The distributional effects of rational (housing) bubbles

Wu You

A thesis for the degree of
Master of Philosophy in Economics

Department of Economics

University of Oslo

May 2015

The distributional effects of rational (housing) bubbles

2015

The distributional effects of rational bubbles

Wu You

http://www.duo.uio.no/

Print: Reprosentralen, Universitetet i Oslo

Abstract

This thesis studies an economy (without growth) populated by overlapping generations of rich and poor agents, with the difference between them being that the rich are endowed with larger amounts of wealth in both period. Both types of agents want to transfer wealth over time and smooth out their consumptions. Agents could borrow from or lend to each other in credit market, when borrowing they are subject to a collateral constraint. Agents could also buy house(s), which are indivisible and pay no dividend whatsoever.

Because of the lack of investment instruments and dynamic inefficiency in bubble-free steady states, a rational housing bubble could arise. Due to its high prices and indivisibility, houses are not affordable to the poor. So in the bubble steady states only the rich get to buy houses and enjoy the high rate of return caused by the housing bubble, while the poor are left out, implying potential distributional effect. With a relaxed collateral constraint, the market interest rate is relatively high and the rich could borrow a lot from the poor through the credit market, thus providing them (the poor) with a mean to transfer wealth across periods and benefit from the housing bubble indirectly. A tight borrowing constraint, on the other hand, limits the rich's borrowing capacity and hurt the poor's lifetime utility indirectly through lower market interest rate (and the resulting inefficient wealth transfer).

This model could be applied to China, where we have witnessed drastic increase in housing prices during the last 15 years. Several researches and empirical evidences point towards the existence of a rational housing bubble in China. Upon a closer look at survey data from selected years we can see a rise in household consumption inequality from 1999 to 2002, and then to 2008. Other research has also found that increasing housing prices have caused much of the increase in wealth inequality in China.

Preface

Writing this thesis has been exhausting, frustrating and yet even more exciting and inspiring. About nine months ago, when I first came up with the intuition and sketched the model, it was something very different from the model in this paper. Even only one month ago I wasn't aware how complicated the steady states could be. Having made so many mistakes, I really do not stand a chance without the help of many others.

First I want to thank my supervisor, professor Kjetil Storesletten, who has always been patient with my procrastination, encouraging me to do better, and inspiring me in my struggle with my model. I would also like to thank postdoc Wang Yikai, postdoc Andreas Muller and professor Marcus Hagedorn for their excellent and helpful comments, which have contributed greatly to the improvement of my work. Last but not least, I am very thankful to ESOP (Center for the study of equality, social organization, and performance) and professor Steinar Holden for awarding me their respective scholarships, their recognition means a lot to me.

Table of Contents

List of Figures

List of Tables

The distributional effects of rational (housing) bubbles

Wu You

May 18, 2015

1 Summary

Bubbles are a fascinating economic phenomenon, not only for the damage they do when bursting, but also for the benefits they bring to an economy. When facing dynamic inefficiency and secular stagnation, bubbles could be the driving force behind economic growth. However, if a bubble arose in, for example, the housing market, households would need to pay a large amount of money to buy one or more houses and enjoy the high rate of return that comes with the housing bubble. But there are poor households who are not wealthy enough to purchase even one house, since you cannot buy one half or one fourth of a house, these poor households will be completely left out. Then we could end up with a situation where the rich get to invest in housing and get richer, while the poor are left out and become relatively poorer. This distributional effect as result of a rational bubble is what I want to examine in my thesis.
To do that I constructed a simple overlapping generations model with two types of agents: the rich and the poor. In each period the agents receive an endowment of consumption goods, with the rich being wealthier and all agents receiving more

endowment when they are young (than when they are old). There is no production or growth in this economy.

In order to maximize their lifetime utility, agents of both types want to transfer wealth from the first period of their lives to the second period. [1] They can achieve this by borrowing from or lending to each other in the credit market, or they can buy house(s) in the first period, and sell it (them) in the second. When borrowing the agents need to put up their house(s) as collateral, which means that only house-owners could borrow, and then only when the housing prices are positive. There is no other asset in this economy.

Houses, as the only asset in the model, do not pay dividend or yield utility to the agents. [2] They are also indivisible, which is important for generating distributional effects out of the potential housing bubbles, since it's now possible that the poor could not afford to buy even one house.

A bubble-free [3] steady state exists in this economy where the agents just consume their endowment. With a negative interest rate, this is an inefficient equilibrium since both the rich and the poor would benefit from some wealth transfer over time.

Due to the lack of investment instruments and dynamic inefficiency in bubble-free steady states, rational housing bubbles could arise in this economy. From the point of view of the economy's efficiency, a housing bubble could be beneficial since it provides the economy with some much needed investment tools and allows for wealth transfer across periods. But because of their high prices and indivisibility,

[1] Agents of both types value consumption in each of the two periods of their lives equally. Being endowed with more wealth when they are young, it's logical that they want to transfer some of that wealth to finance their later-life consumption.

[2] Paying no dividend and yielding no utility means that the housing price should be zero. A positive housing price, therefore, is a housing bubble.

[3] Meaning that the housing price is zero.

houses are too expensive for the poor. So in these bubble steady states only the rich get to invest in the housing market and benefit from the high rate of return provided by the housing bubble, while the poor are left out, implying potential distributional effects.

When the rich are not borrowing constrained we see in the model that they borrow from the poor and generally act as "middle man", giving the poor access to the same rate of return as that of the housing bubble. The poor could thus transfer wealth as efficiently as the rich and benefit from the housing bubble indirectly. In this case the rational housing bubble does not have any distributional effect. When the rich are borrowing constrained, however, the decreased demand for loans would drive down the credit market interest rate, forcing the poor to transfer wealth less efficiently. The result then is increased inequality in lifetime consumption and utility between the rich and the poor (comparing to the bubble-free steady state). Further analysis also shows that a relaxed collateral constraint could alleviate the distributional effects by allowing the rich to borrow more, which leads to relatively high market interest rate and enables the poor to save more efficiently. A tight collateral constraint, however, limits the rich's borrowing capacity, drives down the market interest rate and hurts the poor indirectly. [4]

Then I chose to look at data from China for empirical evidence that support the result of my model. Extensive research has been made that backs the claim that the drastic housing price hike in China during the last 10-15 years is indeed a rational housing bubble. Upon closer look at some survey data, I found that inequality in household consumption (in urban China) has gone up, which, to some degree, collaborates the prediction of my simple model. Other research also found the rising housing prices responsible for much of China's increasing wealth inequality.

[4]By both limiting the amount of wealth they could transfer, and lowering the rate of return by which the poor could transfer this wealth.

2 Introduction And Literature Review

China has experienced drastic increase in housing prices in the last 10-15 years. This is considered by many Chinese to be a bubble. Research seems also to confirm the existence of a rational housing bubble (see Wu, Gyourko and Deng [2012] and Zhao [2013]). This rational bubble might be caused by domestic financial underdevelopment (Caballero and Arvind, 2006), technological progress, rest of the world having lower expansion potential (see Caballero, Emmanuel and Mohamad [2006]), etc. The housing bubble could be beneficial because it provides domestic stores of value and thereby reduces capital outflows while increasing investment, but it could also do damage by exposing China to bubble-crashes and capital flow reversals (see Caballero and Arvind [2006]).

Extensive research has been done on asset bubbles. Many recent papers seem to be focusing on financial friction, collateral constraint and their role in causing a bubble (Zhao, 2013, see also Kocherlakota [2009], López-Salido and Arce [2011]). In this case a rational bubble could benefit the economy by channeling resources towards productive investment and thus raising the growth rates of capital and output (Martin and Ventura, 2012), and/or relaxing collateral constraints and improve investment efficiency (Miao and Wang, 2011).

However, what interests me most about the housing bubble, is its potential distributional effects. I have read a lot about housing prices being too high for common people, while rich and resourceful real-estate investors rip huge profit by investing in the housing market. It leads me naturally to the following intuition: A rational bubble could be good for an economy's aggregate variables for the reasons I just listed, but if it's not accessible to normal households for some reason, than this

bubble might have distributional effect, where the rich get to ride the bubble and become richer, and the poor get left out and even suffer from the price hike.
Very few have touched upon this subject, among them Kocherlakota (2009) who demonstrates that bursting bubbles in land prices may have dramatic and persistent distributional effect, where the workers lose but entrepreneurs gain from the bubble's collapse.
Many papers analyze housing bubble using an agent type "Investors", who do not derive dividend or utility from houses and hold them for resale purposes only (see, for example, López-Salido and Arce [2011], Zhao [2013]). But since I am mostly interested in the distributional effects of a rational bubble, I will not include investors into my model. Instead, In order to focus on the distributional effect, I construct a two-period overlapping-generation model with the twist that half the agents are rich and the other half are poor.
Plan of this paper: In section 3 I construct the model, analyze the different bubble-free and bubble steady states, and examine the distributional effect and its implications. Section 4 looks at empirical data from China. Conclusions are provided in section 5.

3 A Simple Model

3.1 The Agents

The model is populated by overlapping generations of agents who live for two periods. Within each generation we have two types of agents: rich and poor. Both the rich and the poor make up half of each generation. The size of each generation is normalized to two, so the size of rich and poor agents in each generation is normalized to unity. After the death of an old generation, a new one of the same size and composition come into play, therefore the total population size remains constant.

In each period, the young and old agents of both types (rich and poor) receive an exogenous endowment of consumption goods. To keep our analysis simple and clear, we set the endowment of different periods and types to be:

$$w^y_{r,t} = 8w, \quad w^o_{r,t+1} = 4w$$
$$w^y_{p,t} = 2w, \quad w^o_{p,t+1} = w$$

The superscripts y and o stand for young and old, respectively, while the subscript r stands for rich, and p stands for poor. The subscript t stands for period t.

Agents of both types seek to maximize their lifetime utility of the form $ln(c^y_t) + \beta ln(c^o_{t+1})$ where the discount factor β is set to 1 for simplicity, and c^y_t and c^o_{t+1} stand for the agent's consumption when she is young and old, respectively.

3.2 The Assets

There is a long-lived asset which is indivisible in the economy, the asset pays a constant dividend $d_t = 0$ every period. The indivisibility of the asset will be key to our analysis and is one of the reasons that cause the distributional effects of a rational bubble. This indivisibility is also not unreasonable to assume, when you

think about assets like, for example, a house. You either buy one house, or you don't, buying one half of a house isn't normally an option.
The size of the housing stock, H, is fixed to 1. This, combined with the indivisibility of housing, means that within each period, only one of the two types of agents could buy and hold a house.
Note that since houses pay no dividend and are not involved in the agents' utility whatsoever, it is possible to have housing prices equal to zero in equilibrium. In that case, both agents are indifferent between buying or not, and the house goes to one of them randomly.

3.3 The Agents' Optimization Problem

In the first period of their lives, young agents, both rich and poor, will decide between consumption and housing purchase. There is also a credit market where the agents could borrow or lend at a risk-free interest rate. We assume that agents have to put up collateral in order to get loans and impose a borrowing constraint where agents could not borrow more than a fraction θ of their housing wealth. In the second period, the now old agents would sell their houses if they had any, and consume all their wealth.
Formally the optimization problem for the rich agents who are born in period t could be written as:

$$\max \quad \{ln(c^y_{r,t}) + ln(c^o_{r,t+1})\} \tag{1}$$

$$\text{subject to}$$

$$c^y_{r,t} + p_t H_{r,t} = w^y_{r,t} + d_t \tag{2}$$

$$c^o_{r,t+1} = w^o_{r,t+1} - R_t d_t + p_{t+1} H_{r,t} \tag{3}$$

$$d_t \leq \theta p_t H_{r,t} \tag{4}$$

Where $H_{r,t}$ stands for the rich agent's housing purchase, p_t and p_{t+1} stand for housing prices in period t and $t+1$, respectively. d_t represents the agent's financial status, where $d_t > 0$ means that the agent is net debtor, and $d_{t+1} < 0$ means that the agent is net creditor. R is the gross interest rate.

Similarly, the optimization problem for the poor agents who are born in period t could be written as:

$$\max \quad \{ln(c^y_{p,t}) + ln(c^o_{p,t+1})\} \tag{5}$$

subject to

$$c^y_{p,t} + p_t H_{p,t} + a_t = w^y_{p,t} \tag{6}$$

$$c^o_{p,t+1} = w^o_{p,t+1} + p_t H_{p,t} + R_t a_t \tag{7}$$

$$-a_t \leq \theta p_t H_{p,t} \tag{8}$$

Here $H_{p,t}$ stands for the poor agent's housing purchase, while a_t represents the agent's financial status with $a_t > 0$ meaning that the agent is net creditor, and $a_t < 0$ if the agent is net debtor.

We have 1 unit of house which is indevisible, so the following must also be satisfied:

$$H_{r,t} = 0 \ or \ 1 \tag{9}$$

$$H_{p,t} = 0 \ or \ 1 \tag{10}$$

3.4 Clearing The Markets

The solutions of this model are given by (1) – (10) and market clearing conditions for the housing market:

$$H_{r,t} + H_{p,t} = 1 \tag{11}$$

for consumption goods:

$$c^y_{r,t} + c^o_{r,t} + c^y_{p,t} + c^o_{p,t} = w^y_{r,t} + w^o_{r,t} + w^y_{p,t} + w^o_{p,t} \tag{12}$$

and for loans:

$$d_t = a_t \tag{13}$$

3.5 Simplifying The Model

Given the logarithmic form of all the agents' utility function and the difference between their endowment when young and old, it is obvious that agents of both types would want to transfer some of their wealth from their first period of life to their second period. This is because all agents want to smooth out their consumption across both periods and thus maximize their lifetime utility.

Since in the credit market total debt must be equal to total loan (market clearing condition (13)), bubbles in housing prices, if there were any, will be the major channel through which the agents can save and transfer wealth across life periods. In light of this, agents of both types will want to buy houses when there was a housing price bubble, and in the model I have just built, it is possible to have equilibria where the poor gets to buy the house. But these types of equilibria are messy and quite unrealistic for the following reasons: 1. If the poor could afford the house, the rich could afford it, too, then we are confronted by the rather nasty business of allocating the house. If we allocate the house randomly, that is to say the rich and the poor each get to buy the house 50 percent of the time, the house would then change hands from time to time, either from the rich to the poor, or from the poor to the rich. But this is then not a stationary equilibrium (which is the more interesting case that I will be focusing on), and frankly, a very chaotic and unconvincing case. So in order to have a stationary equilibrium where the poor end up with the house, we must allocate the house to the poor by default, but that's just equally unconvincing. 2. If we are being realistic, the rich agent could just outbid the poor agent if he wants.

For the reasons I just discussed above, I think it's both simplifying and reasonable to assume that the poor could not afford the house in a bubble situation and set $H_{p,t}$ to 0 for all period where $p_t > 0$, I will of course verify in my proof that the poor indeed cannot afford to buy the house. This will allow us to drop conditions

(8) and (10), and substitute (6) (7) with:

$$c^y_{p,t} + a_t = w^y_{p,t} \tag{6'}$$

$$c^o_{p,t+1} = w^o_{p,t+1} + R_t a_t \tag{7'}$$

Since the term $p_t H_{p,t}$ will be equal to 0 whether there is a bubble or not.

3.6 Equilibrium

I define a competitive equilibrium for this model as an allocation $\{c^y_{r,t}, c^o_{r,t}, c^y_{p,t}, c^o_{p,t}, d_t, a_t, H_{r,t}\}^{\infty}_{t=0}$ and a price sequence $\{p_t, R_t\}^{\infty}_{t=0}$ such that the rich agents maximize their utility (1) subject to constraints (2)-(4) and (9),the poor agents maximize their utility (5) subject to constraints (6')-(7'), and the market clearing conditions (11)-(13) are satisfied.

I will be focusing on stationary equilibrium where the housing price p and gross interest rate R are constant over time.

3.7 Solving The Model

Solving the optimization problem for the poor agents gives us the following first order conditions:

$$\frac{1}{c^y_{p,t}} = \frac{R}{c^o_{p,t+1}} \tag{14}$$

(14) shows that at equilibrium the marginal utility cost of saving one extra unit of consumption goods (in the first period of life), $\frac{1}{c^y_{p,t}}$, must be equal to the marginal utility benefit from one extra unit of consumption in the second period of life, $\frac{R}{c^o_{p,t+1}}$.

Together with (6') and (7'), (14) can also help us solve for $c^y_{p,t}$, $c^o_{p,t+1}$ and a_t for any given R:

$$c^y_{p,t} = (1 + \frac{1}{2R})w = c^y_p \tag{15}$$

$$c^o_{p,t+1} = (R + \frac{1}{2})w = c^o_p \tag{16}$$

$$a_t = (1 - \frac{1}{2R})w = a \tag{17}$$

Here I have utilized the endowment conditions $w^y_{p,t} = 2w$ and $w^o_{p,t+1} = w$. The last equality sign " $=$ " in (15) (16) and (17) follows from the fact that R and w are constant over time. Thus the equilibrium c^y_p, c^o_p and a will all be stationary.

Solving the optimization problem for the rich agents, on the other hand, will gives us the following conditions:

$$\frac{1}{c^y_{r,t}} = \frac{R}{c^o_{r,t+1}} + \mu_t \tag{18}$$

$$\mu_t \geq 0, \quad \mu_t(d_t - \theta p H_{r,t}) = 0 \tag{19}$$

Where μ_t is the Kuhn-Tucker multiplier associated with the borrowing constraint (4).Condition (19) is the standard Kuhn-Tucker condition associated with the same borrowing constraint.

The first order condition (18), togehter with the Kuhn-Tucker (19), imply that when the borrowing constraint (4) is not binding, i.e.,when $d_t - \theta p H_{r,t} < 0$, μ_t will have to be equal to 0, and the marginal benefit from borrowing and consuming one additional unit in the first period of life, $\frac{1}{c^y_{r,t}}$, will equal the marginal cost in the form of lower consumption in the second period of life, $\frac{R}{c^o_{r,t+1}}$.

when the borrowing constraint (4) is binding ($d_t - \theta p H_{r,t} = 0$), however, we will have $\mu_t > 0$, and the marginal benefit from borrowing and consuming one extra unit in the first period of life, $\frac{1}{c^y_{r,t}}$, will be strictly larger than its marginal cost in terms of less consumption in the second period of life, $\frac{R}{c^o_{r,t+1}}$. This collaborates with the intuition here that the rich agents want to borrow more but are credit-constrained.

3.8 The Bubble-Free Steady States

Since houses pay no dividend, housing price p will be equal to 0 if there were no housing bubbles in the economy. In this case, we are dealing with a much simplified model where

For the rich:
$$\max \quad \{ln(c^y_{r,t}) + ln(c^o_{r,t+1})\}$$
subject to
$$c^y_{r,t} = w^y_r + d_t$$
$$c^o_{r,t+1} = w^o_r - Rd_t$$
$$d_t \leq 0$$

For the poor:
$$\max \quad \{ln(c^y_p) + ln(c^o_p)\}$$
subject to
$$c^y_p + a = w^y_p$$
$$c^o_p = w^o_p + Ra$$

And two market clearing conditions (12) and (13).

Given their endowment pattern, both the rich and the poor want to save. Together with the fact that the credit market must be cleared, this implies

$$a = d = 0$$
$$c^y_r = w^y_r = 8w, \quad c^o_r = w^o_r = 4w$$
$$c^y_p = w^y_p = 2w, \quad c^o_p = w^o_p = w$$

$$\frac{1}{c_r^y} = \frac{R}{c_r^o}, \quad \frac{1}{c_p^y} = \frac{R}{c_p^o} \quad \rightarrow R = \frac{1}{2}$$

In each period of their lives, the rich and the poor consume all their endowment. We have dynamic inefficiency in this steady state: the rich would be strictly better off if they could transfer $2w$ wealth from the first period to the second; the poor would also be strictly better off if they could transfer $0.5w$ wealth from the first to the second period. This dynamic inefficiency is due to shortage of assets which makes the agents (of both types) unable to transfer wealth across periods.

3.9 The Bubble Steady States

In a bubble steady state, that is to say when the housing price $p > 0$, the gross interest rate for investing in housing is 1. Therefore the gross interest rate in the credit market, R, must satisfy $R \leq 1$, otherwise the agents would not invest into housing purchase and the housing bubble will not sustain.

Intuitively (and according to discussion in subsection 2.5), the rich agent is the one being able to invest in housing in a housing bubble situation. Since the gross interest rate in credit market, R, is lower than or equal to the housing market's gross interest, the rich agent will take advantage of this difference in rate of return, i.e., borrow from the credit market at a lower interest rate and invest in the housing market at a higher interest rate. This means that $d \geq 0$ (the rich agent is the borrower in the credit market). Since the credit market must be cleared as shown in condition (13), we must also have $a = d \geq 0 \rightarrow a \geq 0$ (the poor agent is the lender).

Substituting $a \geq 0$ into (17), we have $(1 - \frac{1}{2R})w = a \geq 0$. Solving this will give us $R \geq \frac{1}{2}$.

So an necessary condition for the existence of a bubble steady state, is:

$$\frac{1}{2} \leq R \leq 1 \tag{20}$$

Steady States Where The Borrowing Constraint Does not Bind. — When the borrowing constraint (4) is not binding ($d_t - \theta p H_{r,t} < 0$), we have from (19) that $\mu = 0$. This allows us to rewrite (18) as $\frac{1}{c^y_{r,t}} = \frac{R}{c^o_{r,t+1}}$. Notice that here we actually lack a condition to definitively pin down either the gross interest rate R or the housing price p. As a matter of fact, for every R that satisfies $\frac{1}{2} \leq R \leq 1$, we have a steady state with corresponding p and θ.

To avoid the complication of multiple steady states, I am going to focus on the ONE steady state where the housing price p allows the rich agent to achieve efficient allocation across two periods, i.e., where $c^y_r = c^o_t$. This also implies a steady state R equals to 1.

PROPOSITION 1: *If $\theta > 0.2$, then there exists a steady state allocation $\{c^y_r, c^o_r, c^y_p, c^o_p, d, a, H_r\}$ and price sequence $\{p, R\}$ where*

$$\{c^y_r, c^o_r, c^y_p, c^o_p, d, a, H_r\} = \{6w, 6w, 1.5w, 1.5w, 0.5w, 0.5w, 1\}$$
$$\{p, R\} = \{2.5w, 1\}$$

In this steady state the borrowing constraint (4) is not binding. In addition the housing price p is positive even though it pays no dividend, so we have a rational bubble here

It is easy to verify that this is indeed a steady state, and the housing price 2.5w is more than the poor agent could afford, thus justifying the simplification in (2.5) (where $H_{p,t}$ is set to 0).

In this steady state the rich buys the house and borrows from the poor when young, sells the house and pays back the loan when old, while the poor lends to the rich when young, and collects the loan when old.

The rich agent transfers wealth across two periods of life by investing into housing purchase. The poor, though could not afford to buy a house and transfer wealth through the housing market, could instead lend to the rich and transfer wealth through the credit market.

Both the rich and the poor manage to achieve sufficient transfer of wealth across their two periods of life (without "taking advantages of each other"). They are both unambiguously better off than under the bubble – free steady state. [5] The poor agent would like to invest in housing but could not afford it, luckily, the rich agent is willing to borrow from the poor and invest the loan into the housing market. The credit market gross interest rate $R = 1$ means that the rich only acts as a "middle man", giving the poor access to wealth transfer with the same rate of return as that of the housing market. There should be no surprise that the housing price $p = 2.5w$ is also the exact amount of wealth a whole young generation wants to transfer from the first to the second period of life in order to achieve dynamic efficiency.

Steady States Where The Borrowing Constraint Binds. — Here we are looking at multiple sets of steady states, too. Similar to the last case, this is due to a lack of additional conditions to definitively pin down the housing price p. Once again, I will be focusing on the steady states where the housing prices p allow the rich agent to achieve efficient allocation across two periods, i.e., where $c_r^y = c_t^o$.

PROPOSITION 2: *For any* θ *that satisfies* $0 \leq \theta \leq 0.2$*, there exists a steady*

[5] We know this because the bubble-free steady state allocation is still an option here, but since both agents opt for the allocation from proposition 1 when they are maximizing their utility, they then have to be better off this way.

state allocation $\{c_r^y, c_r^o, c_p^y, c_p^o, d, a, H_r\}$ *and price sequence* $\{p, R\}$ *where*

$$c_r^y = c_r^o = \frac{27}{4} - \frac{R}{2} - \frac{1}{4R}, \quad c_p^y = (1 + \frac{1}{2R})w, \quad c_p^o = (\frac{1}{2} + R)w$$

$$a = d = (1 - \frac{1}{2R})w, \quad H_r = 1$$

$$p = (\frac{9}{4} + \frac{2R^2 - 1}{4R})w, \quad R = \frac{4 - 9\theta - \sqrt{89\theta^2 - 88\theta + 66}}{4\theta}$$

In these steady states the borrowing constraint (4) is binding (the rich is borrowing constrained). In addition the housing price p *is positive even though it pays no dividend, so we have a rational bubble here.*

Figure 1 and Figure 2 show the corresponding R and p for any given θ between 0 and 0.2, respectively.

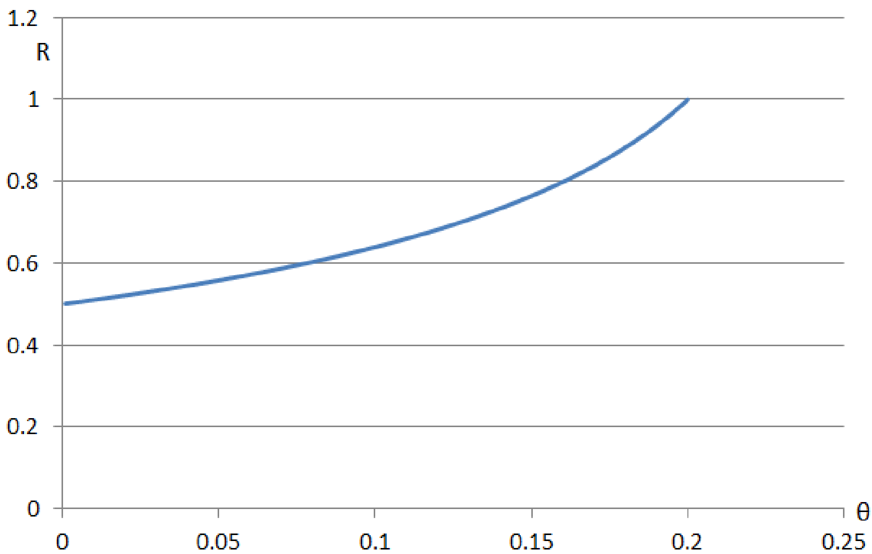


Figure 1: Relation Between Steady States R and θ.

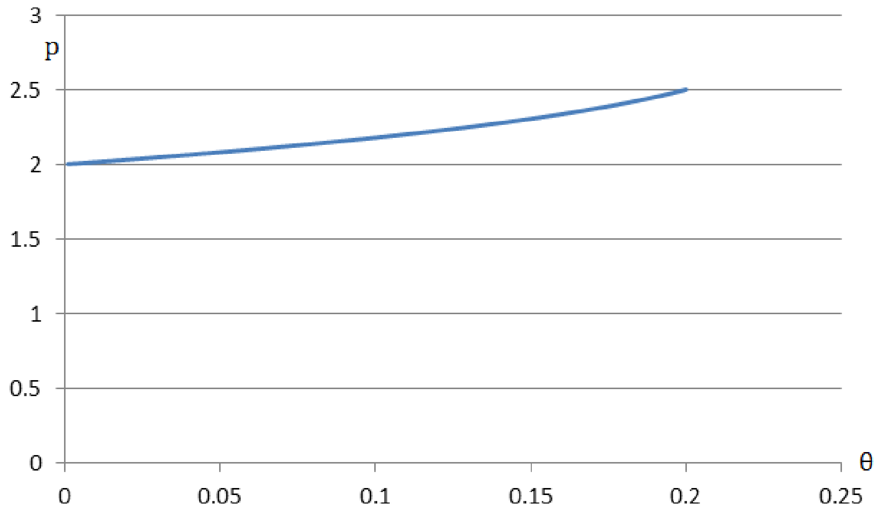


Figure 2: Relation Between Steady States p and θ, using w as the unit of length of Y-axis

Proof.

Substituting c_r^y, c_r^o, d, R, p and H_r into (2) (3) (18) (19), we can easily see that they solve the rich agent's maximization problem. Comparing the rich's utility when not buying the house to when buying the house, it's obvious that buying the house would maximize the utility, justifying $H_r = 1$.

Substituting $c_p^y, c_p^o, a,$ and R into (6') (7') and (14) we see all three conditions satisfied and the poor agent's utility maximized. The poor still could not afford buying a house.

Last but not least, it's easy to check that the market clearing conditions (11)-(13) are also satisfied. ■

The scenario here isn't very different from before: the rich agent buys the house and borrows from the poor when young, sells the house and pays back the loan when old, while the poor lends to the rich when young, and collects the loan when old.

What's different now is that the credit market has a lower rate of return than the housing market does. Having enough wealth to purchase a house, the rich agent would therefore choose to save and transfer wealth (more efficiently) through the housing market. The poor, on the other hand, could not afford a house, and is forced to save (less efficiently) through the credit market where the rate of return is lower.

In this case, the rich still acts as a "middle man", borrowing from the credit market and giving the poor a channel through which to transfer wealth from the first period of life to the second. But here the poor does not get all his savings back in the second period (gross interest rate $R < 1$), comparing to the steady states where the rich is not borrowing-constrained, where the poor saves with $R = 1$. We can almost say that the rich takes some money as payment for supplying the "wealth transfer" opportunity and the poor, eager to smooth out consumptions across periods, accepts it. Both agents are still unambiguously better off than under the bubble-free (and inefficient) steady state, [6] though it is obvious that the rich agent rips more benefit from the rational bubble than the poor does.

Looking closer at Figure 1, we can see that the higher θ is, the higher the steady state R will be. The implication is clear: when the rich is less borrowing-constrained, the steady state interest rate of the credit market will be higher. The mechanism behind this is also not difficult to grapple: since the housing market has a higher rate of return than the credit market has, the rich, who has access to the housing market and its relatively high interest rate, will want to utilize this arbitrage and borrow as much as possible from the credit market. But, exactly how much the rich could borrow is regulated by the borrowing constraint. So intuitively, the more the borrowing constraint is relaxed, the more the rich could borrow (from

[6] Again, the agents choose the allocation from proposition 2 over the bubble-free no-wealth-transfer allocation, implying a higher utility level for the former

the poor). [7] This will result in an increased demand for loans. Since the supply side of loans is not changed (nothing has happened to the poor), gross interest rate in the credit market must be raised to achieve the new steady state.

Similarly, Figure 2 shows a positive correlation between θ and corresponding steady state p, meaning that the less borrowing-constrained the rich is, the higher the steady state housing price will be. Given the discussion above, the explanation here is simple: when less borrowing-constrained, the rich will borrow more and thus need to transfer a larger amount of wealth across periods, therefore the steady state housing price must also rise. This is even more obvious when θ moves close to 0.2, in this case the steady state R is close to 1, p approximately $2.5w$, and we are in a similar situation as in the steady states where the rich is not borrowing-constrained. [8]

3.10 Implications

First observe the lack of investment instrument in this model. There are no government debts and no pension system. Other than trading with each other, the agents' only investment opportunity is buying a house, which doesn't pay any dividend. So in the steady state with no housing bubble, we end up with dynamic

[7] Actually here it is also required that the steady state housing price does not move in the opposite direction and offset the loosening of the borrowing constraint. But as we shall see, a higher θ also leads to higher steady state housing price p, therefore reinforces the original effects and leaves the rich agent even less borrowing-constrained.

[8] Basically what's happening here is that the rich transfers more wealth for the poor when less borrowing-constrained. So when θ moves close to 0.2, the critical value above which the rich will no longer be borrowing-constrained in steady states, the steady state housing price p also moves towards $2.5w$ which is the total amount of wealth young agents of both types want to transfer across periods.

inefficiency: agents of both types just consume their endowment in each period of their lives. [9] No wealth transfer happens, even though everyone wants to transfer wealth over time. [10]

This is why having a rational housing bubble in the economy is a good thing (when there is dynamic inefficiency). In the bubble steady states (whether the rich is borrowing-constrained or not) we see that the housing bubbles provide the economy with an investment opportunity and a way to transfer wealth across periods. As a result, agents now can store value in housing stock, and they are better off than in the bubble-free steady state.

The second implication is that rational housing bubbles can only arise when interest rate is sufficiently low. [11] In our model the gross interest rate for investing in housing is 1 in case of a housing bubble. This is not an especially high rate of return. Thus, if the (credit market) interest rate is not low enough (lower than that of the housing market), people would just invest in the credit market, resulting in insufficient demand for housing and bursting of the housing bubble.

3.11 The Distributional Effects

It is clear that in the bubble steady states where the rich is not borrowing-constrained, the rational housing bubbles do not have any distributional effect (between rich and poor). Both the rich and the poor have access to the same rate of return when transferring wealth, though through different markets. Here the rational housing bubble is very beneficial for the economy, providing it with some

[9] Even though they are both better off with some wealth transfer.

[10] Actually, the fact that everyone wants to transfer wealth over time is essential in causing no trade, since then everyone wants to lend money to others, but no one is willing to borrow.

[11] Remember that the necessary condition for the existence of a housing bubble is $\frac{1}{2} \leq R \leq 1$.

much needed investment instrument and without any real drawback.

Therefore when I talk about distributional effects of the rational housing bubbles, it is based on the steady states where the rich is borrowing-constrained. In this case the housing market has a higher rate of return, but it is not accessible to the poor because of its high price and indivisibility. Only the rich has the means to invest in and transfer wealth through the housing market, the poor, though still able to transfer wealth over time, is forced to make do with a (sometimes much) lower rate of return. In this situation, even though the rational housing bubble still has its upsides (namely providing the society with an investment instrument and store of value), it also has distributional effect: The rich gets to invest in and enjoy the full benefit of this rational bubble, while the poor is left out and only gets some benefit indirectly. In our simple model this is shown by the steady states where the rich could transfer wealth through the bubble interest rate 1, while the poor could only save through a lower market interest rate $R < 1$. [12]

Some Calculations — Remember that in the bubble steady states where the rich is not borrowing-constrained, we have:

$$c_r^y = c_r^o = \frac{27}{4} - \frac{R}{2} - \frac{1}{4R}$$

Figure 3 shows the relation between steady states c_r^y, c_r^o and R.

From Figure 3 we can see that c_r^y and c_r^o first increase with R, then after peaking they become smaller the higher R is. The mechanism is simple: When R is small, the rich could borrow from the poor at a very low interest rate, invest in the housing bubble, and benefit (a lot) from the arbitrage marginally. But since the

[12] This is even more obvious when we are in the extreme case where the rich is not allowed to borrow, i.e., $\theta = 0$. Now only the rich gets to benefit from the bubble while the poor can not transfer wealth over time at all.

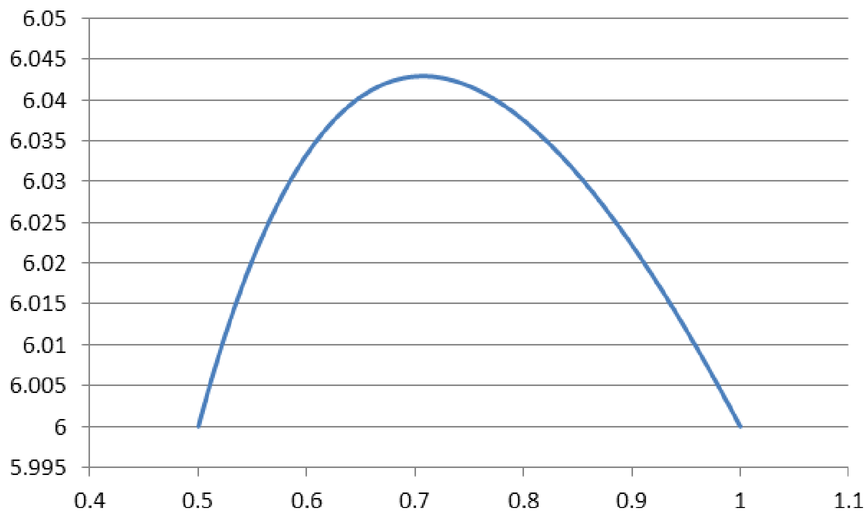


Figure 3: Relation Between Steady States c_r^y, c_r^o and R.
[Y-axis measures c_r^y and c_r^o, with w being the unit of length. X-axis measures R.]

rich is also severely borrowing-constrained at this moment (remember the positive relation between steady states R and θ), the total profit the rich is able to make is actually quite small due to the limited size of loans. The extreme case is when $\theta = 0$ and $R = 0.5$, even though the profit margin for taking up one unit of loan is very high, the rich could not benefit from it at all because he is not allowed to borrow. When θ goes up, the rich is less borrowing-constrained. He/She could thus borrow more from the credit market and invest in the housing bubble, which, alone, means higher profit and higher consumptions in both periods for the rich. But a higher θ also leads to higher R, which means a smaller difference in rate of return between the credit market and the housing market, and therefore a smaller profit margin for taking up loans. A lower profit margin, by itself, implies lower profit and lower consumptions in both periods for the rich. At first (When R is close to 0.5), c_r^y and c_r^o will increase with R because the first (positive) effect is larger. But gradually, the second (negative) effect will outpace the first, and c_r^y and c_r^o will start to decrease the higher R is, the extreme case being when $\theta \geq 0.2$

and $R = 1$ where the rich makes no profit because the profit margin has gone down to zero.

What's more interesting here is that the rich's consumption is above $6w$ in both periods, making the rich's lifetime consumption $C_r = c_r^y + c_r^o > 12w$, which implies that the poor's lifetime consumption $C_p = c_p^y + c_p^o < 3w$. [13] Remember that we have $C_r = c_r^y + c_r^o = 12w$ and $C_p = c_p^y + c_p^o = 3w$ in the bubble-free steady state. So even though agents of both types are better off in the bubble steady states (where the rich is borrowing-constrained), in terms of lifetime consumption, the rich benefits at the expense of the poor, i.e., the inequality in lifetime consumption between rich and poor is higher in bubble steady states than in bubble-free steady state.

As discussed before, In terms of utility level both agents are better off in the bubble steady states. But since the poor is forced to transfer wealth through a lower rate of return than the rich, which has already resulted in lower lifetime consumption for the poor (and higher lifetime consumption for the rich), one expects the gap between their lifetime utility to increase, too. And sure enough, this intuition is supported by our calculation.

Define the rich and the poor's lifetime utility as $U_r = ln(c_r^y) + ln(c_r^o)$ and $U_p = ln(c_p^y) + ln(c_p^o)$, respectively. In the bubble-free steady state, we have the ratio $\frac{U_r}{U_p} = 2$, while in the bubble steady states (where the rich is borrowing-constrained), this ratio is larger than 2. [14] Figure 4 shows different values of $\frac{U_r}{U_p}$ in bubble steady states.

Looking at this from the aspect of θ could also provide much insight. Knowing the positive relation between θ and the steady state R, it is not difficult for us to

[13] Because of the market clearing condition $c_r^y + c_r^o + c_p^y + c_p^o = w_r^y + w_r^o + w_p^y + w_p^o = 15w$.

[14] Except when $R = 1$, in which case (as you remember) the rich only acts as the "middle man", giving the poor access to the same rate of return as the housing bubble.

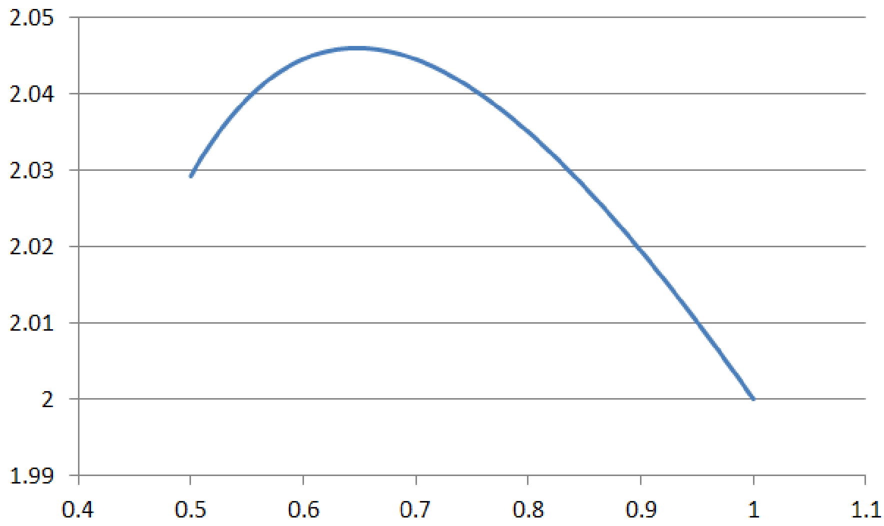


Figure 4: Relation Between Steady States $\dfrac{U_r}{U_p}$ and R.

[Y-axis measures the ratio $\dfrac{U_r}{U_p}$. X-axis measures R. The mechanism behind the bell-shape of the curve is similar to that of Figure 3.]

picture the relation between c_r^y, c_r^o and θ, or between $\dfrac{U_r}{U_p}$ and θ. But just to be clear, Figure 5 and 6 show these two relations, respectively.

In Figure 5 we see that c_r^y and c_r^o are smaller when θ is close to 0 or 0.2, which implies that the gap between the rich and the poor in terms of lifetime consumption is smaller either when θ is small (strict borrowing constraint), or when θ is high (relaxed borrowing constraint). [15]

Notice also in Figure 6 that the ratio $\dfrac{U_r}{U_p}$ is smaller when θ is close to 0 or 0.2, suggesting that either a very high θ or a very low θ would lower the inequality in lifetime utility between the rich and the poor.

The reason that a high θ would lower the inequality in lifetime consumption and

[15] because of the market clearing condition $c_r^y + c_r^o + c_p^y + c_p^o = 15w$, the smaller c_r^y and c_r^o are, the larger $c_p^y + c_p^o$ will be, and thus the smaller the difference in lifetime consumption between the rich and the poor will be.

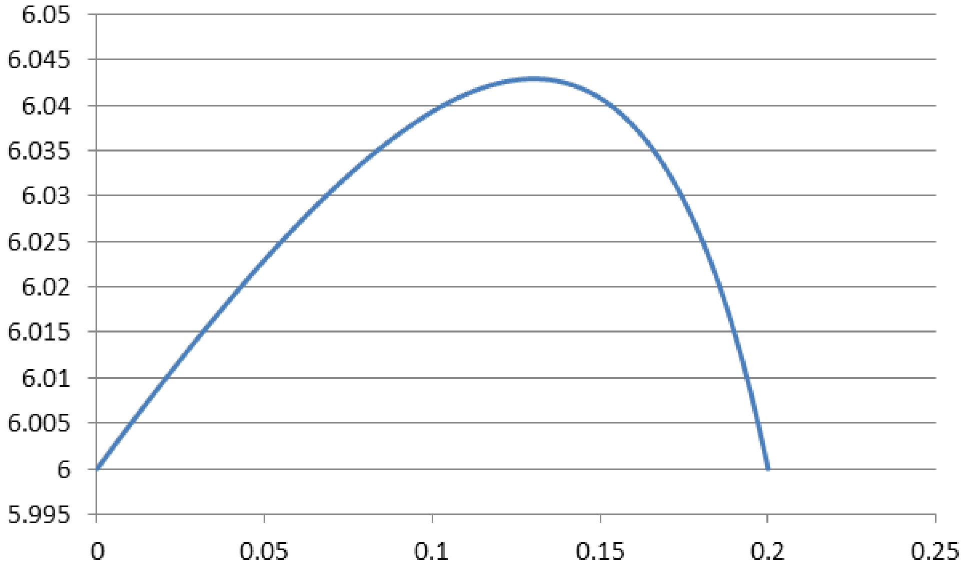


Figure 5: Relation Between Steady States c_r^y, c_r^o and θ.

[Y-axis measures c_r^y and c_r^o, with w being the unit of length. X-axis measures θ.]

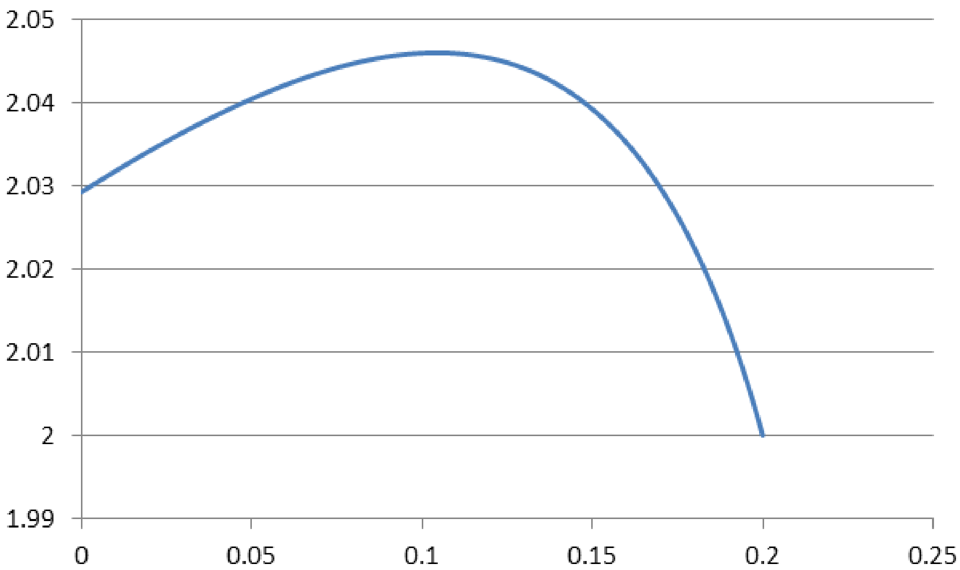


Figure 6: Relation Between Steady States $\dfrac{U_r}{U_p}$ and θ.

[Y-axis measures the ratio $\dfrac{U_r}{U_p}$. X-axis measures θ.]

lifetime utility is that by allowing the rich to borrow more, the poor also gets to store a larger amount of value in the credit market and smooth out consumption over time, resulting in both higher lifetime consumption and utility (for the poor). In addition the increased demand for loans would drive up the market interest rate, which means that the poor could now transfer wealth over periods more efficiently, again resulting in higher lifetime consumption and utility.

The implication is clear: If an economy is plagued by lack of investment instruments and/or dynamic inefficiency, having a rational bubble could be a good thing. But if this rational bubble is within certain sections where one needs to be wealthy enough to get in (housing market, for example), then it will have distributional effect since the poor are left out. Policies that reduce financial frictions (higher θ) could alleviate the distributional effect while retain its benefits at the same time. [16]

[16]Of course, increasing the financial frictions (lower θ) could also mitigate the distributional effects to some degree, but it will be at the expense of the economy's dynamic efficiency. This is because the increasing inequality, in this case, is only alleviated by restricting the rich's borrowing ability and thus preventing the poor from "being taken advantages of". But the poor, driven by the need to transfer wealth over time, is willing to sacrifice some lifetime consumption (in order to reach a higher lifetime utility). Thus the strict borrowing constraint also harms the poor's ability to save, though indirectly.

4 Data From China

4.1 Evidence Of Housing Bubbles In China

China has been experiencing very strong increase in housing prices in the last 15-20 years. Figure 7 shows that the real land-selling price for the whole country increases at an annual rate 15.7 percent from 2000 to 2009 (Zhao, 2013, p.24). Figure 7 also draws the official average commodity building selling price for 35 large cities in China, which exhibits a slower annual growth rate, 7 percent, from year 2000 to 2009 (Zhao, 2013, p.24).

Wu, Gyourko and Deng (2012) managed to construct a constant quality price index for newly-built private housing in 35 major Chinese cities, which is shown in Figure 8. According to their estimates, the annual housing price growth is nearly 10 percent from year 2000 to 2009 (Zhao, 2013, p.24).

Much of the increase in housing prices is occurring in land values (Wu, Gyourko and Deng, 2012). Figure 9 shows the ratio of the land transaction price to the weighted average price of matched housing projects in Beijing (Wu, Gyourko and Deng, 2012). We can see that the ratio went up from little over 0.3 to over 0.5 from year 2003 to 2010.

There are several evidences pointing towards this housing price increase being a housing bubble. One of them is the high vacancy rate (Zhao, 2013, pp.24-27). Another evidence for the housing bubble is a very high price-to-rent ratios, according to Wu, Gyourko and Deng (2012):

"Price-to-rent ratios in Beijing and seven other large markets across the country have increased by 30% to 70% since the beginning of 2007. Current price-to-rent ratios imply very low user costs of no more than 2%–3% of house value. Very high expected capital gains appear necessary to justify such low user costs of owning. Our calculations suggest that even modest declines in expected appreciation would

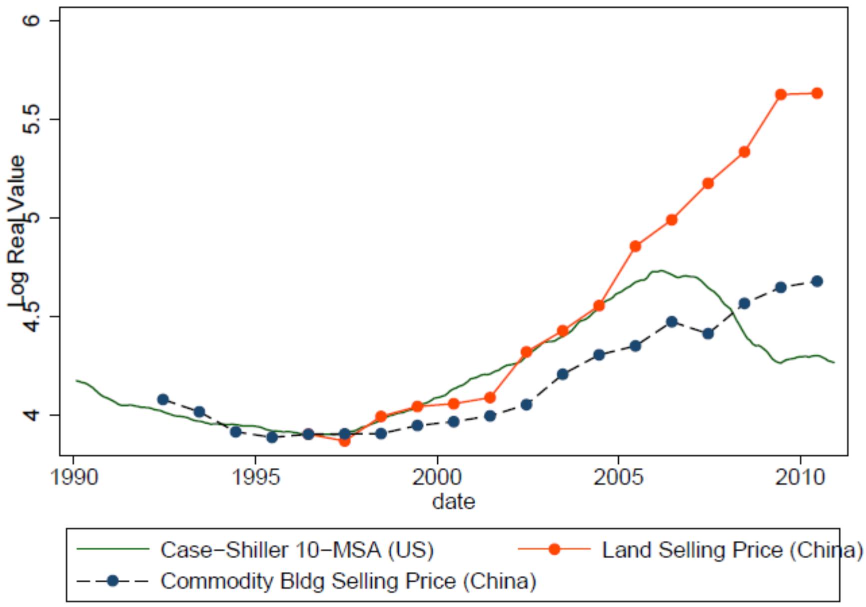
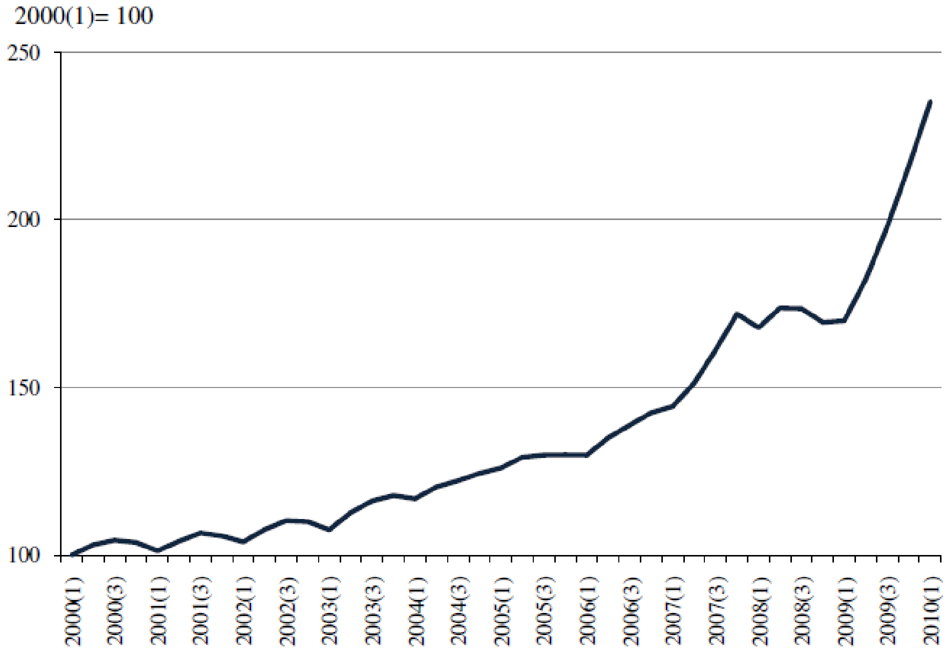


Figure 7: Housing Price and Land Price: China and the US (Zhao, 2013, p.25).

"The US Housing price index is from S&P/Case-Shiller 10-MSA Index. The land selling price is computed by author using data from China Satistics Year Book. The land price is defined as total value of land purchased divided by total land space purchased. The commodity building sell prices is based on the 35-city average selling price series from National Bureau of Statistics. All series are in log real value deflated by CPI (Urban CPI for Chinese data) and normalized to the same level at year 1996" (Zhao, 2013, p.25).



Source : Institute of Real Estate Studies, Tsinghua University.

Notes: Hedonic models are used to control for quality changes in underlying samples of newly-built, private homes in 35 major markets in China. Real indices are created by deflating with the CPI series for each market. Aggregate indices are computed as the weighted average of the local market series, with transactions volume between 2000-2008 as the fixed weight.

Figure 8: Constant quality real price index for newly-built private housing in 35 major Chinese cities, 2000(1)-2010(1)(Wu, Gyourko and Deng, 2012).

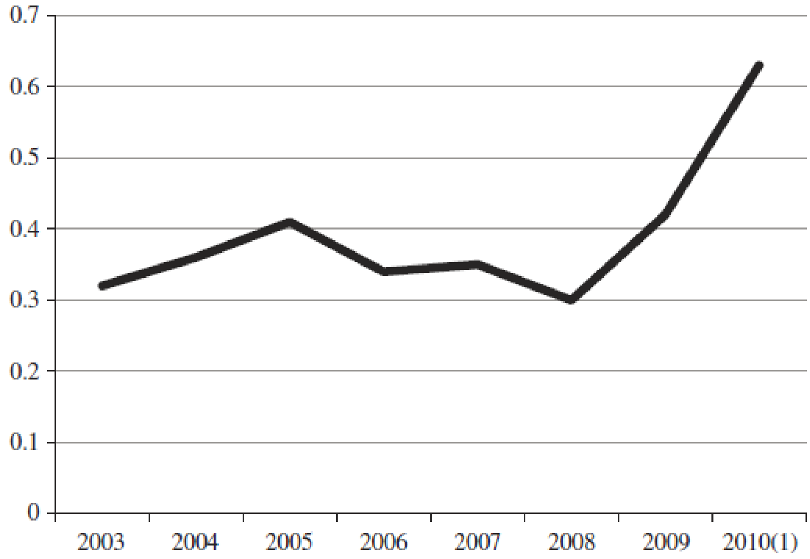


Figure 9: Average land share in house value, Beijing, 2003-2010(1)(Wu, Gyourko and Deng, 2012).

lead to large price declines of over 40% in markets such as Beijing, absent offsetting rent increases or other countervailing factors" (Wu, Gyourko and Deng, 2012).

The existence of a housing bubble could also be detected through changes in the composition of household wealth. In our model it is clear that the ratio $\frac{housing\ wealth}{net\ wealth}$ is higher for the rich (and for the whole population) in bubble steady states (than in bubble-free steady state). Table 1 shows the relevant statistics from China.

We can see from Table 1 that housing wealth as percentage of household net worth has experienced drastic increase: from 44.8% in 1995, to 59.8% in 1999, then to a whopping 80.7% in 2008. This movement also implies that housing wealth has vastly outpaced non-housing wealth in growth. But this is far from being universal, comparing to USA, where housing wealth is only about one half of household net worth, and the growth of housing wealth never outstrips that of the non-housing wealth by such a large margin (Figure 10 shows the composition of household

Table 1: Composition and Mean Value of Household Wealth in Urban China in Selected Years

	1995		1999		2008	
	Mean (yuan)	Proportion of Net worth (%)	Mean (yuan)	Proportion of Net worth (%)	Mean (yuan)	Proportion of Net worth (%)
Housing	17807.4	44.8	48046.5	59.8	447450.3	80.7
Financial assets	11390.2	28.6	24544.1	30.6	73257.2	13.2
Durable goods	9076.5	22.7	7634.1	9.5	22963.3	4.1
Production assets	464.8	1.2	450.2	0.5	19112.9	3.4
Other assets	1699.3	4.3	1669.5	2.1	6960.7	1.3
Debts	810.8	1.5	2027.5	2.5	15295.4	2.8
Net worth	39672.5	100.0	80317.0	100.0	554448.9	100.0

Source: The Longitudinal Survey on Rural Urban Migration in China, CHIP2008/RUMiC2009, China Institute For Income Distribution.
Urban Household Income Project in China, 1999, China Institute For Income Distribution.
The data from year 1995 are from Gustafsson, Li and Wei (2006).

wealth in the United States from 1952 to 2008), [17] the development in China clearly suggests the existence of a housing bubble (Iacoviello, 2011).

[17] We can see from Figure 10 that even at the peak of the US housing bubble before 2008, housing wealth is nowhere close to taking up 80% of household net worth.

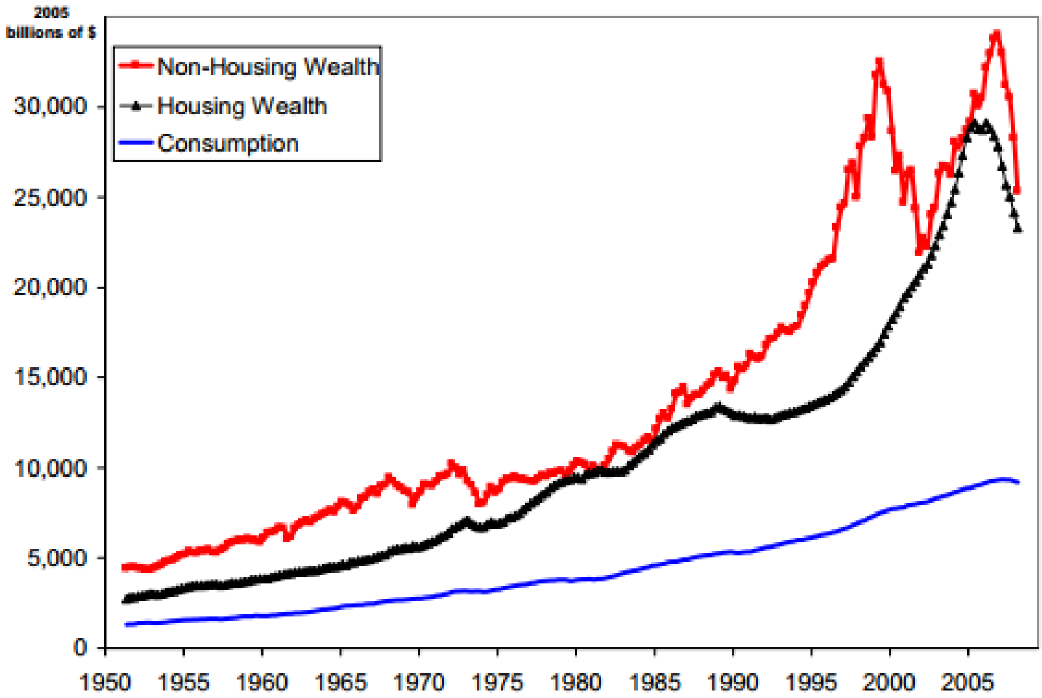


Figure 10: Housing wealth, Consumption and Non-Housing wealth in the United States from 1952 to 2008. The series are expressed in 2005 billions of dollars (Iacoviello, 2011).

4.2 Evidence That The Housing Bubble In China Is Rational

There are several resemblances between China's situation and the rational bubble steady states we just discussed.

In our model there are no government bonds (debts) or any pension system, and all agents want to transfer wealth from the first period of their lives to the second period. This lack of assets to trade and need for wealth transfer is what drives up the housing price. Similarly, in China one of the reasons that households hold empty apartments (as investment) is the lack of other investment instruments and the need for a store of value (Zhao, 2013, p.27). Insufficient social security also plays its part, forcing households to buy empty houses as a store of value to finance their later-life consumption (Zhao, 2013, p.27).

Remember also that one necessary condition for the existence of rational housing bubbles in our model is that the gross interest rate satisfies $\frac{1}{2} \leq R \leq 1$. This is, by all account, a very low interest rate, which suggests low return for investment in credit market. [18] Again, in China we have found a matching situation: "Because (of) the poor development in the financial market, the average return on the stock market over the past twenty years (is) in very low (the average real return on shanghai stock market index is only 2 percent from year 2000 to 2009) and median households can only access to risk-free bond which delivers almost zero interest actually..." (Zhao, 2013, p.27). Figure 11 shows that the real interest rate in China is much lower than the real GNP growth rate, which makes risk-free bond unattractive relative to housing assets (Zhao, 2013, p.27).

Aside from the aforementioned similarities, Zhao (2013, pp.30-32) has also constructed a theoretical model with rational housing bubbles, tested it against empirical data, and the result is significant in proving the existence of rational housing bubble in China.

[18] The low return in credit market is exactly what makes the housing bubble so attractive.

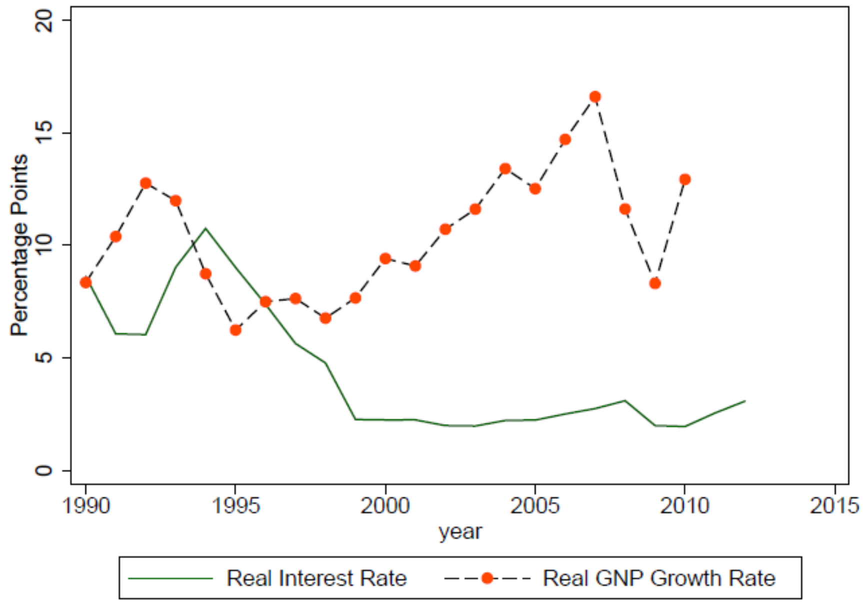


Figure 11: Dynamic Inefficiency (Zhao, 2013, p.29).

"The real interest rate is the benchmark interest rate set by the central bank for one-year fixed-term deposit deflated by CPI. The Real GNP annual growth rate is also deflated by CPI" (Zhao, 2013, p.29).

4.3 Evidence For Distributional Effects Caused By The Rational Housing Bubble

Our model predicts an increased inequality in lifetime consumption and utility between the rich and the poor. It is, however, very difficult to measure such variables in real life. But if we look at the Chinese households' consumption expenditure, the increase in inequality could still be detected. Table 2 shows consumption Gini coefficient in urban China in 1999, 2002 and 2008.

Table 2: Household consumption Gini coefficient in urban China in 1999, 2002 and 2008

Year	1999	2002	2008
Consumption Gini	0.318	0.327	0.353

Source: Urban Household Income Project in China, 1999; Chinese Household Income Project, 2002; The Longitudinal Survey on Rural Urban Migration in China, CHIP2008/RUMiC2009, China Institute For Income Distribution.

The rise in household consumption Gini means that inequality in household consumption has been increased. This might be caused by the rapid housing price increase (the rational housing bubble) between 1999 and 2008.

Of course, with only three sets of data from 1999, 2002 and 2008, it is impossible for us to definitively pin down the causality between the rational housing bubble and the increased inequality in household consumption. For example, the hike in consumption inequality could be the result of increasing income inequality or rising wealth inequality. Ideally, we would need comprehensive panel data which

Table 3: Housing prices and wealth inequality in China (Li, 'n.d.')

	Wealth inequality (Gini)			Changes in Gini during 2002-2010	Due to (%)	
	2002	2010	2010 (Assume constant housing prices)		Housing Prices	Other
Calculation	(1)	(2)	(3)	(4)=(2)-(1)	((2)-(3))/(4)	((3)-(1))/(4)
National	0.537	0.758	0.684	0.221	33.5	66.5
Urban	0.450	0.659	0.569	0.209	43.1	56.9
Rural	0.453	0.709	0.650	0.256	23.1	76.9

The row "Calculation" explains how the last three columns are calculated.

includes at least the annual change in consumption inequality, annual change in housing prices, annual change in GDP / dispensable income and annual change in income inequality over multiple regions and 10-15 years. Then we could use regression to isolate and test the correlation between household consumption inequality and housing price increase, and see if the result is significant enough. But since it's extremely difficult, if not impossible, to find such panel data, the more ideal test is beyond the reach of this thesis and must be left to the future.

Other researches have also been made with empirical evidence that support our theory. According to Li ('n.d.'), housing price increase has contributed substantially to the rising wealth inequality in China, which fits nicely in with our theoretical model. [19] Table 3 shows Li's result.

[19]Technically, our model does not have growth, but the basic mechanism is the same: The rich get to buy houses and get richer due to the housing price hike, the poor are left out and become relatively poorer because of the housing bubble.

5 Conclusions

This thesis studies an economy (without growth) populated by overlapping generations of rich and poor agents, with the difference between them being that the rich are endowed with larger amounts of wealth in both periods. Both types of agents want to transfer wealth over time and smooth out their consumptions. Agents could borrow from or lend to each other in credit market, when borrowing they are subject to a collateral constraint. Agents could also buy house(s), which are indivisible and pay no dividend whatsoever.

Because of the lack of investment instruments and dynamic inefficiency in bubble-free steady states, a rational housing bubble could arise in this model. Due to their high prices and indivisibility, houses are not affordable to the poor. So in the bubble steady states only the rich get to buy houses and enjoy the high rate of return caused by the housing bubble, while the poor are left out, implying potential distributional effect. With a relaxed collateral constraint, the market interest rate is relatively high and the rich could borrow a lot from the poor through the credit market, thus providing them (the poor) with a mean to transfer wealth across periods and benefit from the housing bubble indirectly. A tight borrowing constraint, on the other hand, limits the rich's borrowing capacity and hurt the poor's lifetime utility indirectly through lower market interest rate (and the resulting inefficient wealth transfer).

This model could be applied to China, where we have witnessed drastic increase in housing prices during the last 15 years. Several researches and empirical evidences point towards the existence of a rational housing bubble in China. Upon a closer look at survey data from selected years we can see a rise in household consumption inequality from 1999 to 2002, and then to 2008, which fits the theoretical model's prediction. Other research has also found that increasing housing prices have caused much of the increase in wealth inequality in China.

6 References

Caballero, R.J. & Arvind, K. (2006) Bubbles and capital flow volatility: Causes and risk management. *Journal of Monetary Economics*, 53(1), pp.35–53.

Caballero, R.J., Emmanuel, F. & Mohamad, L.H.(2006) Speculative Growth: Hints From The U.S. Economy. *American Economic Review*, 96(4), pp.1159-1192.

Gustafsson, B., Li, S. & Wei Z. (2006) The Distribution Of Wealth In Urban China And In China As A Whole In 1995. *Review of Income and Wealth*, 52(2), pp.173-188.

Iacoviello, M. (2011) Housing Wealth and Consumption, in: *International Encyclopedia of Housing and Home*, pp.673-678. doi:10.1016/B978-0-08-047163-1.09003-2.

Kocherlakota, N. (2009) Bursting Bubbles: Consequences and Cures. Federal Reserve Bank of Minneapolis, University of Minnesota, Available from: “http://philadelphiafed.org/research-and-data/events/2009/monetary-macroeconomics/papers/narayana.pdf”

Li, S. (‘n.d.’) *Rising income and wealth inequality in China.* [Internet], Available from: < “http://unsdsn.org/wp-content/uploads/2014/05/TG03-SI-Event-LI-Shi-income-inequality.pdf”>[Accessed 10 May 2015].

López-Salido, D. & Arce, Ó. (2011) Housing Bubbles. *American Economic Jour-*

nal: Macroeconomics, 3(1), pp. 212-241(30)

Martin, A. & Ventura, J. (2012) Economic Growth with Bubbles. *American Economic Review*, 102(6), pp.3033-58.

Miao, J. & Wang, P. (2011) Bubbles and Credit Constraints. Available at SSRN: "http://ssrn.com/abstract=1779485" or "http://dx.doi.org/10.2139/ssrn.1779485"

Wu, J., Gyourko, J. & Deng, Y. (2012) Evaluating conditions in major Chinese housing markets. *Regional Science and Urban Economics*, 42(3), pp.531-543.

Zhao, B. (2013) Rational Housing Bubble. Forthcoming, *Economic Theory*, Available from: "http://www.nber.org/papers/w19354".