

Policy Reforms, Housing, and Wealth Inequality*

FANG YANG[†]

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Abstract

I develop a quantitative, dynamic general equilibrium model of life cycle behavior to study the effects of several policy reforms on assets composition over the life cycle, wealth distribution and aggregate saving. Privatizing social security increases aggregate saving, decreases overall wealth inequality, and generates large welfare gain, especially for agents with high initial productivity. Lowering down payment encourages income poor households to hold more housing assets and generates a welfare gain for agents with low initial productivity. Lowering transaction costs encourages households to hold more housing assets and generates a welfare gain for agents of every initial productivity.

JEL Classification: E21, H31, J14, R21

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[†]Mailing Address: Department of Economics, Business Administration Building, Room 123E, University at Albany, State University of New York, Albany, NY 12222. Email: fyang@albany.edu. URL: www.albany.edu/~fy554862.

1 Introduction

Most life cycle models of consumption and saving abstract from housing. Housing has its unique features: it is durable, therefore consumption expenditure is not equal to service flow from it; housing can be used as collateral to borrow in the financial market; trading of houses incur large transaction costs. As I have shown in Yang (2005), that consumption from housing and non-housing is different over the life cycle. Thus the abstraction from housing may bias the study of life cycle consumption and assets accumulation behavior.

I use a life-cycle model of consumption and saving that explicitly incorporates housing to study the effects of several policy reforms on assets composition over the life cycle, wealth distribution and aggregate saving. Several important saving motives have been studied in my model. Households accumulate assets to pay down payment (saving for purchasing housing). Households may save to finance expenditures after retirement (saving for retirement). In addition, households self-insure against uncertainty of earnings (precautionary motive for saving). Furthermore, uncertain lifetime and absence of annuity markets may cause some wealth passed to the next generation unintended (accidental bequests). Finally, they save in order to leave bequests to their children since they derive utility from such behavior (saving for leaving bequests).

The model is calibrated to the U.S. data. The model generates household asset composition over the life cycle and wealth inequity comparable to the data. I then use this framework to study the effects of several policy reforms (privatizing social security, lowering down payment and lowering transaction costs) on consumption and assets composition over the life cycle, wealth distribution and aggregate saving. Privatizing social security increases aggregate saving, decreases overall wealth inequality, and generates large welfare gain, especially for agents with high initial productivity. Lowering down payment encourages income poor households to hold more housing assets and generates a welfare gain for agents with low initial productivity. Lowering transaction costs encourages households to hold more housing assets and generates a welfare gain for agents of each initial productivity.

Several conclusions can be drawn from my quantitative results. First, I find that different

policy reforms affect consumption and saving behavior of each agent differently, depending on their wealth level, age and productivity shock. Thus the net outcome of each policy reform depends on the fraction of households that are affected in a particular way. Second, general equilibrium effects, especially from the change of interest rate, can have large effects and sometimes can reverse the effects of a policy reform in a partial equilibrium.

This paper is related to the literature that studies the welfare implications of alternative social security schemes. Contributors to this literature include, among others, Feldstein (1985), Auerbach and Kotlikoff (1987), Hubbard and Judd (1987), Imrohoroglu, Imrohoroglu and Joines (1995), Huggett and Ventura (1999), Storesletten, Telmer and Yaron (1999), Fuster, Imrohoroglu, Imrohoroglu (2003), Pries (2004) and Rojas and Urrutia (2004). Most of the papers in the literature examine economies with only financial assets and abstract from housing.

Chen (2005) studies how the existence of housing affects the long-run welfare effect of privatizing social security. His model abstracts from bequest motive and could not generate a wealth concentration as is observed in the data. He finds a higher welfare gain of privatizing social security. One reason is that he uses a high replacement rate in the benchmark economy. The other reason is in my model households have bequest motive. In pure life-cycle models, social security lowers the capital stock dramatically since it redistributes income away from younger agents with higher marginal propensities to save to older agents with lower marginal propensities to save. In a model with bequest motive, in addition to the insurance and life-cycle motives, elderly agents intentionally save to leave bequests, and therefore old individuals do not necessarily have a lower marginal propensity to save than young individuals. As a result, social security in my model has a smaller effect on the aggregate saving rate and on capital accumulation than a pure life cycle model.

This paper is also related to the literature that studies the roles of capital market imperfection on consumption behavior. Contributors to the literature include, among others, Hayashi (1985, 1987), Hubbard and Judd (1987), Mariger (1987) and Zeldes (1989). Most of the papers in the literature examine economies with only financial assets and abstract from housing. Jappelli and Pagano (1994) show that countries with higher down payment

ratio for housing mortgage have significant higher aggregate saving rate and that binding liquidity constraint, in some circumstance, may promote growth through higher saving rate. Engelhardt (1996) examines the behavior of household consumption for first-time home buyer to determine the effect of down payment constraint on consumption behavior.

This chapter is organized as follows. In Section 2, I present my model and define the equilibrium. The calibration of the model is presented in Section 3. Section 4 presents the quantitative results of the benchmark model. Section 5 shows the quantitative effect of several policy reforms (privatizing social security, lowering down payment and lowering transaction costs) on consumption and assets composition over the life cycle, wealth distribution and aggregate saving.

2 The Model

The economy is a discrete-time overlapping generation world with an infinitely-lived government. The government taxes labor earnings, and provides pensions to the retirees. There are idiosyncratic income shocks. There are no state contingent markets for the household specific shocks. The only financial instrument is a one-period bond. Housing has a dual role: it provides utility as consumption goods, and it can be used as collateral thus the borrowing limit of each household depends on the value of the house. Trading of houses incurs transaction costs. For simplicity, I assume there is no housing rental market.

2.1 Technology

There is one type of goods produced according to the aggregate production function $F(K; L)$ where K is the aggregate capital stock and L is the aggregate labor input. I assume a standard Cobb-Douglas functional form. The final goods can be either consumed or invested into physical capital or transformed into housing. Physical capital and housing depreciate at rate δ^k and δ^h , respectively. Let H denote the aggregate housing stock in the current period, C the aggregate consumption of non-housing, I^h the aggregate investment on housing, I^k the aggregate investment on physical capital goods, Tc the total transaction

costs for trading housing, respectively. The aggregate resource constraint is:

$$F(K, L) = K^\alpha L^{1-\alpha} = C + I^k + I^h + Tc. \quad (1)$$

Households rent capital and efficient labor units to the representative firm each period and receive rental income at the interest rate r and wage income at the wage rate w .

2.2 Demographics

During each model period, which is 5 years long, a continuum of people is born. I denote age $t = 1$ as 20 years old, age $t = 2$ as 25 years old, and so on. At age 20 each person enters into the model and start working and consuming. Since there are no inter-vivos transfers, all agents start their economic life with no financial assets and no houses. At the beginning of period 3, the agent's children are born, and four periods later (when the agent is 50 years old) the children are 20 and start working. The agents are retired at $t = 10$ (i.e., when they are 65 years old) and die for sure by the end of age $T = 12$ (i.e., before turning 80 years old). From $t = 10$ (i.e., when they are 65 years old), each person faces a positive probability of dying given by $(1 - p_t)$. The probability of dying is exogenous and independent of other household characteristics. The population grows at rate n . Since the demographic patterns are stable, agents at age t make up a constant fraction of the population at any point in time. Figure 1 illustrates the demographics in the model.

2.3 Timing and information

At the beginning of each period, households observe their idiosyncratic earning shocks and possibly receive some inheritance from their parents. Then labor and capital are supplied to firms and production takes place. Next, the households receive factor payments and make their consumption and asset allocation decisions. Housing stocks are not transferred until the end of the period. Thus the addition or subtraction to the stock will not influence the present period service flow. Finally uncertainty about early death is revealed.

The idiosyncratic labor productivity status is private information and the survival status

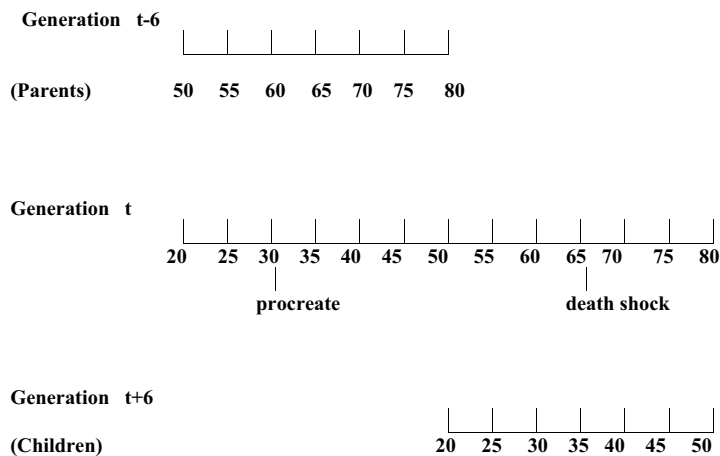


Figure 1: Demographics

is public information. I assume that children can observe their parent's productivity when their parent is 50 and the children are 20.

2.4 Consumer's maximization problem

2.4.1 Preferences

Individuals derive utility from consumption of non-housing goods, c , from the service flow of the housing, h and from bequests transferred to their children upon death. Preferences are assumed to be time separable, with a constant discount factor β . The momentary utility function from consumption is of the constant relative-risk aversion class given by

$$U(c, h) = \frac{g(c, h)^{1-\eta} - 1}{1-\eta}. \quad (2)$$

I choose $g(c, h) = (\omega c^\sigma + (1-\omega)h^\sigma)^{\frac{1}{\sigma}}$, and h is assumed to be equal to the value of housing stock.

Following De Nardi (2004), the utility from bequest is denoted by

$$\phi(b) = \phi_1(1 + b/\phi_2)^{1-\eta}. \quad (3)$$

The term ϕ_1 reflects the parent's concern about leaving bequests to his/her children, while ϕ_2 measures the extent to which bequests are luxury goods¹.

2.4.2 Transaction costs

Due to the heterogeneity of housing and the spatial fixity of housing, both potential buyers and sellers in the housing market are forced to spend considerable amount of time and resource to acquire information about the value of a specific housing units. As a consequence, there are both implicit and explicit search costs associated with moving (Chinloy (1980)). These include opportunity cost of time associated with market search, brokerage and agent fee, recording fee, legal fee, origination fee. Besides, households have to physically move to a new house, which entail moving costs and psychological costs of breaking neighborhood attachments (Smith, Rosen, Fallis (1988)).

I consider non-convex transaction costs in the housing stock. A household can buy a stock of any size, but once the stock has been bought, it is illiquid. I force the household to pay transaction costs every time the household sells and buys a new house. The specification of the transaction costs is:

$$\tau(h, h') = \begin{cases} 0 & \text{if } h' \in [(1 - \mu_1)h, (1 + \mu_2)h] \\ \rho_1 h + \rho_2 h' & \text{otherwise.} \end{cases} \quad (4)$$

This formulation of transaction costs allow households to change their level of housing consumption by undertaking housing renovation up to a fraction of μ_2 the value of house or by allowing depreciation up to a fraction of μ_1 the value of house as an alternative to moving. If the households let the housing depreciate by more that a fraction μ_1 of the value,

¹Note that this form of 'impure' bequest motives implies that an individual cares about the bequests left to his/her children, but not about consumption of his/her children. If an individual is assumed to care about utility of his/her children, and both parents and kids are maximizing utility as different units, the strategic interaction across generations complicates the analysis.

or if the value of the stock increases by more than a fraction μ_2 of the value, I assume that the stock has been sold. In those cases, the household has to pay the transaction costs as a fraction ρ_1 of its selling value and ρ_2 of its buying value.

2.4.3 Borrowing constraints

I assume that only collateralized credit is available and that the borrowing interest rate, mortgage interest rate and deposit interest rate are all equal. This implies that mortgages and deposits are perfect substitutes. I use a_t to denote the net asset position. To buy a house household must satisfy a minimum down payment requirement as a fraction θ of the value of house. Housings also serves as collateral for loans (through home equity loans or refinancing) up to a fraction $(1 - \theta)$. At any given period household's financial assets must hence satisfy:

$$a' \geq -(1 - \theta)h', \quad (5)$$

and household's net worth is thus always non-negative. Notice in this case, a household's net worth is bounded below by a fraction θ of the value of house².

2.4.4 Labor productivity

In this economy all agents of the same age face the same exogenous age-efficiency profile ϵ_t . This profile is estimated from the data and recovers the fact that productive ability changes over the life cycle. Workers also face stochastic shocks to their productivity level. These shocks are represented by a Markov process defined on $(Y; \mathfrak{B}(Y))$ and characterized by a transition function Q_y , where $Y \subset R_{++}$ and $\mathfrak{B}(Y)$ is the Borel algebra on Y . This Markov process is the same for all households. This implies that there is no aggregate uncertainty over the aggregate labor endowment although there is uncertainty at the individual level. The total productivity of a worker of age t is given by the product of the worker's stochastic productivity in that period and the worker's deterministic efficiency index at the same age: $y_t \epsilon_t$.

²For a household without a house, the borrowing constraint reduces to the standard form $a \geq 0$.

To capture the positive correlation in human capital across generation, I assume that the parent's productivity shock at age 50 is transmitted to children at age 20 according to a transition function Q_{yh} , defined on $(Y; \mathfrak{B}(Y))$. What the children inherit is only their first draw; from age 20 on, their productivity y_t evolves stochastically according to Q_y .

For computational reasons, I assume that children cannot observe directly their parent's assets, but only their parent's productivity when their parent is 50 and the children are 20, that is, the period when they leave the house and start working³. Based on this information, children infer the size of the bequests they are likely to receive.

2.4.5 The household's recursive problem

In the stationary equilibrium, the household's state variables are given by (t, a, h, y, yp) , the first 4 variables of which denote the agent's age, financial assets and housing stock carried from the previous period and the agent's productivity, respectively. The last term yp denotes the value of the agent's parent's productivity at age 50 until the agent inherits and zero thereafter. The law of motion of yp is dictated by the death probability of the parent. When yp is positive, it is used to compute the probability distribution on bequests that the household expects from the parent. When the agents have already inherited, yp is set to be 0.

According to the demographic transitions, there are four cases.

(i) From $t = 1$ to $t = 3$ (from age 20 to 35), the agent survives with certainty until next period and does not expect to receive a bequest soon because his or her parent is younger than 65. For these sub periods $yp' = yp$.

$$V(t, a, h, y, yp) = \max_{c, a', h'} \left\{ U(c, h) + \beta E(V(t+1, a', h', y', yp)) \right\} \quad (6)$$

³For example, allowing children to observe parents productivity at two periods adds one more state variable and also increases substantially the time needed to iterate over the bequest distributions. Since income in the calibration is very persistent, an observation of one year of income is likely to be not much less informative than two.

subject to (5) and

$$c + a' + h' + \tau(h', h) = (1 - \tau_l)w\epsilon y + (1 + r)a + (1 - \delta^h)h, \quad (7)$$

$$c \geq 0, h' \geq 0. \quad (8)$$

At any subperiod, the agent's resources are derived from asset holdings, a , labor endowment, $\epsilon_t y$ housing stock holding, h . Asset holdings pay a risk-free rate r and labor receives a real wage w . Houses depreciate at rate δ^h . The evolution of y is described by the transition function Q_y . Government taxes labor income at the rate τ_l .

(ii) From $t = 4$ to $t = 6$ (from age 35 to 50), the worker survives for sure until the next period. However, the agent's parent is at least 65 years old and faces a positive probability of dying at any period; hence, a bequest might be received at the beginning of the next period. The conditional distribution of bequest a person of state x expects in case of parental death is denoted by $\mu_b(x; \cdot)$. In equilibrium this distribution must be consistent with the parent's behavior. Since the evolution of the state variable yp is dictated by the death process of the parent, yp' jumps to zero with probability $1 - p_{t+6}$. Let $I_{yp>0}$ be the indicator function for $yp > 0$; it is one if $yp > 0$ and zero otherwise.

$$V(t, a, h, y, yp) = \max_{c, \tilde{a}, h'} \left\{ U(c, h) + \beta E(V(t+1, a', h', y', yp')) \right\} \quad (9)$$

subject to (5), (8), and

$$\begin{aligned} c + \tilde{a} + h' + \tau(h', h) &= (1 - \tau_l)w\epsilon y + (1 + r)a + (1 - \delta^h)h, \\ a' &= \tilde{a} + b' I_{yp>0} I_{yp'=0}, \end{aligned} \quad (10)$$

where \tilde{a} denotes the financial assets at the end of the period before receiving bequest.

(iii) The subperiods $t = 7$ to $t = 9$ (from age 50 to 65) is the periods before retirement, during which no more inheritances are expected because the agent's parent is already dead by that time. Thus yp is not in the state space any more. The agent does not face any

survival uncertainty.

$$V(t, a, h, y) = \max_{c, a', h'} \left\{ U(c, h) + \beta E(V(t+1, a', h', y')) \right\} \quad (11)$$

subject to (5), (7) and (8).

(iv) From $t = 10$ to $t = 12$ (from age 65 to 80), the agent does not work and does not inherit any more, but faces a positive probability of dying. Let p_t denote the conditional survival probability at age t . In case of death, the agent derives utility from bequeathing his or her assets. When the agent dies, the house is sold automatically and transaction costs are incurred⁴.

$$V(t, a, h) = \max_{c, a', h'} \left\{ U(c, h) + \beta p_t (V(t+1, a', h')) + (1 - p_t) \phi(b) \right\} \quad (12)$$

subject to (5), (8) and

$$c + a' + h' + \tau(h', h) = (1 + r)a + (1 - \delta^h)h + P,$$

$$b = a' + h' - \tau(h', 0). \quad (13)$$

Households receive pension income P . For simplicity, I assume the pension level is independent of household's income history⁵.

2.4.6 Definition of the stationary equilibrium

I focus on an equilibrium concept where factor prices are constant over time and where capital and labor are constant in per capita terms. In addition, the age-wealth distribution is stationary over time. Each agent's state is denoted by x . An equilibrium is described as follows.

Definition 1 *A stationary equilibrium is given by government policies τ_t, P ; an interest*

⁴I made this simplification since the children already have houses of their own when they inherit.

⁵A more realistic assumption is that social security benefit is a concave function of the accumulated contribution. Under this assumption, the accumulated contribution becomes a state variable, which increases the computation time dramatically.

rate r and a wage rate w ; value functions $V(x)$, allocations $c(x)$, $a'(x)$, $h'(x)$; a family of probability distributions for bequests $\mu_b(x; \cdot)$ for a person with state x ; and a constant distribution of people over the state variables x : $m^*(x)$, such that the following conditions hold:

(i) Given the government policies, the interest rate, the wage, and the expected bequest distribution, the functions $V(x)$, $c(x)$, $a'(x)$, and $h'(x)$ solve the above described maximization problem for a household with state variables x .

(ii) m^* is the invariant distribution of households over the state variables for this economy.⁶

(iii) All markets clear.

$$\begin{aligned} K &= \int am^*(dx), \quad H = \int hm^*(dx), \quad C = \int cm^*(dx), \\ L &= \int \epsilon ym^*(dx), \quad Tc = \int \tau(h', h)m^*(dx), \\ F(K; L) &= C + (1+n)K - (1-\delta^k)K + (1+n)H - ((1-\delta^h)H - Tc). \end{aligned}$$

(iv) The price of each factor is equal to its marginal product.

$$r = F_1(K, L) - \delta^k, \quad w = F_2(K, L).$$

(v) The family of expected bequest distributions is consistent with the bequests that are actually left by the parents.

(vi) Government budget is balanced at each period.

3 Calibration

I choose some parameters used in the benchmark model from estimations by other studies. The remaining parameters are chosen so that the model generated data match a given set of targets. Since one period in my model corresponds to 5 years in real life, I adjust parameters

⁶I normalize m^* so that $m^*(X) = 1$, which implies that $m^*(\chi)$ is the fraction of people alive that are in a state χ . Yang (2005) describes the calculation of invariant distribution in greater detail.

accordingly.

The rate of population growth, n , is set to the average population growth from 1950 to 1997 from Economic Report of the President (1998). The p_t 's are the vectors of conditional survival probabilities for people older than 65. I use the mortality probabilities of people born in 1965 provided by Bell, Wade, and Goss (1992).

I construct measures of output Y , capital K and housing H and their investment counterparts according to my model. I use data from the National Income and Product Accounts and the Fixed Assets Tables both from the Bureau of Economic Analysis for the year 1954-1999. The aggregate ratios for US economy are calibrated to explicitly consider the existence of housing that comprises residential assets. Output is defined as measured GDP minus housing services. Capital is defined as the sum of nonresidential private and government fixed assets plus the stock of inventories. Investment in capital, I is defined accordingly. The housing stock is defined as the stock of private residential assets. Investment in housing, I^h , is constructed accordingly. The term α is the share of income that goes to capital, which I turns out to be 0.226. This capital share (non residential stock of capital) is much lower than that in other calibrations, which abstract from housing. The rate r is the interest rate on capital net of depreciation. I calibrate δ^k to be 0.0700 and δ^h to be 0.0294. Given the calibration for the US production function, this interest rate is endogenous, and turns out to be 4.37%. Yang (2005) explains the rationale behind these choices in greater detail.

The deterministic age-profile of the unconditional mean of labor productivity, ϵ_t , is taken from Hansen (1993). Since I impose mandatory retirement at the age of 65, I take $\epsilon_t = 0$ for $t > 9$. The stochastic productivity process is assumed to be an AR(1) process:

$$\ln y_t = \rho_y \ln y_{t-1} + \mu_t \quad \mu_t \sim N(0, \sigma_y^2).$$

The persistence ρ_y and variance σ_y^2 are estimated from Panel Study on Income Dynamics (PSID) data, aggregated over five years in order to be consistent with the model period (Altonji and Villanueva (2002)). The parent's productivity shock at age 50 is transmitted

to children at age 20 according to the following transition function:

$$\ln y_1 = \rho_{yh} \ln y_{h,7} + \nu_1, \quad \nu_1 \sim N(0, \sigma_{yh}^2).$$

I take ρ_{yh} from Zimmerman (1992), and choose σ_{yh}^2 to match the Gini coefficient of 0.44 for earnings.

The down payment ratio θ is set to be 0.2, which is commonly used in housing literature. Recently some households are allowed to purchase houses without much initial wealth. However, Caplin et al. (1997) argue that “it is almost impossible for a household to purchase a home without available liquid assets of at least 10% of the home’s value”. In addition, what is crucial for my model is the assumption that young and poor household can not borrow beyond the liquidation value of their collateral. Thus I choose a higher down payment ratio despite the recent decline of down payment ratio. I see the effect of down payment ratio in Section 6.

Since one of my main interest is to look at how transaction costs affect consumption and saving decisions, one key calibration is the type of transaction costs that I choose. Smith, Rosen and Fallis (1988) estimate the transaction costs of changing houses, including searching, legal costs, cost of readjusting home, and psychological costs from disruption. Their estimation is approximately 8-10 percentage the unit being changed. Martin (2002) finds that the monetary costs of buying a new home, which include agent fee, transfer fee, appraisal and inspection fee, range on average from 7 to 11 percent of purchase price of a home. Gruber and Martin (2003) estimate the reallocation cost of tax and agency costs from CEX and find the median household pays costs of the order of 7 percent to sell their houses and 2.5 percent to purchase. In my simulation, I choose transaction costs from sale to be $\rho_1 = 6\%$, and transaction costs from purchase to be $\rho_2 = 2\%$. These values are lower than the transaction costs reported above therefore they serve as a lower bound of the effect of transaction costs. I set $\mu_1 = \mu_2 = 0$. That is to say, if the value of the housing stock increases or decreases, I assume that the house has been sold.

The social security income P is chosen to be 40% of the average household after tax

earnings, a number commonly used in the social security literature. The labor income tax τ_l is chosen to balance government budget.

I take risk aversion parameter, η , to be 1.5, from Attanasio et al. (1999) and Gourinchas and Parker (2002), who estimate it from consumption data. This value is in the commonly used range (1-5) in the literature. σ governs the elasticity of substitution between housing and non-housing. Ogaki and Reinhart (1998) use aggregate data and a similar specification, and obtain an estimated $\sigma = 0.145$, not significantly different from zero. I thus choose σ to be 0 so that the momentary utility function $g(c, h)$ takes the Cobb-Douglas form⁷. I see the effect of elasticity of substitution between housing and non-housing in Section 6.

I choose the discount factor, β , to match the capital-output ratio. The parameter ω determines the share of consumption allocated to the non-housing consumption goods and is set to match the ratio of non-housing expenditure to housing stock. I use ϕ_1 to match bequest output ratio of 2.65% in the US simulation (Gale and Scholz (1994))⁸. ϕ_2 is chosen to match the ratio of average bequest left by single decedents at the lowest 80th percentile over average household earnings. According to Hurd and Smith (2001), the average bequest left by single decedents at the lowest 80th percentile was \$125,000 (Asset and Health Dynamics Among the Oldest Old (AHEAD) data sets, 1993-95).

4 Numerical Results

The benchmark economy allows for housing transaction costs and $\mu_1 = \mu_2 = 0$. That is to say, if the value of the housing stock increases or decreases, I assume that the house has been sold. In this case, the household has to pay the transaction costs as a fraction $\rho_1 = 6\%$ of its selling value and $\rho_2 = 2\%$ of its buying value. Some parameters are set so that the model-generated data match a given set of targets (see Section 3). Yang (2005) describes the computation algorithm in greater detail.

⁷In this case I add a positive number ε so that utility function is well defined at $h = 0$. The term ε is small enough that it does not affect the results. The utility function takes form $g(c, h) = c^\omega (h + \varepsilon)^{1-\omega}$

⁸Since in my model output corresponds to GDP minus housing service, I adjust it accordingly.

Parameters		Calibrations
Demographics		
n	population growth	1.2%
p_t	survival probability	see text
Technology		
α	capital share in National Income	0.226
δ^k	depreciation rate of capital	0.0700
δ^h	depreciation rate of housing	0.0294
Endowment		
ϵ_t	age-efficiency profile	see text
ρ_y	AR(1) coefficient of income process	0.85
σ_y^2	innovation of income process	0.30
ρ_{yh}	AR(1) coefficient of income inheritance process	0.677
σ_{yh}^2	innovation of income inheritance process	0.37
Government policy		
τ_l	social security tax	0.07
P	social security replacement rate	0.40
Housing market		
θ	down payment ratio	0.20
ρ_1	transaction costs of selling housing	6%
ρ_2	transaction costs of buying housing	2%
μ_1	Maximum depreciation	0
μ_2	Maximum renovation	0
Preference		
η	risk aversion coefficient	1.5
σ	substitutability of housing and non-housing	0
ω	weights of non-housing in utility function	0.8615
β	discount factor	0.946
ϕ_1	weight of bequest in utility function	-17
ϕ_2	shifter of bequest in utility function	8

Table 1: Parameters used in the benchmark model

4.1 Life cycle profiles

Now I show the average life cycle profiles of financial assets, total net worth, non-housing consumption and housing consumption. All figures are normalized by the average household earnings. These averages are obtained by integrating the policy function with respect to the equilibrium measure of agents, holding age fixed. For example, the average housing consumption by an agent at age t is given by

$$H = \frac{\int h(t, a, h, y, yp) m^*({t}) \times da \times dh \times dy \times dyp)}{\int m^*({t}) \times da \times dh \times dy \times dyp)}$$

Figure 2 compares the average life cycle profiles of annual non-housing consumption and housing consumption in the model with those in the data. I adjust the data so that aggregate non-housing consumption is the same in the data as in the model⁹, and aggregate housing stock is the same in the data as in the model. From Figure 2, we see the hump shape of average non-housing consumption, which peaks at age 50's. The non-housing consumption at age 50 is 80% more than that of age 20, which is similar to the pattern reported in the data. After the peak, non-housing consumption decreases steadily with age. The non-housing consumption at age 50 is 25% more than that of age 75. Facing an increasing future income profile, young agents would like to borrow to finance their current consumption but they are borrowing constrained. This explains why early in life consumption path increases as income path does. As households age, they start to decrease their non-housing consumption due to the fact that time preference is higher than the interest rate and mortality rates are increasing along the life cycle. Compared with data, the non-housing consumption is lower between age 20-35. This may be due to the abstraction of inter-vivos transfers or housing rental market in the model. Inter-vivos transfer relaxes borrowing constraints, while a housing rental market allows young households to have high non-housing consumption while renting.

The housing consumption profile in the model reproduces the empirically observed in-

⁹In the model I match the aggregate consumption with this in the NIPA. Compared with NIPA, CEX underreports consumption by a fraction of 30% (see Attanasio, Battistin and Ichimura [2004] for detailed discussion). Thus I adjust for the difference accordingly.

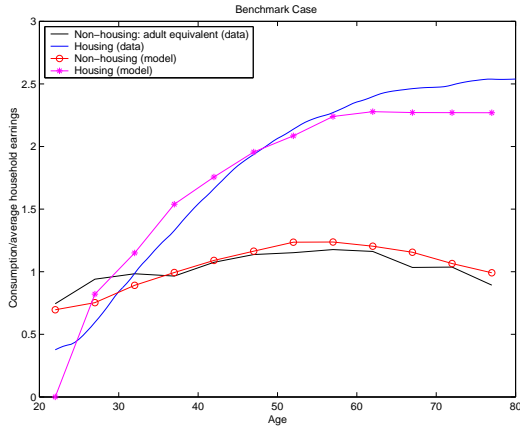


Figure 2: Life cycle patterns of consumption (benchmark)

creasing early in life and slow downsizing later in life. Agents build their housing stock early in life and compromise on non-housing consumption. Agents build up their highest housing stock at the age of 60, 5 years later than the peak of non-housing consumption. The elderly do not decrease their housing stock later in life.

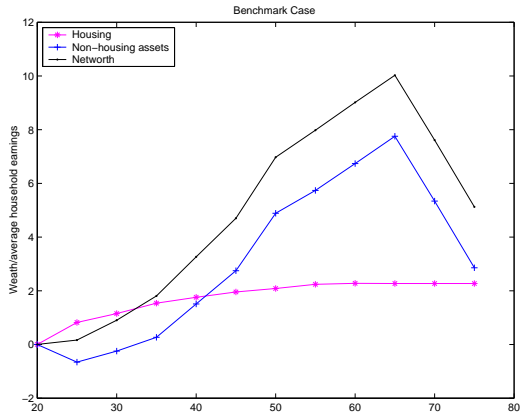


Figure 3: Life cycle patterns of wealth composition

Figure 3 displays the evolution of wealth portfolio over the life cycle. Young agents tend to hold little wealth. They start with zero wealth and they expect to have much higher earnings in the future. Thus to smooth consumption, they do not hold much wealth. Early in life households borrow as much as possible to buy houses, and thus save in the form of housing. As time goes by, agents have built stocks of houses and start to increase their

holding of financial assets. The profile of financial assets and housing assets intersect in their early 40's, as is observed in the data. The wealth holding peaks at age 65, the year before retirement. After retirement, they start to dissave assets to finance consumption. Old agents discount their future consumption at a higher rate since the survival probabilities are declining in age. This implies that the consumption profile is declining later in life and hence little wealth is needed to finance consumption later in life. Compared with data reported in Yang (2006), the wealth profile and assets profile have humps that are more pronounced. Since I abstract from health expenditure uncertainty or other shocks that could motivate precautionary assets holding in old age, old agents do not have precautionary saving motives as they do in the data, therefore they run down their assets more quickly than in the data.

4.2 Wealth distribution

Table 2 reports values for the wealth distribution for my benchmark economy. I present quintile shares, the 90-95%, the 95-99%, the top 1% shares and Gini coefficient for net worth, housing stocks and financial assets. US wealth distribution is calculated using 1998 SCF. In the data wealth is highly unevenly distributed with a Gini coefficient of 0.80. The top 1% of the households hold 34% of the total wealth and the 95-99% of the households hold 24% of the total wealth. Housing is more evenly distributed than net worth with a Gini coefficient of 0.63. The top 1% of the households hold 11% of the total housing wealth and the 95-99% of the households hold 17% of the total housing wealth. Financial asset is more unevenly distributed than net worth with a Gini coefficient of 0.99. The top 1% of the households hold 46% of the total financial wealth and the 95-99% of the households hold 28% of the total financial wealth¹⁰.

The benchmark model matches the distribution of wealth, housing and financial wealth quite well, with the exception of top 1%. It also replicates the empirical finding that inequality in financial assets is much higher than housing. This is because households are allowed to borrow against housing so financial assets can be negative but the housing stock can not be. Also for households that are not borrowing constrained, the return of housing,

¹⁰All Gini coefficients are calculated without replacing the negative numbers with zeros. If I replace the negative numbers with zeros, then the Gini coefficients become slightly smaller

	Gini	1st	2nd	3rd	4th	5th	90-95	95-99	99-100
Total wealth									
U.S. data	0.80	-0.28	1.35	5.14	13.00	81.59	11.48	23.72	33.65
Model	0.74	0.13	0.67	4.04	17.35	77.81	19.91	25.12	10.00
Housing									
U.S. data	0.63	0	1.09	13.66	24.10	61.15	13.87	17.12	11.32
Model	0.48	1.73	8.39	14.71	24.59	50.58	13.02	11.79	3.74
Financial wealth									
U.S. data	0.99	-6.00	-0.12	1.26	7.23	97.64	11.98	28.20	46.35
Model	0.86	-6.07	-2.68	-0.29	12.32	96.71	24.51	33.70	14.07

Table 2: Wealth distribution

marginal utility of housing, is decreasing, while the return to financial assets, the interest rate, is constant. Thus housing as the fraction of net worth is decreasing.

5 Policy Reforms

I consider several policy changes, privatizing social security, lowering down payment and lowering transaction costs. For each policy changes, I explore the life-cycle profiles of consumption and wealth portfolio in the economy. Then I report the aggregate statistics and show the distributional and welfare effects of each policy reform. The welfare effects of each policy reform can be measured by the compensating variations, fraction of consumption that should be given to each household in the steady state of a given policy reform to make the household as well off as in the steady state of the benchmark economy. The welfare gain for an unborn agent (before the realization of all contingencies), denoted as w , is defined as,

$$w = \left(\frac{\int V_n(0, i, j, 0, 0) di dj}{\int V_b(0, i, j, 0, 0) di dj} \right)^{\frac{1}{1-\sigma}} - 1 \quad (14)$$

where V_n and V_b refer to the value in the new and the benchmark economy, respectively, and i, j refer to the initial productivity of each households and their parents, respectively¹¹. To

¹¹The expected life-time utility includes utility from leaving bequests. Therefore, strictly speaking, w defined in this way is not equal to the consumption variation. This is of minor importance since for most households the discounted utility from leaving bequests is small compared with the the discounted utility from consumption.

better understand the aggregate welfare effects, I classify all agents by the types of shocks to labor productivity they receive at the beginning of the first age. Agents who receives initial productivity shock y_i , $i = 1, \dots, 4$, are referred to as type- i agents. For a newborn type- i agent, the welfare gain of a new policy reform, denoted as w_i , is

$$w_i = \left(\frac{\int V_n(0, i, j, 0, 0) dj}{\int V_b(0, i, j, 0, 0) dj} \right)^{\frac{1}{1-\sigma}} - 1 \quad (15)$$

Note that a negative number indicates that the given agent experiences welfare loss.

When I change a given policy regime, the interest rate and the wage will adjust to clear the markets for labor and capital. To disentangle these effects I report two different types of experiments. In the first experiments I keep prices fixed, thus U.S. is treated as a small open economy. This experiment shows the effect of each policy change on consumption and savings. In the second experiment, I adjust the interest rate and the wage to clear the markets. Since in my model hours worked and retirement behavior are exogenous, the government social security tax and social security payment are always fixed and the government budget in each policy experiments is always balanced, as in the benchmark.

5.1 Privatizing social security

This section explores the long-run effects of privatizing social security, that is, eliminating the pay-as-you-go system and allowing households to save through private asset markets for their own retirement.

5.1.1 Life cycle profiles

Now I look at an economy without a pay-as-you-go social security system and prices are fixed. This modification strengthens saving for retirement, thus the aggregate capital stock and output are higher than in the benchmark economy. If I abandon a pay-as-you-go system in which the government taxes working agents and provides social security to retired agents, then young agents are less likely to be borrowing constrained, making the average non-housing and housing consumption increasing faster early in life. Also abandoning a pension

system decreases the hump of wealth profile. Figure 4 shows the average life cycle profiles of consumption paths. We observe that the shapes of housing and non-housing consumption are similar as in the benchmark economy. The higher level of consumption is caused by the abandonment of social security tax which leaves agents more resources to consume.

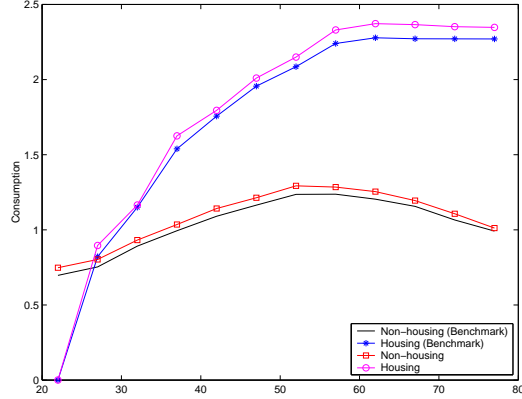


Figure 4: Life cycle patterns of consumption (no social security: $P=0$)

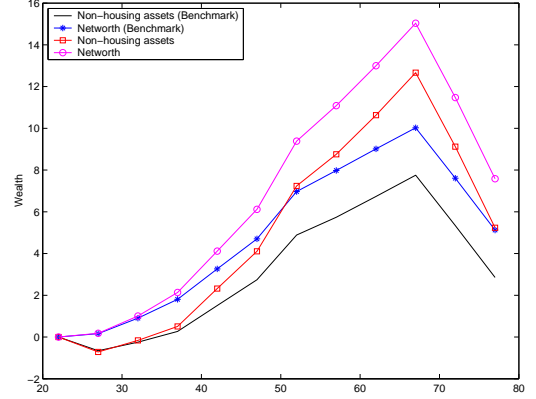


Figure 5: Life cycle patterns of wealth composition (no social security: $P=0$)

Figure 5 shows the average life cycle profiles of assets when there is no pay-as-you-go social security system. Abandoning a social security system encourages private saving for retirement, thus wealth since the middle age, is much higher than in the benchmark case, and we see much more pronounced humps in wealth and financial asset profiles.

Figure 6 shows the life cycle profiles of housing and non-housing consumption when prices are allowed to adjust. If I abandon a pay-as-you-go system in which the government taxes working agents and provides social security to retired agents, then young agents have higher disposable income and are less likely to be borrowing constrained, making the average non-housing and housing consumption higher early in life. Later in life, the non-housing consumption is lower than the benchmark economy. This comes from the general equilibrium effect. Without social security system, households save more. Thus the equilibrium interest rate is lower and consumption declines more rapidly. This feature differs from consumption of non-housing in Figure 4 where prices are fixed.

The housing consumption is higher than in the benchmark economy at all age. This is because without social security system, households save more and gain more average

output, thus have more lifetime resources to spend in housing. The housing consumption is higher compared with Figure 4 where prices are fixed. This also comes from the general equilibrium effect. When interest rate is lower, housing assets become more attractive and households shift their portfolio from financial assets towards housing assets.

With respect to non-housing assets, privatizing social security lowers the interest rate and strengthens the incentive of households to borrow early in life. In addition, it significantly enhances the saving motives for middle-aged households, when they have built up housing assets. As a result, we see in Figure 7 that the average level of non-housing assets around the retirement age is much higher in the privatized system than in the unfunded system. The assets profile increases less when prices are changing compared with Figure 5 where prices are fixed. This also comes from the general equilibrium effect. When interest rate is lower, financial assets become less attractive and households shift their portfolio from financial assets towards housing assets.

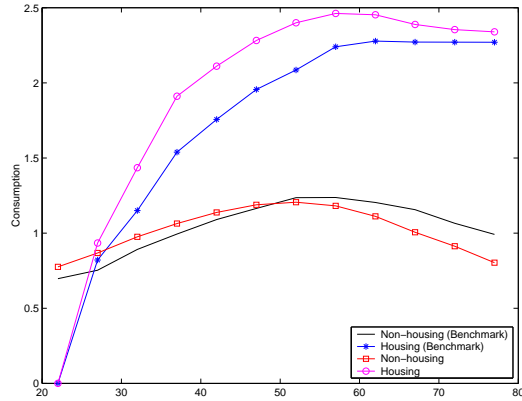


Figure 6: Life cycle patterns of consumption (no social security: $P=0$)

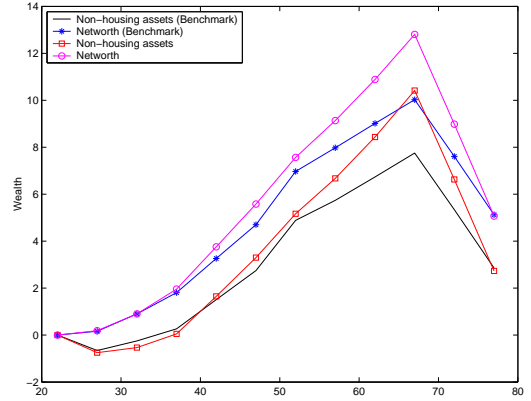


Figure 7: Life cycle patterns of wealth composition (no social security: $P=0$)

5.1.2 Summary statistics

Table 3 summarizes the aggregate statistics in the alternative social security systems. In the initial steady state the economy has an unfunded social security system with a replacement rate $P = 0.40$. At the final steady state, the social security system is completely eliminated by setting the replacement rate and therefore the social security tax rate equal to 0. We

see that privatizing social security leads to several changes specific to the economy with housing. If prices are fixed, privatizing social security boosts household savings in the form of interest bearing assets, as evidenced by a rise of 60.87% in K/Y . Social security provides imperfect annuity to partially insure against mortality risk. Furthermore, the nonlinear relation between social security contribution and benefits provides within-cohort income risking. Thus privatizing social security, by eliminating the above two effects of pay-as-you-go social security, leads to an dramatic increase of saving in the form of financial assets.

Second, the aggregate demand for housing rises, as reflected by a 4.66% increase in the H/Y ratio. This is mainly because households on average have more lifetime resource through the extra saving, thus demanding more housing as consumption goods.

Aggregate wealth, defined as $(H+K)/Y$, increases by 39.32%. Finally, non-housing consumption increases by 4.51% for the same reason as the increase of housing consumption.

If interest rate and wage rate are allowed to adjust to clear the markets, then interest rate decreases by 1.4 percentage points and wage rate increases by 3.88%. The decline of interest rate discourages saving as financial assets and encourages holding of housing assets. Thus K/Y rises by 13.66%, much lower than 60.87% when prices are fixed. The aggregate demand for housing rises, as reflected by a 9.06% increase in the H/Y ratio. Although young households consume more of non-housing consumption, elderly households consume less, therefore aggregate non-housing consumption decreases by 3.44%.

Variables	Initial steady state	Fix prices	Change (%)	Change prices	Change (%)
P	40%	0			
r	4.37%	4.37%		3.01%	-1.4%
w	1	1		1.0388	3.88%
Y	1	1	0	1.0387	3.87%
K/Y	1.9874	3.1972	60.87%	2.2589	13.66%
H/Y	1.2134	1.2630	4.66%	1.3240	9.06%
$H+K/Y$	3.2014	4.4602	39.32%	3.5828	11.91%
C/Y	0.7811	0.8163	4.51%	0.7541	-3.44%

Table 3: Aggregate statistics (privatizing social security)

An unfunded social security system with a 40% replacement rate crowds out only 14% of

the capital stock, which is smaller than the results obtained in pure life-cycle models. Chen (2005) finds that social security system with a 48% replacement rate reduces the steady-state capital stock by 27.9% in a model with housing and by 29.3% in a model without housing¹². This difference is partially due to the existence of bequest motive in my model. In pure life-cycle models, social security lowers the capital stock since it redistributes income away from younger agents with higher marginal propensities to save to older agents with lower marginal propensities to save. In a model with bequest motive, in addition to the insurance and life-cycle motives, individuals save for bequest motives, and therefore old individuals do not necessarily have a lower marginal propensity to save than young individuals. As a result, social security in my model has a smaller effect on the aggregate saving rate and on capital accumulation than a pure life cycle model.

Table 4 summarizes the wealth distribution in the alternative social security systems. Privatizing social security boosts household savings but decreases overall wealth inequality. The gini coefficient of net worth decreases from 0.74 in the benchmark economy to 0.70 if the price is fixed and 0.69 if the price adjusts. Households at the bottom 20-80% hold more assets than the benchmark economy.

The effect of privatizing social security on the distribution of housing assets is quite small. This shows that although privatizing social security boosts housing assets holding, the increase is quite even among different households.

The effect of privatizing social security on the distribution of financial assets is quite large. The gini coefficient of financial assets decreases from 0.86 in the benchmark economy to 0.79 if the price is fixed and 0.80 if the price adjusts. Privatizing social security encourages saving for retirement, thus households at the bottom 80% hold more assets than the benchmark economy.

If prices are allowed to adjust, the lower interest rate increases borrowing. Thus households at the bottom 40% borrow more compared with the case of fixed prices. Households at the top 5% mainly save for bequest and are less affected by interest rate, thus the share

¹²Among the literature that abstracts from housing, Auerbach and Kotlikoff (1987) find that a social security system with a 60% replacement rate reduces the steady-state capital stock by 24%. In Imrohoroglu, Imrohoroglu and Joines (1999), capital stock decreases by 26% with a 40% social security replacement rate. Conesa and Krueger (1999) find the reduction in capital stock to be around 11% to 17%.

of wealth held by them barely changes by the decrease of interest rate.

	Gini	1st	2nd	3rd	4th	5th	90-95	95-99	99-100
Total wealth									
Benchmark	0.74	0.13	0.67	4.04	17.35	77.81	19.91	25.12	10.00
Fix prices	0.70	0.11	1.11	6.84	20.21	71.73	18.31	22.54	8.80
Change prices	0.69	0.14	1.06	7.25	21.41	70.15	18.25	21.49	7.88
Housing									
Benchmark	0.48	1.73	8.39	14.71	24.59	50.58	13.02	11.79	3.74
Fix prices	0.49	1.77	7.33	15.29	23.95	51.66	12.98	11.86	3.91
Change prices	0.49	1.54	8.06	14.92	23.89	51.58	13.64	11.53	3.60
Financial wealth									
Benchmark	0.86	-6.07	-2.68	-0.29	12.32	96.71	24.51	33.70	14.07
Fix prices	0.79	-3.40	-0.68	3.88	18.47	81.74	20.65	26.97	10.90
Change prices	0.80	-6.19	-1.51	3.26	19.79	84.65	21.64	27.53	10.70

Table 4: Wealth distribution (privatizing social security)

Table 5 reports the overall welfare effects of privatizing social security for the economy as a whole, as well as for each type of agents. As is shown in the second row, by living in the privatized system an unborn agent experiences a welfare gain. The reason is that the benefit from social security as insurance against income shocks and as annuity against mortality risk is outweighed by the loss generated from the financial market imperfection which limits households ability to smooth consumption. Proportional payroll tax on current income depress consumption dollar by dollar when liquidity constraints are binding¹³.

Households with high initial productivity seem to be much more in favor of privatizing social security. If prices are fixed, household with low initial productivity level lose while households with high initial productivity level gain. This mainly comes from the redistribution effect of social security since pension income is independent of income history. When income shocks are quite persistent, high initial productivity households are more likely to have high lifetime income and contribute more social security tax than low initial productivity households. Therefore high initial productivity households prefer privatizing social

¹³The effect of borrowing constraint on the welfare and aggregate effect of social security is illustrated by Hubbard and Judd (1987) in a model without housing.

security.

The results that households of all initial productivity gain from privatizing social security is different from Fuster, Imrohoroglu and Imrohoroglu (2003). They show that in a model with two-sided altruism, family insurance plays an important role and for a majority of households the benefits of social security outweigh the relatively small cost in terms of the crowding out of the capital stock. In my model, households only have one-sided impure altruism which does not provide insurance among generations. Therefore similar to the vast majority of the life cycle models, the large negative effect of social security on capital accumulation leads to an important reduction in steady-state welfare.

Variables (%)	Fix prices	Change prices
w	4.53	4.97
w ₁	-0.76	3.08
w ₂	1.21	4.12
w ₃	5.83	5.72
w ₃	14.76	7.08

Table 5: Average welfare gain (privatizing social security)

If prices are allowed to adjust, then households at all initial productivity levels gain. Furthermore, the welfare gain is increasing in the level of productivity shock. Households with low initial productivity level, as net borrower especially when young, benefit from low interest rate and high wage rate. Household with high initial productivity level, as net saver, facing low interest rate, lose some benefit of privatizing social security.

5.2 Lowering down payment

Recently there has been a decline of the down payment requirement in purchasing houses. Now I check the long-run effect of lowering down payment ratio.

5.2.1 Life cycle profiles

I show the average life cycle profiles of assets and consumption paths when the down payment ratio is 0 and prices are fixed. The down payment ratio does affect the consumption of

housing and non-housing when the households are young. If the down payment ratio is low, then young households are more likely to move into big houses, therefore the housing profile increases quickly. Figure 8 and Figure 9 show the average life cycle profiles of assets and consumption paths when the down payment ratio is 0. Compared with the benchmark, the consumption of housing goods is higher early in life. The profiles of wealth and consumption are similar to these in the benchmark economy for middle and old households, indicating that most of them are not constrained by the down payment requirement. Households use houses as collateral and they have negative financial wealth until their forties, a point at which they begin to save for retirement. This indicates that saving for purchasing houses is the main saving motive for young households.

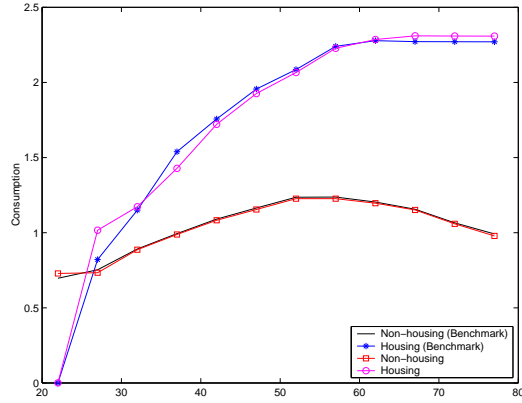


Figure 8: Life cycle patterns of consumption (no down payment: $\theta=0$)

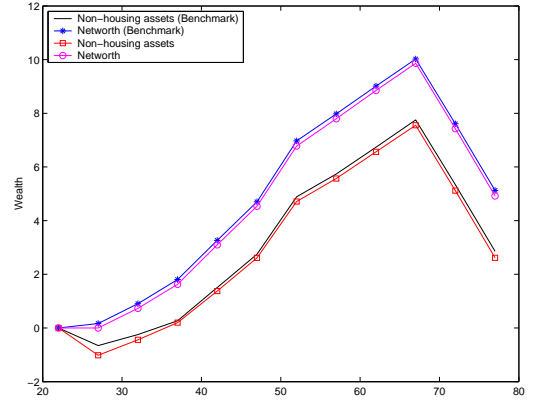


Figure 9: Life cycle patterns of wealth composition (no down payment: $\theta=0$)

Figure 10 and Figure 11 show the average life cycle profiles of assets and consumption paths when the down payment ratio is 0 and prices are allowed to change. Compared with the benchmark economy, the consumption of housing goods is higher early in life. If the down payment ratio is low, then young households are more likely to move into big houses, therefore the housing profile increases quickly. The profiles of wealth and consumption are similar to these in the benchmark economy for middle and old households, indicating that most of them are not constrained by the down payment requirement. This comparison indicates that saving for purchasing houses is the main saving motive for young households. Figure 10 and Figure 11 are similar to Figure 8 and Figure 9, indicating that the general

equilibrium effect on consumption and wealth path is small.

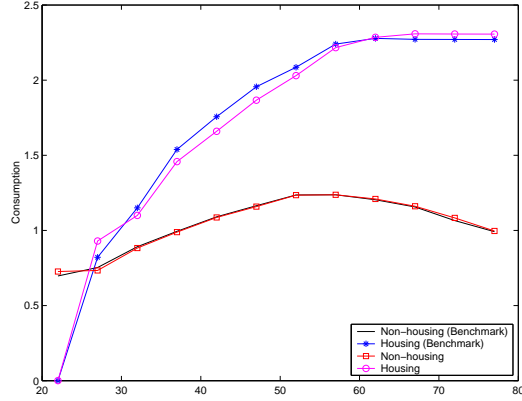


Figure 10: Life cycle patterns of consumption (no down payment: $\theta=0$)

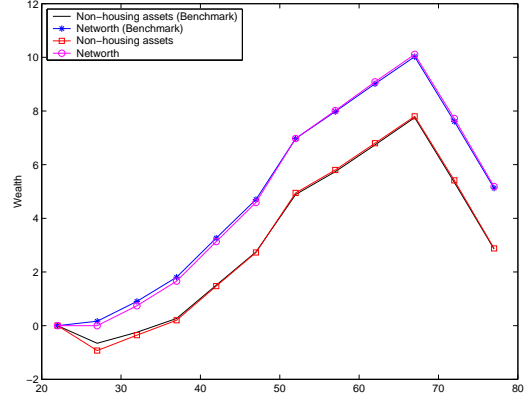


Figure 11: Life cycle patterns of wealth composition (no down payment: $\theta=0$)

5.2.2 Summary statistics

Table 6 summarizes the aggregate statistics in the economy with no down payment. We see that lowering down payment requirement leads to only minor changes to the aggregate economy. If prices are fixed, lowering down payment requirement encourages households to borrow to purchase houses, as evidenced by a decline of 6.46% in K/Y . Second, the aggregate demand for housing rises slightly by 0.74% increase in the H/Y ratio.

If interest rate and wage rate are allowed to adjust to clear the markets, then interest rate increases by 0.1 percentage points. As a consequence, saving increases, as evidenced by a decrease of 0.81% in K/Y , compared with a decline of 6.46% when prices are fixed. Second, the positive effect on aggregate demand for housing is reversed and the H/Y ratio declines slightly by 0.74%.

Table 7 summarizes the wealth distribution in the economy with no down payment. Less restrictive borrowing constraints generate more inequality in wealth holdings. The gini coefficient of net worth increases slightly from 0.75 in the benchmark economy to 0.76. Lowering down payment loosens borrowing constraint, thus households are allowed to have zero wealth. Indeed more than 40% of households choose to hold zero wealth.

However, less restrictive borrowing constraints generate less inequality in housing assets

Variables	Initial steady state	Fix prices	Change (%)	Change prices	Change (%)
θ	20%	0			
r	4.37%	4.37%		4.48%	0.1%
Y	1	1		0.99	-1%
K/Y	1.9874	1.8595	-6.46%	1.9714	-0.81%
H/Y	1.2137	1.2226	0.74%	1.2042	-0.74%
C/Y	0.7811	0.7776	-0.46%	0.7842	0.39%

Table 6: Aggregate statistics (no down payment)

holdings. The gini coefficient of housing decreases slightly from 0.48 in the benchmark economy to 0.47. Lower down payment allows households to buy bigger houses, thus households at the bottom 20% choose to hold more housing assets.

Less restrictive borrowing constraints generate more inequality in financial assets holdings. The gini coefficient of financial assets increases from 0.86 in the benchmark economy to 0.87. Lower down payment allows households to borrow more in the financial market. thus households at the bottom 60% choose to borrow more financial assets when purchase houses.

	Gini	1st	2nd	3rd	4th	5th	90-95	95-99	99-100
Total wealth									
Benchmark	0.74	0.13	0.67	4.04	17.35	77.81	19.91	25.12	10.00
Fix prices	0.76	0	0	3.18	17.37	79.45	20.28	25.74	10.28
Change prices	0.76	0	0	3.20	17.31	79.49	20.23	25.77	10.41
Housing									
Benchmark	0.48	1.73	8.39	14.71	24.59	50.58	13.02	11.79	3.74
Fix prices	0.47	2.32	8.27	14.82	24.38	50.20	12.92	11.78	3.63
Change prices	0.47	2.37	7.77	15.14	23.63	51.09	13.16	11.72	3.75
Financial wealth									
Benchmark	0.86	-6.07	-2.68	-0.29	12.32	96.71	24.51	33.70	14.07
Fix prices	0.87	-8.26	-4.38	-0.57	12.02	101.19	25.62	35.42	14.87
Change prices	0.87	-7.30	-3.82	-0.49	12.36	99.27	25.16	34.70	14.73

Table 7: Wealth distribution (no down payment)

Table 8 reports the overall welfare effects of privatizing social security for the economy

as a whole, as well as for each type of agents. As is shown in the second row, by living in an economy with no down payment an unborn agent experiences a welfare gain.

Households with high initial productivity in the benchmark economy seem to gain less. If prices are fixed, household with high initial productivity level lose while household with low initial productivity level gain. Furthermore, the welfare gain is decreasing in the level of shock. When income shocks are quite persistent, high initial productivity households are more likely to have high lifetime income and less likely to be constrained by the down payment requirement than low initial productivity households. Therefore high initial productivity households does not gain much from the low down payment.

If prices are allowed to adjust, then households at all initial productivity levels gain. Furthermore, the welfare gain is decreasing in the level of productivity shock. The intuition is that, when interest rate is allowed to change, interest increases slightly. Thus those who borrow suffer and most of them are with low initial productivity level. Households with high initial productivity level are more likely to be saver and benefit from the increase of interest rate.

Variables (%)	Fix prices	Change prices
w	1.02	0.86
w ₁	3.02	2.57
w ₂	1.52	1.14
w ₃	0.26	0.16
w ₄	-0.38	0.18

Table 8: Average welfare gain (no down payment)

5.3 Lowering transaction costs

As housing markets develop, the implicate and explicate search costs associated with housing move may decline, so may be the brokage and agent fees incurred to reduce the search costs. Also, part of the transaction costs are in the form of legal fees, which can be changed by the government policy. Now I show the long-run effect of lowering housing transaction costs.

5.3.1 Life cycle profiles

Figure 12 shows the effect of low transaction costs on average non-housing and housing consumption when prices are allowed to adjust (the life cycle profiles of consumption and wealth when the prices are fixed are similar). The housing consumption is higher than the benchmark. This is because when transaction costs are lower, housing assets become more attractive than financial assets. Figure 13 shows that the effect of low transaction costs on net worth profile is small.

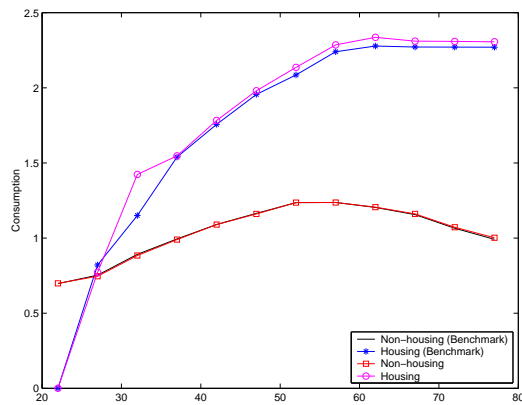


Figure 12: Life cycle patterns of consumption (low transaction costs: $\rho_1 = 3\%$, $\rho_2 = 1\%$)

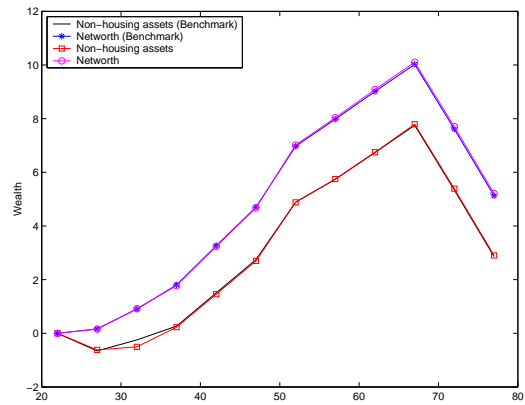


Figure 13: Life cycle patterns of wealth composition (low transaction costs: $\rho_1 = 3\%$, $\rho_2 = 1\%$)

5.3.2 Summary statistics

Table 9 summarizes the aggregate statistics in the economy with low transaction costs. We see that lowering transaction costs leads to only minor changes to the aggregate economy. If prices are fixed, lowering transaction costs encourages households to shift portfolio from financial assets to housing assets, as evidenced by a decline of 3.98% in K/Y. Second, the aggregate demand for housing rises, as indicated by 3.27% increase in the H/Y ratio.

If interest rate and wage rate are allowed to adjust to clear the markets, then interest rate increases by 0.1 percentage points. As a consequence, saving increases, as evidenced by a decline of -0.7% in K/Y, compared with 3.98% if prices are fixed. Second, the aggregate demand for housing increases by 3.18% in the H/Y ratio.

Variables	Initial steady state	Fix prices	Change (%)	Change prices	Change (%)
ρ_1, ρ_2	6% 2%	3% 1%		3% 1%	
r	4.37%	4.37%		4.46%	0.1%
Y	1	1		0.9975	-0.25%
K/Y	1.9874	1.9084	-3.98%	1.9730	-0.7%
H/Y	1.2134	1.2534	3.27%	1.2523	3.18%
C/Y	0.7811	0.7784	-0.35%	0.7824	0.16%

Table 9: Aggregate statistics (low transaction costs)

Table 10 summarizes the wealth distribution in the economy with low transaction costs. We see that lowering transaction costs leads to only minor changes to the wealth distribution. The gini coefficients of net worth, housing assets, financial assets increase slightly. Households at the top hold more wealth in form of financial assets.

	Gini	1st	2nd	3rd	4th	5th	90-95	95-99	99-100
Total wealth									
Benchmark	0.74	0.13	0.67	4.04	17.35	77.81	19.91	25.12	10.00
Fix prices	0.75	0.13	0.66	3.85	17.22	78.14	19.97	25.25	10.06
Change prices	0.75	0.13	0.65	3.84	17.28	78.10	19.93	25.26	10.12
Housing									
Benchmark	0.48	1.73	8.39	14.71	24.59	50.58	13.02	11.79	3.74
Fix prices	0.48	1.66	8.01	15.08	24.15	51.10	12.94	12.63	3.63
Change prices	0.48	1.67	8.09	15.07	24.45	50.72	13.12	12.27	3.68
Financial wealth									
Benchmark	0.86	-6.07	-2.68	-0.29	12.32	96.71	24.51	33.70	14.07
Fix prices	0.87	-6.73	-3.00	-0.53	11.64	98.62	24.87	34.32	14.50
Change prices	0.87	-6.45	-2.82	-0.41	11.99	97.70	24.64	34.09	14.42

Table 10: Wealth distribution (low transaction costs)

Table 11 reports the overall welfare effects of lowering transaction costs for the economy as a whole, as well as for each type of agents. As is shown in the second row, by living in an economy with low transaction costs an unborn agent experiences a welfare gain. If prices are fixed, households with different initial productivity in the benchmark economy seem to gain the same amount.

If prices are allowed to adjust, the welfare gain is increasing in the level of productivity shock. This comes from the increase of interest rate. Households with high initial productivity level are more likely to be saver and benefit from the increase of interest rate.

Variables (%)	Fix prices	Change prices
w	0.45	0.34
w ₁	0.48	0.17
w ₂	0.49	0.21
w ₃	0.41	0.33
w ₄	0.41	0.82

Table 11: Average welfare gain (low transaction costs)

6 Conclusions

I use a quantitative, dynamic general equilibrium model of life cycle behavior to study the effects of several policy reforms on assets composition over the life cycle, wealth distribution and aggregate saving. Privatizing social security increases aggregate saving, decreases overall wealth inequality, and generates large welfare gain, especially for agents with high initial productivity. Lowering down payment encourages income poor households to hold more housing assets and generates a welfare gain for agents with low initial productivity. Lowering transaction costs encourages households to hold more housing assets and generates a welfare gain for agents of every initial productivity.

In this paper, I have abstracted from some important issues in order to make the model manageable. Now I discuss these simplifications and their likely implications. I calibrate my model to the U.S. data and examine the stationary equilibrium. It is interesting to look at the transition path of the policy changes. However, due to the computational reasons, I leave this interesting issue for future research.

In my model there is no housing rental market. In the presence of rental markets, policy reform will affect the assets composition over the life cycle, wealth distribution and aggregate saving through its impacts on the home ownership ratio.

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