Living the American Dream?

Home Ownership, Housing Wealth Effects and the Great Recession

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Preliminary and incomplete.

Housing wealth effects—the reaction of consumption to changes in house prices—were at the heart of the Great Recession in the US.

First, we show that aggregate housing wealth effects are proportional to the homeownership rate in a tractable lifecycle model with housing. A numerical example suggests that housing wealth effects can explain 30 % of the boom and all of the bust in non-durable consumption. 7% of this can be explained by the boom and bust in homeownership rates.

Second, providing closed forms for housing wealth effects, we can show that indebtedness might lead to stronger, weaker or equal housing wealth effects, depending on the reason why households are more indebted (preferences for houses, age or income paths).

Keywords: Housing wealth effects, homeownership rate, house price crash, housing boom and bust, consumption dynamics, Great Recession

JEL Codes: D14, D91, E21, E32, R21

The severity of the Great Recession is often attributed to housing wealth effects—the reaction of non-durable consumption to changes in house prices (e.g. Mian, Rao, and Sufi, 2013). In this paper we study how the push for homeownership during the late 1990s and early 2000s impacted aggregate housing wealth effects.

In a tractable life-cycle model of housing and consumption we show that aggregate housing wealth effects were not just driven by changes in house prices (intensive margin) but also homeownership (extensive margin). We find that changes in the homeownership rate amplify housing wealth effects by 7 % in the boom and bust in consumption around

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the Great Recession. Housing wealth effects explain 30% of the boom and 100% of the bust in our numerical example.

The consumption dynamics in the recession were not only driven by housing wealth effects of existing homeowners but also by those who only shortly before the peak of the housing boom acquired a house. This line of thought gives aggregate housing wealth effects both an intensive and extensive margin.

Just like with house prices and consumption, there was a boom and bust in homeownership. Since 1990 it has increased from 64 % to its historical peak of 69% before the crisis. Since then the homeownership rate has been steadily declining (now at below 64 %).

Part of the boom might be have been due to political campaigns. Homeownership rates have been high on the political agenda in the decades before the crisis. Presidents Clinton and Bush jr announced plans to raise homeownership by several millions (8 million and 5.5 millons, respectively). Given the time horizons and population growth Clinton's goal is the more ambitious. Nevertheless, both goals were not met (see figure 1).

We address the impact of these policies on housing wealth effects.We ask (i) what would have been the housing wealth effects and corresponding consumption expenditures if the homeownership rate remained at its 1990 level? (ii) did the drop in the homeownership rate during the recession had a mitigating impact on aggregate housing wealth effects by isolating former homeowners from negative house price developments?

To address these question this paper develops a tractable life-cycle model with housing, mortgages, homeowners and renters. We derive closed forms for housing wealth effects for renters and owners. The model shows how the consumption reaction depends on house prices, the preferences for housing, age and rental status. The crucial assumptions are deterministic incomes, the choice of the bequest motive and the assumption that house price changes are probability-0 events (so-called MIT shocks).

Our tractable framework allows us to clarify and sharpen the results of a growing literature of quantitative macroeconomic models with housing. Berger, Guerrieri, Lorenzoni, and Vavra (2018), Guren, McKay, Nakamura, and Steinsson (2018) Kaplan, Mitman, and Violante (2017) Garriga and Hedlund (2017) have studied housing wealth effects and provided quantitative evidence that housing wealth effects individually vary with age, leverage, rental status, and initial value of the house[1]. The nature of the large scale macro models in use makes it hard to rigorously study and disentangle the underlying mechanisms.

So far, the main insight that we add to this literature is on the role of household debt. Berger et al. (2018) show that debt is largely irrelevant, except for very highly levered households. Guren et al. (2018) shows that the housing wealth effects are hump-shaped in debt. It reaches the maximum for a high loan-to-value (LTV) and decreases thereafter.

We show that the effect of debt can go into two directions, depending on the reason of being indebted. Housing wealth effects are stronger for older households (less indebted)

[1] As a notable exception, Berger et al. (2018) provide theoretical result, that housing wealth effects are a product of the value of the house and the marginal propensity to consume, which by itself is an endogenous object in their models.

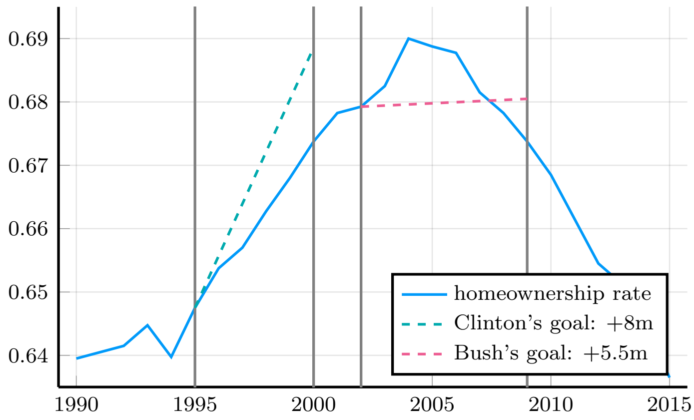


Figure 1: Homeownership in the US and policy goals

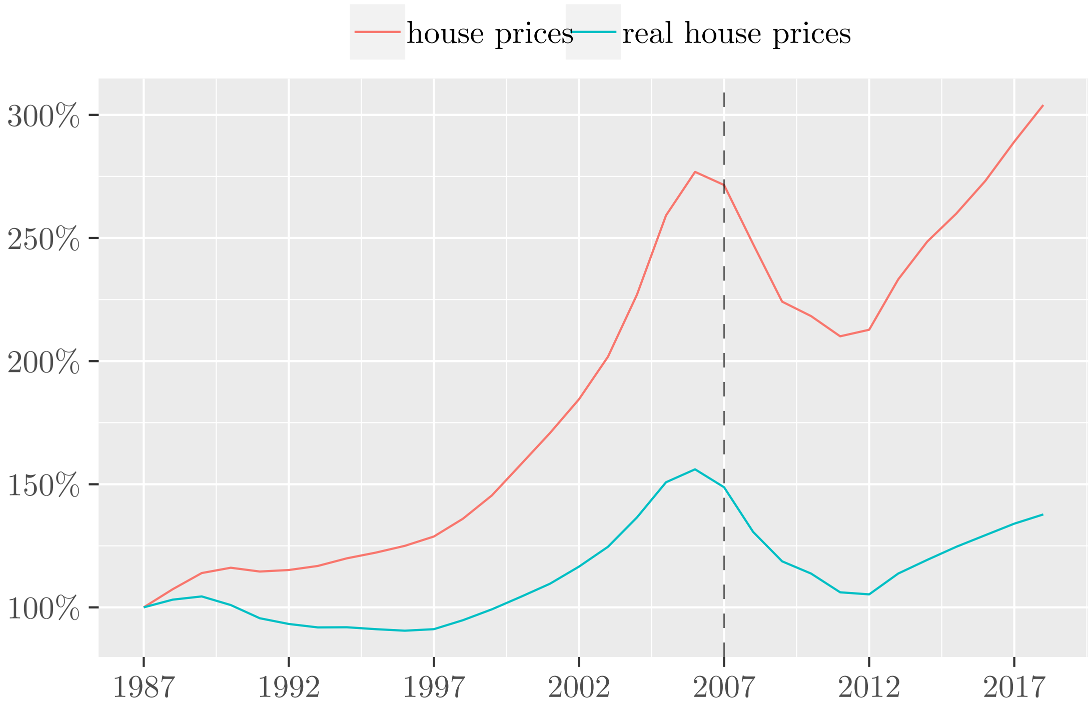
but also for "house-lovers" (more indebted).

The paper is organized as follows. First, we summarize the role of housing wealth effects in the existing literature (section 1). Then we present our tractable life-cyle model with housing and mortgages and its solution (section 2). Subsequently we derive closed forms for housing wealth effects in our model (this is our main result) in section 3. Finally, we discuss policies that might have mitigated the Great Recession in section 4.

Housing policies This section gives a brief overview on housing policies in the US. It is mostly based on **?** which gives a more detailed overview and also discusses the evidence on the effectiveness of many of these policies.

In the USA owning a house has always been part of the "American Dream". If newly arrived immigrants would only work hard enough they could eventually afford their own home and live a comfortable life. Due to this connotation housing policies have often taken prominent roles in presidents' agendas from both sides of the isle. Apart from this perspective, another motivation to promote homeownership were and still are positive externalities associated with it, e.g. more civic engagement, increased neighborhood improvements and more community stability. As George W. Bush put it in a speech in Atlanta in 2002: "It [The American Dream] means we use the mighty muscle of the federal government in combination with state and local governments to encourage owning your own home. ".

Among the first policies to promote homeownership in the US was the Homestead Act of 1862 which enabled people to receive previously unsettled land, predominantly in the Midwest and Great Planes. Later, under the New Deal, housing policies gained relevance again. This was motivated by the Great Depression and the accompanying high rate of foreclosures. To promote market liquidity of mortgages the Federal National Mortgage Association (Fannie Mae) was founded in 1938. During the post WWII era the GI bill was responsible of promoting homeownership among veterans. Additionally, legislature was enacted which established the Federal Home Loan Mortgage Corporation (Freddie



Nominal: Case-Shiller house price index. Real: nominal / CPI. Source: FRED.

Figure 2: Real and nominal house prices

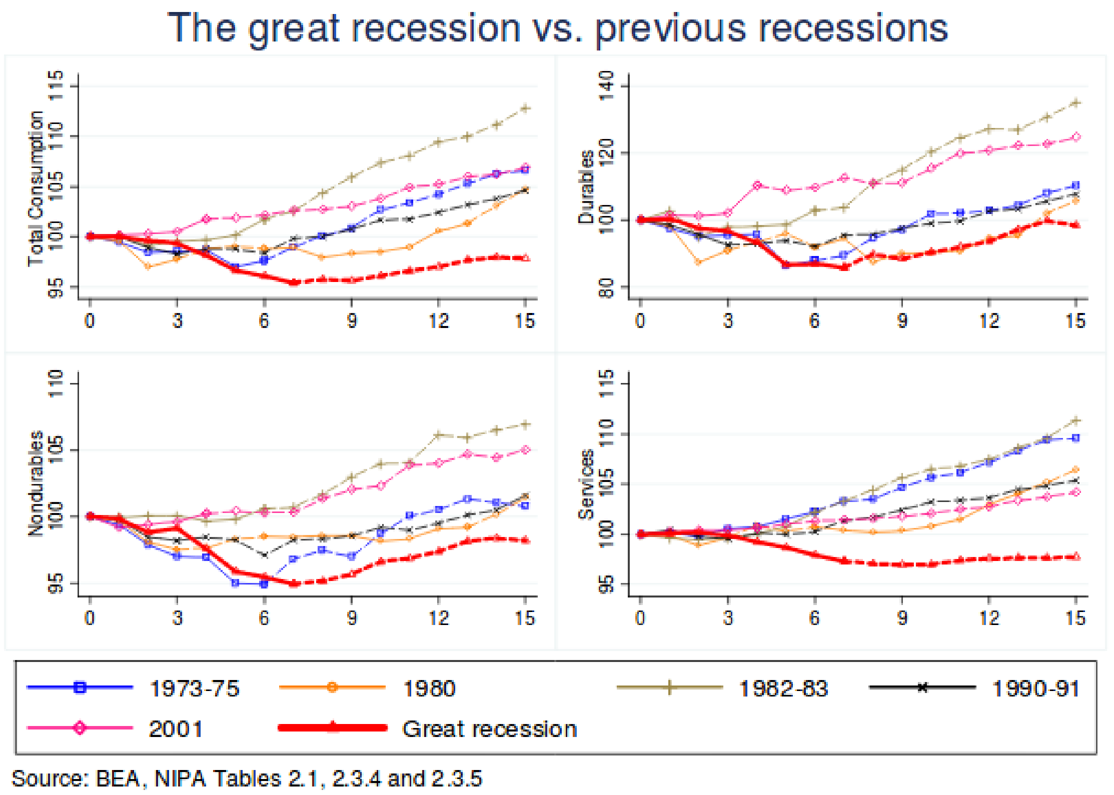


Figure 3: Consumption During Recessions (Quarters From Start)

Figure 3: Consumption during the past recessions. Taken from Petev, Pistaferri & Eksten (2011).

Mac) in 1970, motivated by the Savings & Loan Crisis at that time.

More recently and more importantly for this paper, homeownership was promoted during the presidencies of Clinton and Bush whereas the Obama administration tried to mitigate the bursting of the house price bubble. These policies are discussed in more detail below. We focus on these three administrations' policies because they coincide with an unprecedented boom in bust in the homeownership rate (see Figure 1). Starting in the beginning of 1994 the fraction of homeowners among all households started to increase from 63.8% until it peaked at the end of 2004 at 69.2%. From there on, it started to decline again until the second quarter of 2016 where it reached its trough of 62.9%.

Under President Clinton housing policy became a focus of the administration. In the first year of presidency the Federal Housing Enterprises Financial Safety and Soundness Act of 1992 (GSE act) was put into law. It demanded that the GSEs purchase a certain amount of loans which were originated in poorer neighborhoods and/or by poorer households. Then, in 1995 the administration published its "National Homeownerhsip Strategy" (NHS). In this strategy paper it laid out the goal of increasing the number of households that own their home by 8 million (which translates to an increase of 5 percentage points in the homeownership rate). In particular, emphasize was put on increasing homeownership rates for minorities, young people and low- and moderate-income households among others. For this purpose the NHS formulated 100 actions with the support of 56 organizations connected to the real estate sector. Proposed actions concerned aspects of production, financing, zoning laws and others. In 2001, under HUD secretary Cuomo the GSEs were further pushed to purchase even more loans from poor households. For an overview on the development of the affordable housing goals see Bolotnyy (2013). Some commentators have attributed the Great Recession in 2008 to these policies. As an example see the dissenting view by Wallison in the FCIC report (2011). However, this view is controversial. For an opposing view, see Bolotnyy (2013).

After his inauguration in 2001 President Bush continued to promote the so-called "ownership society". In June 2002 he visited Atlanta to announce a new goal of increasing the number of minority homeowners by 5.5 million. Among his policies was the "American Dream Downpayment Assistance Act" which was signed into law in 2003. This law provided grants for low-income households to finance downpayments, which was regarded as a main obstacle in achieving homeownership. During the later part of Bush's presidency the main focus was on mitigating the effects of the housing crisis. Congress past the Housing and Economic Recovery Act of 2008 which eventually lead to Fannie Mae and Freddie Mac being put under conservatorship in 2008. Furthermore it provided a tax credit for first-time home buyers under the Housing Assistance Tax Act, increased the loan limit for mortgages guaranteed by the FHA to 110% of area median home price in the FHA Modernization Act and tried to facilitate the financing of loans for distressed borrowers in the HOPE for Homeowners Act.

After Obama took Office in 2008 the administration continued to deal with the aftermath of the financial crisis. The US was facing a recession while at the same time, house prices were falling and foreclosures spiked. To stabilize the economy the goal of economic policy was to prevent people from defaulting on their mortgage payments, which would have worsened the crisis, as well as providing some financial relief. Two major programs were put in place to deal with these problems. Under the Home Affordable Modification Program (HAMP) distressed borrowers could receive a reduction in their monthly mortgage payments if they met certain eligibility requirements. A second major program, the Home Affordable Refinance Program (HARP) allowed homeowners whose LTV was above 80% (and therefore could not refinance at cheap interest rates) to refinance with the GSEs.

For more than 150 years housing policy had a prominent place in American politics. Many laws were passed and agencies created to support the housing market. However, evidence is mixed on some of the reforms (e.g. the ones passed by Clinton) and its effectiveness. Especially during the late 1990s and early 2000s market conditions such as low interest rates and small down payment requirements appear to have played an important role (see Gabriel & Rosenthal, 2015). Nevertheless, the continued presence of housing policies and promotion of homeownership in the public debate could have contributed to reinforce the notion of homeownership as part of the American Dream in the collective conscience.

1. Housing wealth effects in the literature

Housing wealth effects are central to the growing literature on housing and mortgages in financial crises. The literature has found that the individual responses vary along various dimension: age, LTV, housing share, between owners and renters. With one exception these findings are the results of numerical experiments. Berger et al. (2018) derive conditions under which the consumption response is proportional to housing wealth and show that this relationship approximately holds in more general settings.

This paper adds to the growing literature on macro housing and housing wealth effects.

Guren et al. (2018) analyze how a change in LTV distribution affects the aggregate consumption response to changes in house prices. Their model features several aspects that are also present in many other papers.

First, housing wealth effects vary across individuals (e.g. across the LTV distribution) and in particular, the response, as a function of LTV, is hump shaped. Households with a LTV of more than one ("underwater mortgage") do not exhibit any responses to changes in housing wealth. These household do not own any equity in their houses. Hence, marginal changes in the value of housing do not affect their net wealth and consumption expenditure. On the other hand households with a high LTV below one display strong reactions to changes in house prices. For this set of households an increase in the value of their house usually means a relaxation of collateral borrowing constraints. A more valuable house enables agents to borrow more against their collateral. Because these agents are constraint in their consumption they will use a large amount of the additional dollars they can spend on consumption. Lastly, households with a low LTV usually have a high net worth already and the collateral borrowing constraint is not binding (anymore). For this set of households, higher house prices are similar to an increase in wealth. However, their propensity to consume out of wealth is smaller compared to high

LTV households leading to a muted response.

The authors conduct a policy experiment where they subject the economy to house price shocks under different LTV distributions (from 1980 and 2007). They find that the aggregate reaction of consumption expenditure to housing wealth effects is invariant to different LTV distributions.

Next, Kaplan et al. (2017) additionally highlight the reaction of renters and the effect of long-term mortgages on housing wealth effects.

In contrast to homeowners, renters to not experience a wealth effect through changes in house prices. By definition, these households do not own their home. Hence, the house prices affect them only through their effect on rental rates. Since rent and house prices usually are positively related, an increase in prices means an increase in rent. As renting becomes more expensive, households will instead consume more (substitution effect). However, because of high prices, they are also poorer in real terms, such that they consume less (income effect). In what follows substitution and income effect cancel out perfectly due to Cobb-Douglas aggregation. Regardless of the sign of the effect, the literature agrees that the reaction of renters is very much muted to housing wealth shocks.

Long-term mortgages also mitigate the response to housing wealth effects. The reason for this observation is that through long-term financing the collateral borrowing constraint only binds at origination. Hence, the additional house value does not have an effect on everybody in the economy, only on those that take on a new loan or refinance.

The previous two papers both contain large, quantitative models which can only be solved numerically. In contrast to that Berger et al. (2018) prove a rule-of-thumb for housing wealth effects in a simplified economy that also holds approximately in more complex settings. In particular they show that the housing wealth effects are approximately proportional to the initial value of the house $\times$ MPC. Furthermore, they show numerically that consumption elasticities vary with income, age, housing, liquid assets and renting decision. These are all dimensions which we can investigate analytically in our model. Important for the aggregate response in their framework are both the (i) joint distribution of housing and debt and (ii) the history of shocks. Unfortunately, the rule of thumb breaks down for underwater households. They have very high MPCs but still exhibit no reaction to house prices shocks, as argued above. reaction to house price and credit supply growth.

2. A tractable life-cycle model with housing

In the following we develop a tractable life-cycle model with closed forms for optimal consumption, house size, mortgages and, most importantly, housing wealth effects (the individual consumption response to house price changes). We build on the insight of Drechsel-Grau and Greimel (2018) that mortgage debt can be analyzed in the absence of income risk. Their model with infinitely-lived agents trivially features constant choices across time. Here, we generalize their framework to agents with finite or infinite life-time $J \in \mathbb{N} \cup \{\infty\}$. We assume that agents bequeath their houses and positive assets to the next generation. We construct a bequest motive function, such that the policies are constant over time.

THE IDEA IS to start from the deterministic infinite horizon case, and separate from the discounted lifetime utility a part that will serve as the *warm glow bequest motive*.

$$\sum_{t=0}^{\infty} \beta^t u(c,h) = \sum_{t=0}^{J-1} \beta^t u(c,h) + \underbrace{\sum_{t=J}^{\infty} \beta^t u(c,h)}_{\text{bequest motive}}$$

Importantly, the agent chooses (c_t, h_t, a_{t+1}) from birth to death at $t = J-1$ subject to the constraint that the mortgage must be repaid by the end of life $a_J = 0$. That is, the agent can bequeath neither debt nor assets other than housing.

As opposed to the infinite horizon model in Drechsel-Grau and Greimel (2018), the agent has varying leverage over her lifetime since the value of the optimal size of the house is constant over the life-cycle but the outstanding mortgage is decreasing.

In this section we present the model and solve for an equilibrium. In section 3 we derive closed forms for the housing wealth effects and in section 4 we discuss the policy implications of our results.

2.1. Setup

Agents live for J periods. The agent chooses (c_t, h_t, a_{t+1}) from birth to death at $t = J-1$ subject to a lifetime budget constraint $a_J = 0$. At death, the houses h_{J-1} is bequeathed to the agents descendants. The agents gets a warm glow $\psi(h_{J-1})$ from the bequest. Incomes are deterministic.

The agent's problem can be summarized as

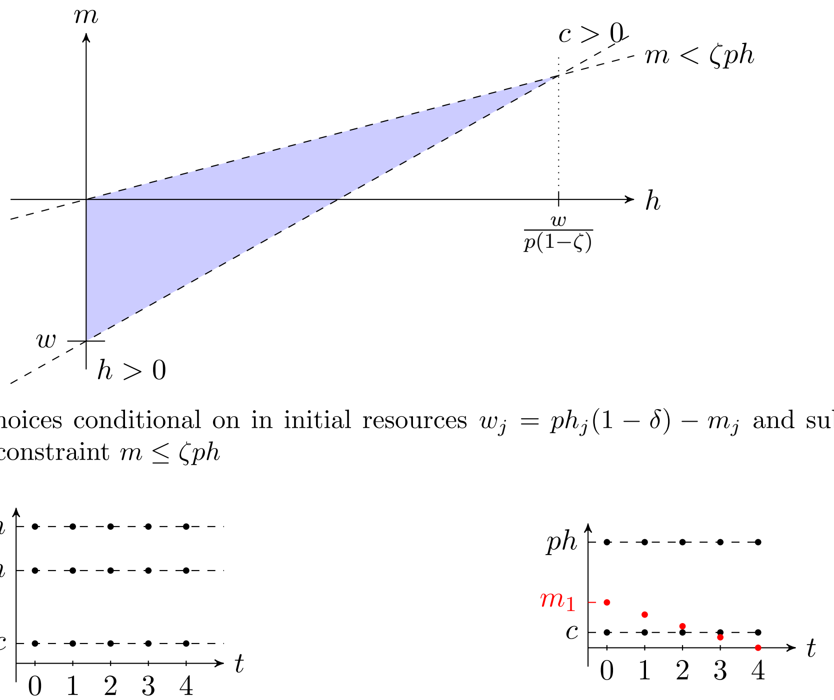
$$\begin{aligned} &\max \sum_{t=0}^{J-1} \beta^t u(c_t, h_t) + \beta^{J-1} \psi(h_{J-1}) \\ &\text{s.t. } c_t + p(h_t - (1-\delta)h_{t-1}) + a_{t+1} = (1+r)a_t + y_t \\ &\qquad h_{-1} = 0, a_0 \text{ given} \\ &\qquad a_J \geq 0 \end{aligned}$$

In order to maintain tractability of the model we construct the bequest motive $\psi(\cdot)$ so that the choices are constant over time.

Assumption 1 (Constant incomes)**.** $y_t = y$ for all t.

Assumption 2 (Cobb-Douglas aggregation)**.** $u(c,h) = f(c^{1-\xi} h^{\xi})$

This assumptions 1 and 2 are not very realistic, but convenient. Assumptions 1 can very likely be relaxed to *deterministic* but potentially time varying incomes. All formulas depend on life-time income only.



(a) Feasible choices conditional on in initial resources $w_j = ph_j(1-\delta) - m_j$ and subject to a collateral constraint $m \leq \zeta ph$

(b) Optimal choices for $J = \infty$

(c) Optimal choices for $J = 5 < \infty$

Figure 4: Feasible and optimal choices.

Proposition 1. *Let preferences satisfy assumption 2. In order to get constant choices $c_t = c$ and $h_t = h$ for all $0 < t < J-1$ for an unconstrained agent, the bequest function needs to have the following form*

$$\psi(h) = \kappa_1 f(\kappa_2 h),$$

where $\Omega = \frac{1-\xi}{\xi}\frac{r+\delta}{1+r}$, $\kappa_1 = \frac{1-\xi}{\Omega} - \xi$ *and* $\kappa_2 = (p\Omega)^{1-\xi}$.

Proof. Guess and verify. To be written up. □

2.2. Optimal housing

Lemma 1. *Assume that policies are constant over time. Further assume that $c = p\Omega h$. Then optimal housing is given by*

$$h = \mathcal{Y}\frac{1}{p\big(1-\delta+\theta(J,r)\cdot(\delta+\Omega)\big)},$$

where $\theta(J,r) := \sum_{j=0}^{J-1}\left(\frac{1}{1+r}\right)^j$ *and $\mathcal{Y}$ is life-time income.*

Proof. The life-time budget constraint is given by

$$(1-\delta)ph + \sum_{j=0}^{J-1}\Big(\frac{1}{1+r}\Big)^j(\delta ph + c) = a_0 + \sum_{j=0}^{J-1}\Big(\frac{1}{1+r}\Big)^j y =: \mathcal{Y}$$

Using the definition of θ, and the assumption on c we get

$$\begin{aligned}\mathcal{Y} &= (1-\delta)ph + \theta(J,r)\cdot(\delta ph + p\Omega h)\\ &= ph\big((1-\delta) + \theta(J,r)\cdot(\delta+\Omega)\big)\end{aligned}$$

Rearranging yields the desired result. □

2.3. Optimal mortgages

Mortgages are constant amortization mortgages,

$$m_0 = \sum_{j=0}^{J-1}\Big(\frac{1}{1+r}\Big)^j \pi = \theta(J,r)\pi$$

where m_0 is the outstanding mortgage in period 0, *before making the debt service payment* and π is the constant debt service payment in each period. Note that the law of motion for outstanding debt is given by

$$\begin{aligned} m_t &= (1+r)(m_{t-1}-\pi)\\ \iff m_t &= \frac{1}{1+r}m_{t+1} + \pi\end{aligned}$$

solving forward yields

$$m_{J-t} = \sum_{i=0}^{t-1}\Big(\frac{1}{1+r}\Big)^{i-1}\pi = \theta(t,r)\pi$$

E.g., $m_J = 0$, $m_{J-1} = \pi$, $m_0 = m_{J-J} = \theta(J,r)\pi$

Let us discuss two useful special cases.

Special case 1: $J = \infty$. If the agent is infinitely lived, then $\pi = m_0\frac{r}{1+r}$. From the law motion we get that

$$m_1 = (1+r)\Big(m_0 - m_0\frac{r}{1+r}\Big) = (1+r-r)m_0 = m_0.$$

By induction it follows that the outstanding mortgage is constant over time,

$$m_t = m_0 \quad \text{for all } t\in\mathbb{N}$$

Special case 2: $J < \infty$ and $r = 0$. In this case we get simple formulas as well since $\theta(J,0) = J$.

$$\pi = \frac{m_0}{J}, \qquad m_{J-t} = \frac{t}{J} m_0$$

That is, the outstanding mortgage declines exactly linearly to 0.

Initial mortgages

We can now compute the initial debt level of agents. We know that

$$\pi = y - \delta ph - c = y - (\delta + \Omega) ph$$

Plugging in for houses we get that

$$\pi = y - \mathcal{Y} \frac{\delta + \Omega}{(1-\delta) + \theta(\delta + \Omega)}$$

We can rewrite this to see the dependence on the ratio of flow income *inc* and initial assets a_0,

$$\begin{aligned}
&= y - (\theta y + a_0) \frac{(\delta + \Omega)}{(1-\delta) + \theta(\delta + \Omega)} \\
&= y \Big(1 - \underbrace{\frac{\theta(\delta + \Omega)}{(1-\delta) + \theta(\delta + \Omega)}}_{\in(0,1)} \Big) - a_0 \underbrace{\frac{\delta + \Omega}{(1-\delta) + \theta(\delta + \Omega)}}_{>0} \\
m_0 = \pi\theta &= y\theta \underbrace{\frac{(1-\delta)}{(1-\delta) + \theta(\delta + \Omega)}}_{\in(0,1)} - a_0 \underbrace{\frac{\theta(\delta + \Omega)}{(1-\delta) + \theta(\delta + \Omega)}}_{\in(0,1)}
\end{aligned}$$

Plugging in $\mathcal{Y} - a_0 = \theta y$ gives

$$\begin{aligned}
m &= (\mathcal{Y} - a_0) \frac{(1-\delta)}{(1-\delta) + \theta(\delta + \Omega)} - a_0 \frac{\theta(\delta + \Omega)}{(1-\delta) + \theta(\delta + \Omega)} \\
&= \mathcal{Y} \frac{(1-\delta)}{(1-\delta) + \theta(\delta + \Omega)} - a_0
\end{aligned}$$

Now we see that mortgages are positive, as long as the income is sufficiently high or initial assets are sufficiently low.

$$\begin{aligned}
& m_0 > 0 \\
\iff & y \frac{(1-\delta)}{(1-\delta) + \theta(\delta + \Omega)} > a_0 \frac{\delta + \Omega}{(1-\delta) + \theta(\delta + \Omega)} \\
\iff & \frac{y}{a_0} > \frac{\delta + \Omega}{(1-\delta)}
\end{aligned}$$

2.4. Optimal policies of renters

An agent decides to rent some housing units instead of buying them if there is no bequest motive. Furthermore, since the agent does not own any housing the (depreciated) value of the house in the next period is irrelevant for the optimal choice today. Therefore the renter's problem becomes static. The renter's problem is then given by

$$\max_{\{c_t,h_t\}_{t=0}^{J-1}} \sum_{t=0}^{J-1} \beta^t u(c_t^{1-\xi} h_t^{\xi})$$
$$s.t. c_t + \rho h_t + a_{t+1} = (1+r)a_t + y_t$$
$$a_J \geq 0$$

where ρ denotes the price of renting one unit of the housing good.

Under our given assumptions, agents' consumption choice will not depend on the rental price (which is a function of the house price).

Proposition 2. *Under deterministic lifetime income and Cobb-Douglas aggregation of consumption and housing goods optimal policies of renters are constant across time. Furthermore, the level of consumption is independent of the cost of renting.*

Proof. As before the budget constraints can be combined into one lifetime budget constraint. Let $\mathcal{Y}$ denote lifetime income. Let λ denote the Lagrange multiplier of the constraint maximization problem. The FOCs of the new problem are given by

$$(1-\xi)u'(c_t^{1-\xi}h_t^{\xi})\left(\frac{h_t}{c_t}\right)^{\xi} = \lambda$$
$$\xi u'(c_t^{1-\xi}h_t^{\xi})\left(\frac{c_t}{h_t}\right)^{(1-\xi)} = \lambda\rho$$

From here it follows that policies are constant over time. Furthermore, rearranging the FOCs and plugging them back into the lifetime budget constraint yields the optimal policies:

$$c^* = (1-\xi)\frac{\mathcal{Y}}{\theta}$$
$$h^* = \xi\frac{\mathcal{Y}}{\theta\rho}$$

where θ is as defined before. The desired result follows. □

In this framework renters' optimal consumption is independent of the cost of rent. Now suppose, that rent increases with rising house prices and vice versa. A decrease in house prices then, which reduces consumption of home owners, has no effect on renters. Their wealth is unaffected and therefore also spending on consumption. This is in line with e.g. Berger et al. (2018); Aladangady (2017) who find very small reactions of renters' consumption expenditure to changes in house prices.

3. Housing wealth effects with closed forms

We can now derive one of the main results of this paper: closed forms for the consumption response to house price shocks. We assume that house price shocks are permanent MIT shocks. That is, agents act as if prices where deterministic and constant over time. (Also remember, we are in a partial equilibrium setting with exogenous prices). As we have shown in lemma 1, agent's optimal choices are a function of their life-time income and their remaining life-time.

Due to exponential discounting, agents' choices are *time consistent* (Strotz, 1955). That is, if an agent is allowed to reconsider her optimal decisions, she will not want to (in an unchanged environment). In mathematics,

$$c^*(\mathcal{Y}_0, J) = c^*(\mathcal{Y}_j, J - j)$$
$$h^*(\mathcal{Y}_0, J) = h^*(\mathcal{Y}_j, J - j)$$

where

$$\mathcal{Y}_0 = \tilde{a}_0 + \theta^J y$$
$$\mathcal{Y}_j = \tilde{a}_j + \theta^{J-j} y$$

and

$$\tilde{a}_j = (1-\delta) p h_{j-1} - m_j.$$

If, however, the environment changes, the agent will want to reallocate their expenditures.

Proposition 3. *After an unexpected price change from p to q at the beginning of a period, an agent of age j will adjust their consumption. The consumption response is*

$$\frac{c_j^*}{c_0^*} = \frac{(1-\delta)\frac{q}{p} + \theta^{J-j}(\delta + \Omega)}{(1-\delta) + \theta^{J-j}(\delta + \Omega)}$$

Proof. After the price change, agent's optimal choices are given by

$$h_j^* = \mathcal{Y}_j \frac{1}{q\big((1-\delta) + \theta^{J-j}(\delta + \Omega)\big)} \tag{1}$$
$$c_j^* = q \Omega h_j^*$$

where the new lifetime income at age j is given by a combination of current wealth (h and m) and future income

$$\mathcal{Y}_j = \tilde{a}_j + \theta^{J-j} y$$

with

$$\begin{aligned}\tilde{a}_j &= (1-\delta)qh - m_j \\ &= (1-\delta)qh - m_{J-(J-j))}.\end{aligned}$$

Plugging in our formulas for m_{J-t} (lemma XXX) and c (assumption XXX) we get

$$\begin{aligned}\tilde{a}_j &= (1-\delta)qh - \theta^{J-j}\pi \\ &= (1-\delta)qh - \theta^{J-j}(y - c - \delta ph) \\ &= \big((1-\delta)q + p\theta^{J-j}(\Omega+\delta)\big)h - \theta^{J-j}y.\end{aligned}$$

Thus, agents lifetime income at age j is

$$\mathcal{Y}_j = \big((1-\delta)q + p\theta^{J-j}(\Omega+\delta)\big)h_0^* \tag{2}$$

Combining equations (1) and (2) we get new optimal house at age j,

$$h_j^* = \frac{p}{q}\frac{(1-\delta)\frac{q}{p} + \theta^{J-j}(\delta+\Omega)}{(1-\delta) + \theta^{J-j}(\delta+\Omega)}h_0^*$$

The new optimal consumption level at age j is given by

$$c_j^* = q\Omega h_j^* = \frac{p}{q}\frac{(1-\delta)\frac{q}{p} + \theta^{J-j}(\delta+\Omega)}{(1-\delta) + \theta^{J-j}(\delta+\Omega)}\frac{q}{p}\underbrace{p\Omega h_0^*}_{c_0^*}$$

The optimal consumption response to an unexpected house price shock follow directly from the previous equation. □

3.1. How does the consumption response vary with different characteristics?

Corollary 1. *The consumption response to an unexpected house price shock is*

1. *zero for renters*
2. *negative for owners (to a negative house price shock)*
3. *stronger for older people*
4. *stronger for house lovers*

Proof. The consumption response has the following structure,

$$\frac{c_j^*}{c_0^*} = \frac{a + f(x)}{b + f(x)}$$

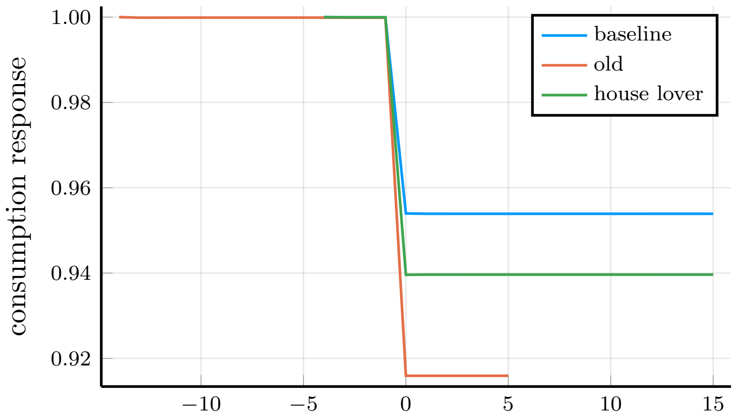


Figure 5: Housing wealth effects—the consumption response to a drop in house prices—by age and housing preferences. Shock happens in $t = 0$.

where $a = (1-\delta)\frac{q}{p}$, $b = (1-\delta)$ and $f(J, j, \delta, \Omega) = \theta^{J-j}(\delta + \Omega)$. The derivative is given by

$$\begin{aligned}\frac{\partial}{\partial x}\frac{c_j^*}{c_0^*} &= \frac{f'(x)(b + f(x)) - f'(x)(a + f(x))}{\big(b + f(x)\big)^2} \\ &= \frac{f'(x)(b-a)}{\big(b + f(x)\big)^2} \\ &= f'(x)\frac{(1-\delta)(p-q)}{p\big(1-\delta+f(x)\big)^2} \\ &\propto f'(x)\end{aligned}$$

for a ngetive shock to prices. That is we can look at the partial derivative of f only.

$$\frac{\partial f}{\partial \Omega} = \theta^{J-j} > 0$$

Higher Ω means a bigger weight on consumpion, that is agents *hate houses more*. Thus,

$$0 < CR(\Omega_L) < CR(\Omega_H) < 1,$$

or

$$-100\% < \%CR(\Omega_L) < \%CR(\Omega_H) < 0\%.$$

That is, agents who love house more (lower Ψ), react stronger. For the following result consider the extension of θ to the real numbers,

$$\begin{aligned}\theta(t, r) &= \frac{1 - \left(\frac{1}{1+r}\right)^t}{1 - \frac{1}{1+r}} \\ \frac{\partial f}{\partial j} &= (\delta + \Omega)\underbrace{\theta'(J-j, r)}_{>0}(-1) < 0\end{aligned}$$

That is, agents with higher age react stronger (Using the same reasoning as above). □

3.2. Housing wealth effects and indebtedness

Our results show that the effect of debt on housing wealth effects are not clear cut.In the current version of the model we can distinguish three reasons for indebtedness.

1. *y vs a_0:* Varying the ratio of initial endowment and flow incomes will change the debt holdings for given lifetime income. If more of the lifetime income is earned through flow income, optimal debt will be higher. (We can distinguish three reasons for indebtedness. However, in our complete markets setup all that matters is (discounted) lifetime income itself. So, comparing agents of income composition, more indebted agents react *equally strongly*.

2. *Age:* Households repay their debt over their lifetime. Older agents are less indebted than poor agents. As shown above, older agents have a stronger consumption response. So, comparing agents of different ages, more indebted agents react *less strongly*.

3. *Preferences for housing ξ:* We have shown that house lovers, agents with stronger preferences for houses, are more indebted. They also react stronger to house price changes. So, comparing agents of different housing preferences, more indebted agents react *more strongly*.

From the perspective of our model, it is non-sensical to claim that more indebted (or more leveraged) agents react stronger to house price changes. Depending on the reason of the indebtedness, agents react more, equally or less strongly when they are more indebted.

3.3. Aggregate housing wealth effects

From Corollary 1 and Proposition 2 we know the housing wealth effects for owners and renters. We showed that under Cobb-Douglas aggregation, renters do not react at all.

Thus we can write the aggregate response as

$$\text{Homeownership rate} \times \text{mean response of owners.}$$

Thus, bigger homeownership rate will lead to a stronger aggregate consumption response to a house price change.

4. Aggregate wealth effects, homeownership and housing policies

We have just shown that aggregate housing wealth effects are proportional to the homeownership rate. In this section we discuss three counterfactual experiments to assess the role of the homeownership rate in driving aggregate housing wealth effects.

To illustrate our point and to keep the analysis simple we take values for the preference parameters from the literature. Additionally, we abstract in this stage from any general equilibrium dynamics. House prices are taken as given and moving from an owner-occupied to a renter-occupied real estate (i.e. selling the house) does not necessarily imply that somebody else has to purchase the same house. By the assumption of Cobb-Douglas aggregation of non-durable consumption and housing, renters' non-durable consumption does not react to changes in house prices. This will be generalized in the future.

First, we establish in our simple model framework the individual consumption response of homeowners and renters to the boom in house prices experienced between 1990 and 2006 of about 50% and the subsequent bust until 2012 of the same size. Next, we obtain the aggregate consumption response by incorporating information about the homeownership rate, which also experienced a boom-and-bust episode. Starting in the 1990s it steadily increased from 64% up to 69% in 2005. From there on it declined such that it reached its initial level of 64% again in 2012.

Having established the baseline, we turn to our experiments. In the counterfactual *C1* we try to isolate the impact of the rise in house prices on aggregate wealth effects. For that purpose, we repeat the first part of the baseline calculation while fixing the homeownership rate at its 1990 level, i.e. we want to see what the model predicts would have been the consumption expenditure response if people were stuck with their 1990 housing choice. We study this counterfactual to understand in what way aggregate wealth effects were driven not only by the intensive margin (increase in house prices) but also by the extensive margin (increase in homeownership rate).

We continue in the same spirit with counterfactual *C2* were we fix the homeownership rate level at its 2005 peak level of 69% but let the agents experience the bust in house prices of about 50%. Again, we conduct this analysis to deepen the understanding of driving forces in the decline in consumption. By fixing the homeownership rate we ignore the mitigating effect of the housing choice. While house prices were falling after 2006, homeowners decided to move back into rental homes. This behavior isolated them from the negative wealth effects of falling house prices such that the drop in consumption expenditure was less pronounced than it would have otherwise been.

Lastly, in counterfactual *C3* we ask what would have been the aggregate wealth effects in response to rising house prices from 1990 to 2006 if the housing goals of Clinton's Homeownership Strategy (NHS) from 1995 would have been realized (8 million additional homeowners, equivalent to a homeownership rate o f 70%). In this scenario 70% of households are homeowners such that they experience the housing boom.

Note that in all four cases we assume for simplicity that agents experience the change in house prices immediately and not gradually over several periods. Hence, we are looking at the cumulative aggregate housing wealth effect over time.

Table 1 displays the results. The column labeled "Boom" ("Bust") displays the aggregate wealth effects during the boom (bust) for every scenario, respectively. The third and fourth column gives percentage differences relative to the benchmark scenario.

Scenario "Baseline Boom" gives the wealth effects of homeowners during the boom (between 1990 and 2006) where house prices increased by 50 percent. This translates

Table 1: Counterfactual analysis. Homeownership rates and the boom and bust in (non-durable) consumption.

	Boom	Bust	Boom relative	Bust relative
Benchmark	12.21 %	-11.71 %	0.0 %	0.0 %
C1: HOR 1990	11.33 %	- %	-7.21 %	- %
C2: HOR 2005	- %	-12.63 %	-	7.83 %
C3: Clinton's goal	12.39 %	-12.81 %	1.47 %	9.39 %
Data	30.80 %	-8.27 %		

Notes: "Data" refers to change in non-durable consumption per capita. The boom periods are from 1990 to the peak (before 2010). The bust periods are from the peak to lowest value until the present.

to an increase in private expenditure by about 17.7 percent for homeowners. At the same time the share of homeowners increased by 5 percentage points to 69 percent. In total, this translates to an aggregate consumption wealth effect of 12.21 percent. The scenario "Baseline Bust" shows the estimated aggregate wealth effects after 2006. Due to the house price decline of about 50 percent homeowners decrease their consumption expenditure by 18.3 percent in our model. At the same time the HOR declines by 5 percentage points translating to an aggregate effect of -11.71 percent.

Next, in counterfactual *C1* the individual increase in household spending is still 17.7 percent. However, the HOR remains fixed. This translates to an aggregate increase in consumption spending of 11.33 percent. This is 7.21 percent lower than in the baseline scenario suggesting that the increase in the homeownership rate contributes almost decrease in aggregate consumer spending.

Counterfactual *C2* is shown in the fourth row. Individual responses are as before, however we ignore now the decline in the HOR, fixing it at 69%. Aggregate effects now amount to -12.63 percent. This is 7.83 percent smaller than in the baseline scenario. Hence, our model suggests that changing housing tenures enabled consumers to avoid parts of the negative wealth effects due to falling house prices. Would they have kept their houses, aggregate decline in consumption spending would have been substantially deeper.

Lastly, the results from counterfactual *C3* suggest that, would the goals of the National Homeownership strategy have been realized, both the boom and the bust would have been more pronounced compared to the baseline (1.47 and 9.39 percent each). It is not clear if this policy would have been welfare improving. However, it suggests that there may be a role for housing policy in not just promoting homeownership but also supporting other sections of the economy.

4.1. Outlook: Managing Housing Wealth Effects: A Policy Proposal

If the sole objective of the government where to minimize housing wealth effects, a government should aim for people renting instead of owning, and if they own, have houses that are not too valuable. Such policies might include cutting the tax incentives on mortgages and the introduction of an inheritance tax (which is would cut one of the main incentives to own: to bequeathe it to ones children).

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A. Lemmas and Proofs

B. Numerical solution

Let $w = ph(1-\delta) - m(1+r)$

$$\begin{aligned}
V_t(w, y) = \max_{h', m'} & \, u(c, h') + \mathrm{E}\, V_{t+1}(w', y') \\
\text{s.t.} \; & c + ph' - \frac{m'}{1+r} = w + y \\
& w' = (1-\delta)ph' - m' \\
& c, h' \geq 0 \\
& m' < \theta h' \\
V_{J-1}(w, y) = \max_{h', m'} & \, u(c, h') + \psi(h') \\
\text{s.t.} \; & c + ph' = w + y \\
& c, h' \geq 0
\end{aligned}$$

In order to bound the choice of housing we use the positivity of c and the collateral constraint.

$$0 < c = w + y - ph' + \frac{m'}{1+r}$$

using $m' < \theta ph'$

$$\begin{aligned}
ph' < w + y + m' < w + y + \frac{\theta}{1+r} ph' \\
ph'(1 - \frac{\theta}{1+r}) < w + y \\
\implies h' < \frac{(w+y)(1+r)}{p(1+r-\theta)}
\end{aligned}$$

Thus,

$$0 < h' < \frac{(w+y)(1+r)}{p(1+r-\theta)} =: \kappa_0$$

Turning to w', we use its definition and again the positivity of c.

$$\begin{aligned}
& m' = (1-\delta)ph' - w' \\
& 0 < c = w + y - ph' + m' = w + y - \delta ph' - w' \\
\implies & w' < w + y - ph'\delta := \kappa_1
\end{aligned}$$

Now we use the collateral constraint $m' < \theta p h'$

$$m' = (1-\delta)ph' - w' < \theta p h'$$
$$w' > ph'(1-\delta-\theta) := \kappa_2$$

Thus

$$\kappa_2 < w' < \kappa_1$$
$$\implies 0 < \frac{w' - \kappa_1}{\kappa_2 - \kappa_1} < 1$$