, the model parameters are calibrated. A summary of the parameter values can be found in Table 2. Age is indexed by $j = 0, ..., J-1$. The model frequency is five-year intervals. Households start their life at age 20, work for 40 years until age 60, and then live for 20 years in retirement, so $J = 12$ and $Jy = 8$. Households do not have initial liquid savings, i.e., $a_0 = 0$.

The discount factor is set to $\beta = 0.93$. The utility function is,

$$u(c) + v(h) = \begin{cases} \ln c + s \ln h, & if \quad h > 0, \\ \ln c & if \quad h = 0. \end{cases}$$

where s denotes the utility weight on housing services. I set $s = 0.25$, so that the expenditures on housing account for 20% of total consumer expenditures, consistent with household survey data from the Chinese Household Income Project Series for 2002.[4]

[4]The Chinese Household Income Project Series (CHIPS) are intended to measure the distribution of

The bequest function is

$$\Phi(w) = \eta \ln(w)$$

where $w \equiv (1+r)a + ph - (1+r^b)b$ denotes the total wealth. η is the bequest parameter. I set $\eta = 1$.

I use the Chinese Household Income Project Series data for 2002 to calibrate household income by age group. The survey provides the household head income between 1998 and 2002. I average the head income across these years, and compute the mean for each age group. I normalize the income of age group 26-30 to 1. Figure 1 shows the age distribution of income.

I normalize the house price to $p = 1$. The mandatory fraction of income to be deposited into the program is set as $\theta = 0.15$, consistent with the average of the workers' contribution rate across cities in China from 1999 to 2015. The market savings rate is set at $r = 0.05$, consistent with the deposit interest rate in China. In all simulations, the HPF program creates an interest rate spread of 2 percent, i.e., $r^b = 0.03$. The transaction cost is assumed to be normally distributed with the mean and variance chosen to match the distribution of homeownership rate by age group.

4 Policy Experiments

In this section, I evaluate the impact of the HPF program on the homeownership rate and on the average home size in steady state. This helps control for transition dynamics as the program is introduced. I compute the optimal life-cycle choices in steady state by simulating the life-cycle profiles of 4,000 households. I show that the program meets the government's objective of enhancing homeownership. The expected increase is 4 percentage points. The HPF also raises the average home size by 21%. Since the program has two distinct features, each of which may affect household decisions differently, I also investigate the impact of these two features separately. The results are summarized in Table 3. I conclude that each feature alone can enhance homeownership and the home size almost as much as the two features combined. The main benefit of combining both features is an increase in the average house size. I also examine how sensitive the rate of homeownership and the average home size are to changes in the key policy parameters.

personal income in both rural and urban areas of China. These survey data were collected in 1988, 1995 and 2002. Individual respondents reported their demographic characteristics, income, employment, and expenditures. I obtain the 2002 CHIPS data from the ICPSR at the University of Michigan.

4.1 The Impact of HPF

Figure 2 shows the life-cycle profile of four key variables in the baseline model (solid lines) and under the HPF program (dotted lines). These variables include the purchase rate (the fraction of homebuyers), the homeownership rate (the fraction of homeowners), the average purchase size of homebuyers, and the average home size of all homeowners. In the baseline model, the purchase rate, shown in the upper left panel, peaks at age 30 to 35 and then gradually declines. Since for each age group there is always a fraction of households becoming new homeowners, the homeownership rate, shown in the upper right panel, is monotonically increasing with age and is concave after age 35. The purchase size in the lower left panel shows a weak hump during age 35 to 70. After age 70, the purchase size declines, because the life horizon shortens. Simply put, old purchasers do not need a large home. The average home size, shown in the lower right panel, is roughly flat across age. This means that in the baseline model households within the same generation do not differ much in the size of the home they purchased, but that they do differ in the timing of their purchases.

Under the HPF program, a substantial fraction of households purchases their homes at age 25 to 30, earlier than in the baseline model. In addition, households between age 70-75 increase their purchases. For all other age groups, the program does not change much the purchase rate. This implies that there are some households who otherwise would not purchase a house, but choose to buy one under this program. The average homeownership rate across all age groups increases by 4 percentage points relative to the baseline model, as shown in Table 3. The average purchase size increases in all age groups under the HPF program, especially after age 30. This implies that the average home size increases in all ages. Overall, the average home size across all age groups increases by 21% relative to the baseline model.

To understand these results, I conduct two additional policy experiments in the remainder of this section. First, I consider a housing program that requires mandatory savings, but that does not offer mortgages at below-market rates. Second, I consider a program that offers below-market rate mortgages, but that does not require mandatory savings.

4.2 The Effect of the Mandatory-Savings Policy in Isolation

Figure 3 shows for different age groups the home purchase rate and the average size of new homes purchased, when the government introduces a housing program that only has a mandatory savings feature as described in Section 2.2. As shown in the left panel, the mandatory savings policy pushes forward the timing of purchasing a home, especially

for young households. It also increases the homeownership rate in all age groups. The intuition is that the mandatory savings program forcibly reallocates a fraction of income of young households to later in their life, making it harder for young people, who are already liquidity constrained, to smooth consumption. Hence, many households choose to become a homeowner earlier in life to avoid these forced savings. Since more young households choose to buy a home at the time when they do not have much income, they choose a smaller home. Those who purchase a house in a later stage of life get refunded for the past mandatory deposits, allowing them to afford a larger home, as shown in the right panel.

The mandatory savings policy also affects household wealth and consumption. As shown in Figure 4, mandatory deposits during the working life reduce household liquid wealth, and create a jump in wealth at the retirement age when non-homeowners get a large refund from all previous mandatory savings. This implies that the consumption path is less smooth, and also exhibits a major jump at the retirement age.

4.3 The Effect of Below-Market Mortgage Rates in Isolation

Figure 5 shows the home purchase rate and the average size of new homes purchased by age group when the government introduces a housing program that provides below-market rate mortgages as described in Section 2.3. This policy lowers the borrowing cost and hence creates a wealth effect for all homeowners. Many young households choose to purchase a house earlier in their life at age 30, rather than age 35, as housing becomes more affordable in the early stage of life. This policy also drives some old households aged 70 to 75, who otherwise would not become a homeowner, to purchase a house. This directly explains the increase in the home purchase rate at age 75 under the HPF program, as shown in Figure 2. The policy increases overall home purchase size, especially of middle-aged and old homebuyers, again due to the wealth effect.

The wealth effect of this policy can be illustrated by plotting the average wealth over the life cycle. Figure 6 shows that average wealth increases at all ages. Because of this wealth effect, average consumption beyond age 45 is higher than in the baseline economy. Consumption below age 45 is lower, because many households in that age group choose to purchase a house in response to this policy.

4.4 Sensitivity Analysis

There are two key parameters in the model that capture the features of the HPF program: workers' contributions to the program, expressed as a fraction θ of income, and the mortgage rate provided by the program, r^b (or equivalently, the interest rate spread, $r - r^b$). I now

examine how sensitive the homeownership rate and the average home size are to changes in these parameters. Figure 7 shows the homeownership rate and the home size normalized relative to the baseline model as a function of θ, assuming a mortgage rate of 2 percent below the market rate. For low θ, the homeownership rate is not sensitive to θ. Increasing θ only increases the average home size. For θ greater than 0.15, increasing θ further raises both the homeownership rate and the average home size. Figure 8 shows the results of a similar exercise with θ fixed at 0.15 and different values of the mortgage rate. As long as the mortgage rate is only slightly below the market rate, the homeownership rate does not change much. As the mortgage spread widens beyond about 2 percent, both variables increase.

5 The Role of the Employer Contribution

Another feature of the HPF program is that the employer of a program participant is required by the government to contribute to the participant's HPF savings. Both the worker's deposits and the employer's contributions are refunded to the worker with interest when the worker purchases a house or retires, whichever is earlier. How much an employer contributes, however, is chosen by the employer, and varies according to local regulations and the employer's profit condition. The HPF program requires that the employer should contribute 5-20% of the worker's income, and that the employer's contribution should not exceed the worker's deposit. In addition, unprofitable firms may lower their contributions, or may temporarily suspend them.

To understand how this additional feature affects homeownership and the average home size, I first consider a model without the below-market mortgage rates. I consider a housing program that requires a participant to deposit 15% of his or her income and requires the employer to match x% of the worker's deposit, where $0 \leq x \leq 100$. For example, $x = 0$ represents the program in section 2.2, and $x = 100$ means that the employer matches the worker's contribution dollar by dollar.

Figure 9 shows the results for this exercise. When x is high, households tend to postpone their home purchase. This is especially true for young households. The intuition is that the longer a worker contributes to the program, the more additional contributions will be made by his or her employer. As a result, when x is high, many households delay their home purchase until retirement. In contrast, when x is low, the employer contribution has almost no incremental effect on the homeownership rate. However, it does increase the average size of new homes.

Next, I reintroduce the below-market mortgage rate feature and show that the effect

on the average homeownership rate and the average home size are robust to the inclusion of employer contributions. Table 4 summarizes the homeownership rate and the average home size for different x, where $x = 0$ represents the HPF program discussed in section 4.1. Employer contributions increase the homeownership rate slightly once x approaches 80. Likewise, the average home size rises slightly once x increases beyond above 50. Overall, however, the results in section 4.1 are robust to the inclusion of employer contributions.

One can also break down these results by age. Similar to Figure 9, Figure 10 shows the effect of employer contributions by age. When x is low, employer contributions have almost no incremental effect on the purchase rate. When x is high, on the one hand, young households postpone their purchase decisions, and on the other hand, many old households, who have accumulated enough savings both from their own deposits and from employer contributions, choose to become homeowners. The average size of new homes also increases with the employer contribution rate.

6 Conclusion

There has been much interest in the question of how the HPF has affected homeownership in China. This question is of interest not only to Chinese authorities but to policymakers more broadly, because similar policies have been implemented in a range of countries. Addressing this question empirically is not straightforward because of selection bias, because of anticipation effects, and because of the short duration of this program to date.

An alternative approach to quantifying the expected effects of this program is the use of quantitative theory. Existing theoretical studies of this question have relied on representative-agent models (see., e.g., Buttimer et al. (2004) and Tang and Coulson (2017)). Such models are not well-suited for studying the effect of these policies, because in representative-agent models either everyone or no one buys a house. The current paper introduces a life-cycle model with heterogeneous agents that allows agents' purchases of homes to depend on their age and unobserved characteristics. This model allowed me to quantify the increase in homeownership one would expect in response to this program. I showed that the HPF program is expected to increase the rate of homeownership by 4 percentage points in steady state. It also increases the average size of homes. This result is robust to allowing employers to match the workers' contributions in part or in full.

One advantage of addressing this question based on a theoretical model is a better understanding of the mechanisms by which these policies affect economic outcomes. I find that the mandatory savings program affects home purchases primarily by making it hard for young people, who are already liquidity constrained, to smooth consumption. Hence, many

of these households choose to become a homeowner earlier in life to avoid additional forced savings. The HPF program accounts for as much as a 7 percentage point increase in the purchase rates among young households with little additional effect on households of older ages.

Regardless of how long households are forced to save, the program provides access to subsidized mortgages intended to make home more affordable. Households' ability to take advantage of these rates depends on unobservable characteristics. In the calibrated model, the fraction of participating households who are unable to buy a house by the end of their life time is about 30%. I show that the incremental contribution of subsidized mortgage rates to the rate of homeownership is minor. However, subsidized mortgage rates may serve as an effective substitute for mandatory savings plans.

Although the model presented in this paper is more realistic than previous theoretical analysis of Chinese housing policies, my analysis in this paper is only a first step. A more detailed analysis of the effects of Chinese housing policies would have to take account of changes in house prices and monetary policies, for example. Incorporating these features into the life-cycle framework is nontrivial and left for future research.

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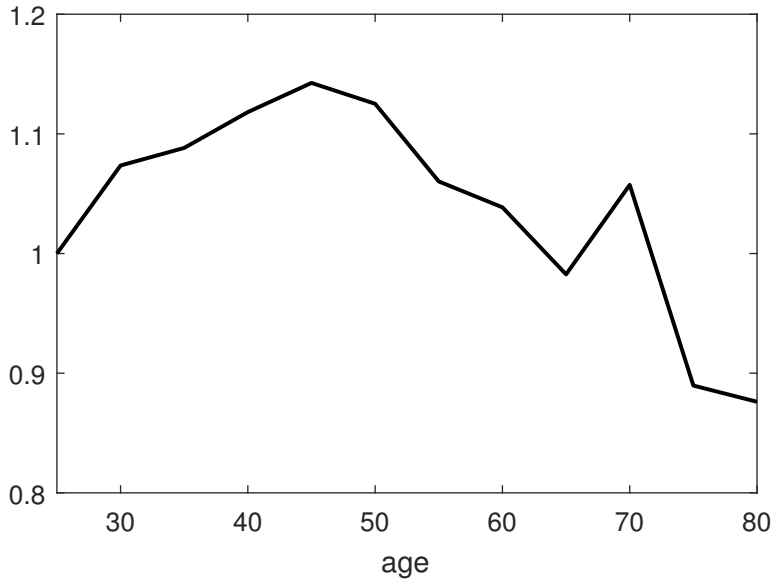
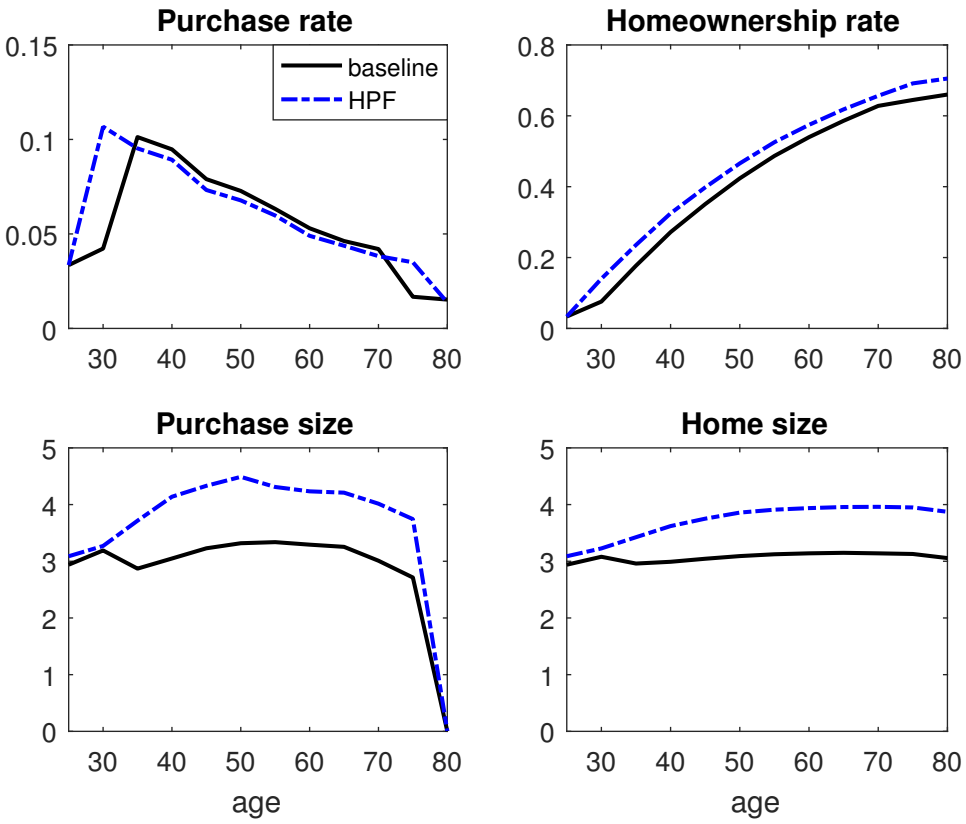
Figure 1: Household income by age, China 1998-2002



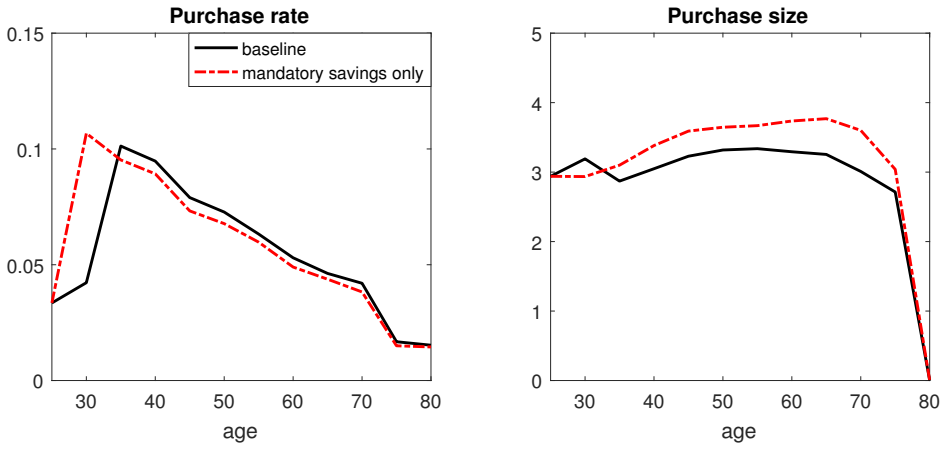
Source: Chinese Household Income Project Series 2002. Income for the age group 20-25 is normalized to 1.

Figure 2: The impact of the HPF program



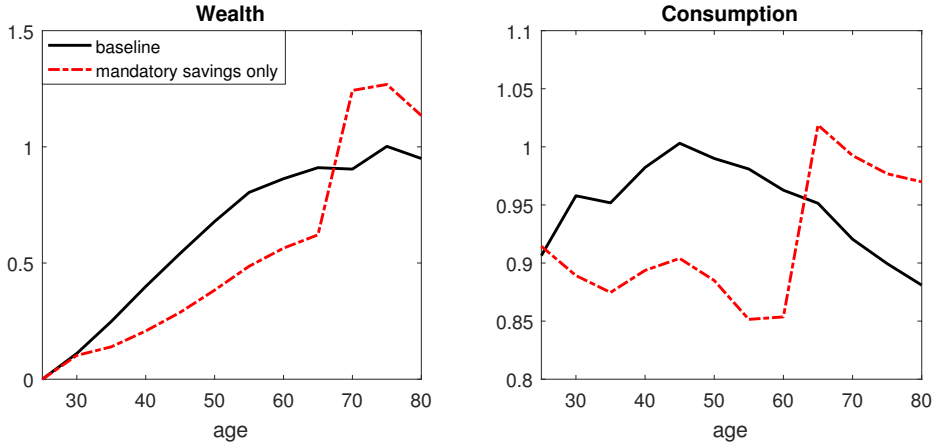
Notes: Simulations based on the baseline model and based on the HPF program. The purchase rate is defined as the fraction of homebuyers (or the fraction of new homeowners) in the population. The homeownership rate is defined as the fraction of all homeowners in the population. The purchase size is defined as the average size of new homes purchased (in terms of the numeraire consumption good). The home size is defined as the average home size of all homeowners.

Figure 3: The effect of the mandatory-savings feature



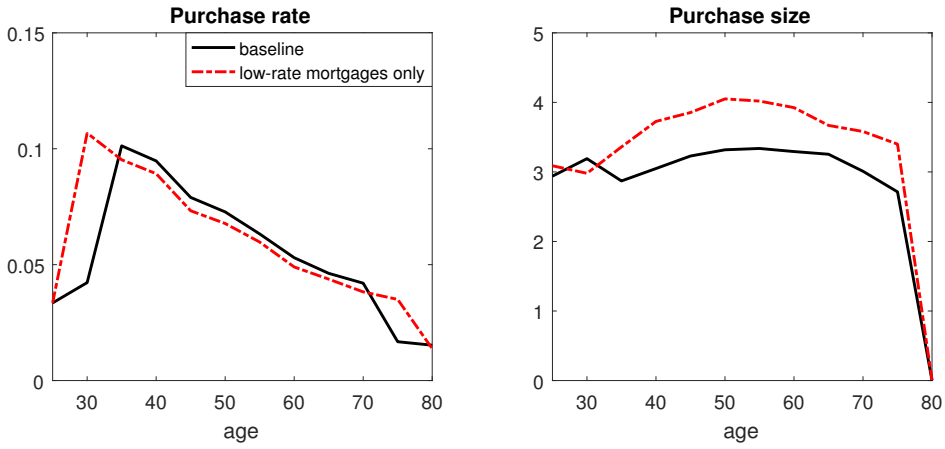
Notes: See Figure 2.

Figure 4: Consumption and wealth under mandatory savings



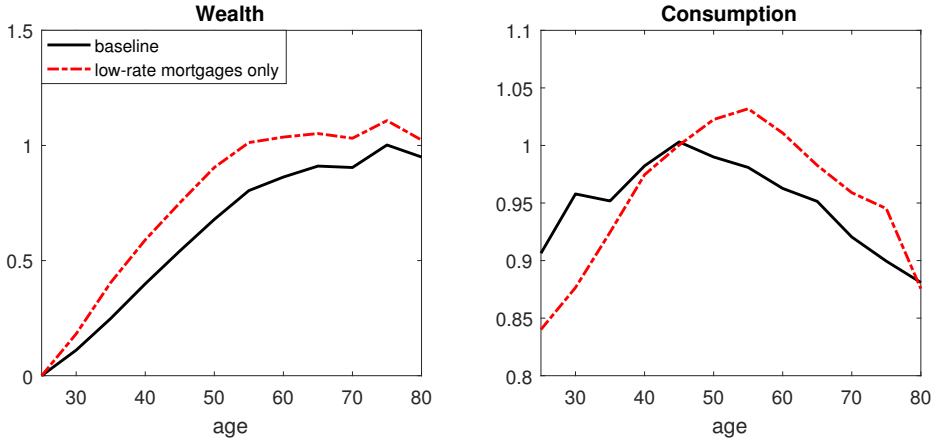
Notes: Wealth is defined as the sum of liquid savings and the value of one's home. Consumption refers to non-housing consumption.

Figure 5: The effect of the below-market rate mortgage feature



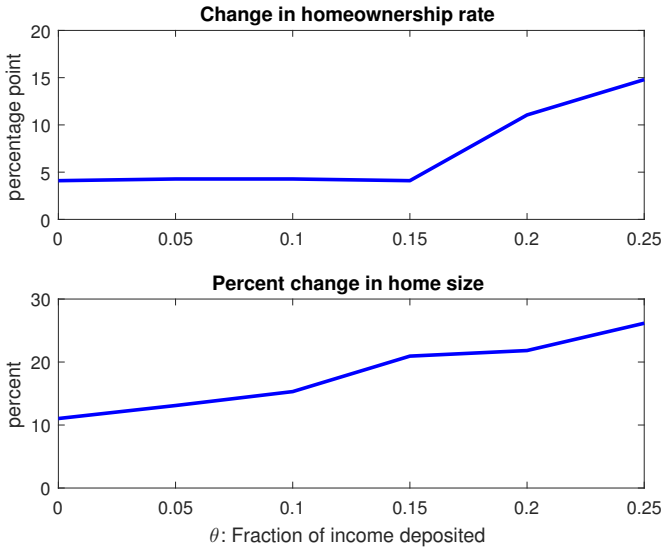
Notes: See Figure 2.

Figure 6: Consumption and wealth under below-market rate mortgages



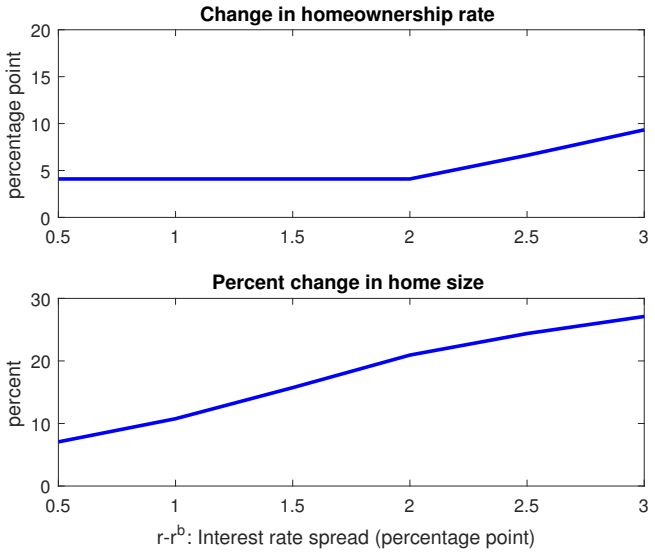
Notes: See Figure 4.

Figure 7: The effect of the fraction θ of income deposited into the HPF



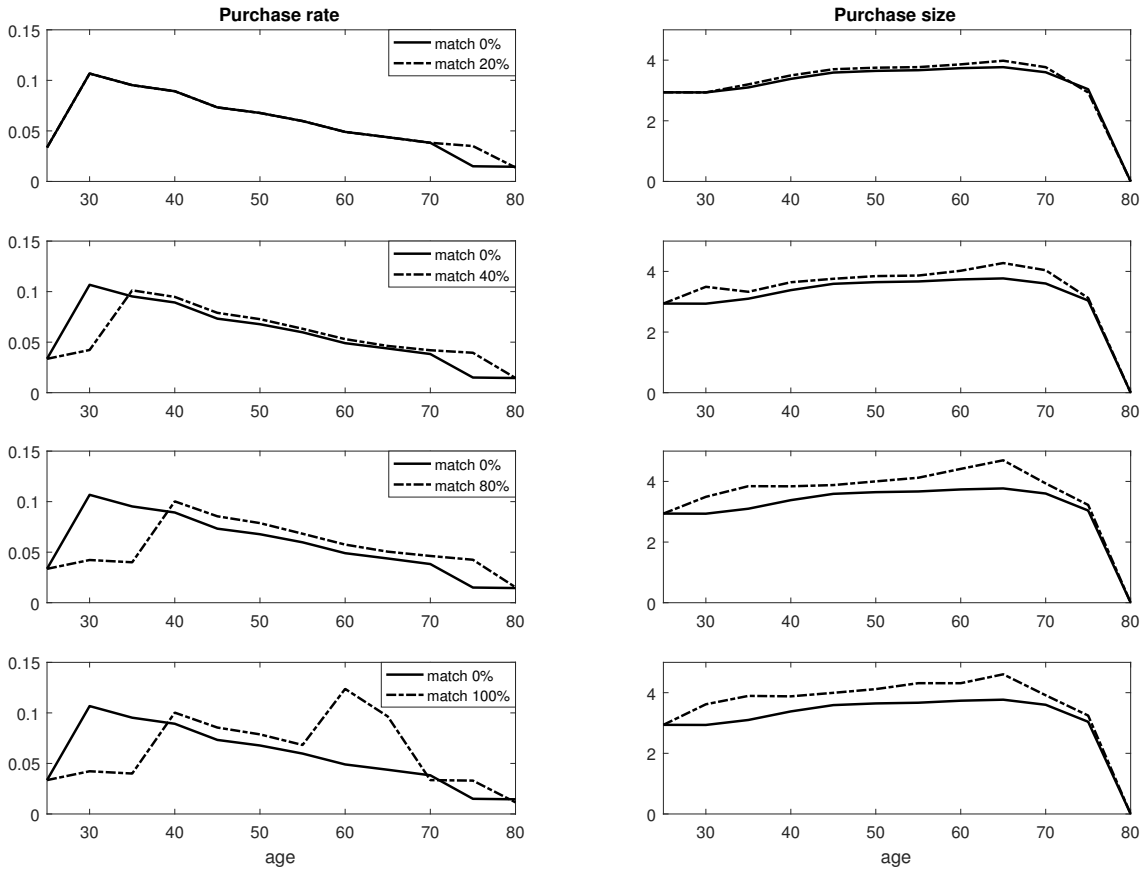
Notes: This figure illustrates the change in the homeownership rate and the percent change in the average home size relative to the baseline model, generated by housing programs with a mortgage rate of 2 percent below the market rate.

Figure 8: The effect of the mortgage rate spread



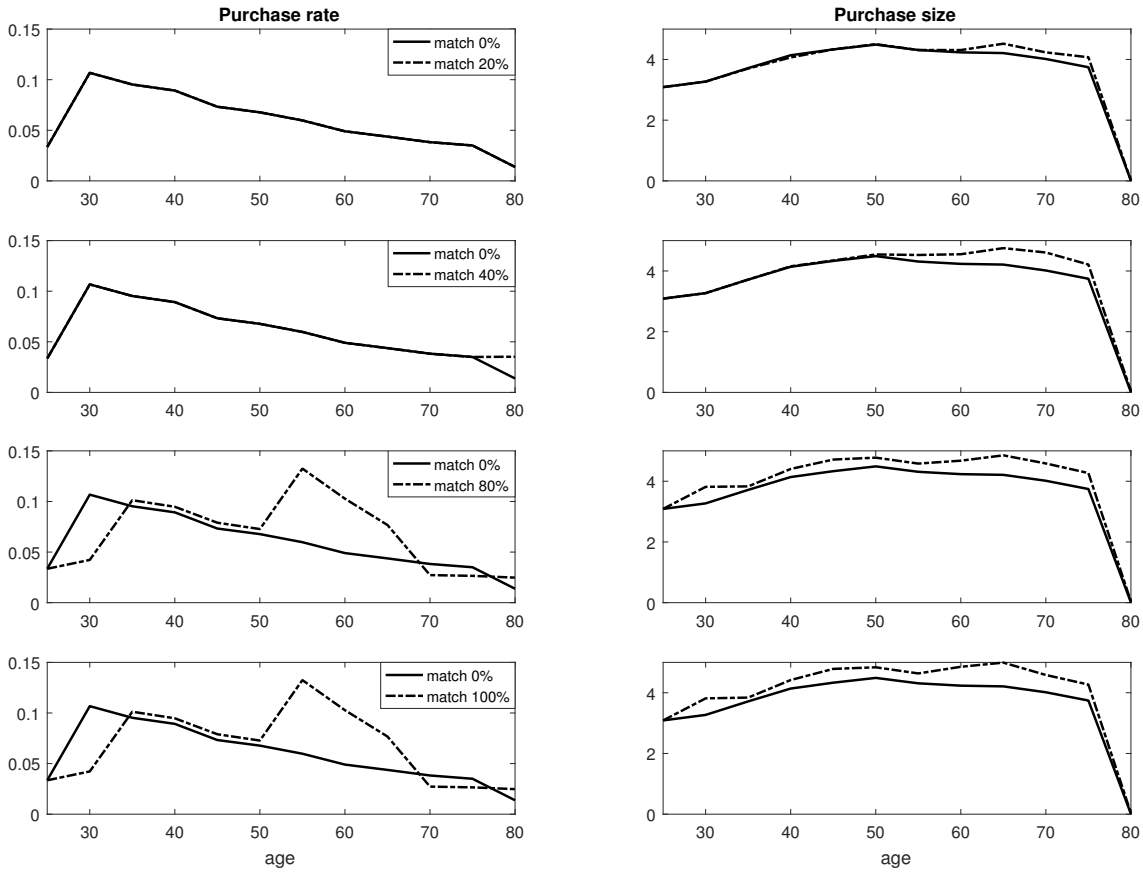
Notes: This figure illustrates the change in the homeownership rate and the percent change in the average home size relative to the baseline model, generated by housing programs with $\theta = 0.15$.

Figure 9: The effect of employer contributions under a mandatory-savings-only program



Notes: This figure illustrates the purchase rate and the average purchase size generated by housing programs with a mandatory fraction of income deposited, $\theta = 0.15$, and an $x\%$ matching contribution from the employer.

Figure 10: The effect of employer contributions in the HPF program



Notes: This figure illustrates the purchase rate and the average purchase size generated by housing programs with a mandatory fraction of income deposited, $\theta = 0.15$, and an $x\%$ matching contribution from the employer. In addition, the program offers mortgages at a rate of 2 percent below the market rate.

Table 1: Government savings programs intended to foster homeownership

Country	Program	Mandatory	Contribution as a fraction of income (%)	Purpose
China	HPF	Yes	5 - 20	Housing, retirement
Singapore	CPF	Yes	5 - 20	Housing, education medical care, retirement
India	EPF	No	12	Housing, education medical care, retirement marriage
Malaysia	EPF	Yes	8 - 11	Housing, retirement

Source: Information complied from the official websites of the various programs.
China's HPF (Ministry of Housing and Urban-Rural Development of China): www.mohurd.gov.cn/zfgjjjg/index.html.
Singapore's CPF (CPF Board): www.cpf.gov.sg/members.
India's EPF (EPF Organisation): www.epfindia.com/site_en/.
Malaysia's EPF: www.kwsp.gov.my/portal/en/web/kwsp/home.

Table 2: Calibration

Parameter		Value
Demographics		
J	Number of age groups	12
J_y	Number of working periods	8
Preferences		
β	Discount factor	0.93
s	Utility weight on housing	0.25
η	Utility weight on bequest	1
Transaction cost		
μ_f	Mean of the distribution	1.5
σ_f	Std. dev. of the distribution	1
Aggregate variables		
p	House price	1
r	Market savings rate	0.05
Policy parameters		
θ	Fraction of income deposited	0.15
r^b	Discounted mortgage rate	0.03

Notes: This table shows calibrated parameters. See Section 3 for method description.

Table 3: Summary of steady-state results

	Baseline	HPF program	Mandatory-savings feature only	Low-rate-mortgage feature only
Homeownership rate	40.7	44.7	44.4	44.7
Home size	3.07	3.71	3.21	3.41

Notes: The homeownership rate is defined as the fraction of all homeowners in the population. The home size is defined as the average home size (in terms of the numeraire consumption good) of all homeowners.

Table 4: The effect of employer contributions

	Employers match workers' deposits by					
	0 pct	20 pct	40 pct	60 pct	80 pct	100 pct
Homeownership rate	44.7	44.7	44.9	44.8	47.1	47.1
Home size	3.71	3.72	3.75	3.96	4.06	4.10

Notes: See Table 3. This table shows results that allow employers to contribute to workers' HPF savings according to some percentage.