HOMEOWNERSHIP, GEOGRAPHIC MOBILITY AND MORTGAGE STRUCTURE

by

AYMAN MNASRI

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Abstract

This thesis studies the impact of geographic mobility on the decision of a household to whether to buy or to rent a house, and sheds light on the efficiency of mortgage default prevention policies. The first chapter provides an introduction and an overview of the ongoing policy debates on homeownership and mortgage terms. In the second and third chapters, I study the housing tenure decision in the context of a life cycle model with uninsurable individual income risk, plausibly calibrated to match key features of the U.S. housing market. I find that the relatively low ownership rate of young households is mainly explained by their high geographic mobility. Downpayment constraints have minor quantitative implications on ownership rates, except for old households. I also find that idiosyncratic earnings uncertainty has a significant impact on ownership rates. Based on these results, I argue that the long term increase in ownership rates observed over the period 1993-2009 was not necessarily due to mortgage market innovations and the relaxation of downpayment requirements, as is often argued. Instead, it was simply an implication of U.S. demographic evolution, most notably the decline in interstate migration and, less importantly, population aging. Finally, in Chapter 4, I study the impact of the relaxation of downpayment requirement on homeownership and default risk. Given its quantitative success in matching the U.S. homeownership curve, my model represents a reasonable benchmark to assess the efficiency of mortgage default prevention policies. I find that both income and mobility are the main trigger factors for default decisions. In fact, households with a higher mobility (i.e. young households) rate are more likely to default. According to the welfare analysis, I suggest that policymakers include a minimum downpayment requirement of 9.5% in the new definition of the Qualified Residential Mortgage. This number should, however, be viewed with some caution, since I focus on a steady state economy, in which house prices are constant. In fact, the house price represents an important factor influencing the default rate. Potentially, the optimal minimum downpayment requirement should be set at higher value than 9.5%.
Dedication

To the memory of my dad Ezzeddine.
To my mother Essia, and my siblings Sirine and Nouha for your unconditional love, support and patience throughout my life.
To my wife Ines, for your constant support, and encouragement.
To my son Ahmed, for your love and smiles that inspired me.
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All errors are my own.
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Chapter 1

Introduction

Homeownership is considered by many as a key pillar of economic and social welfare. Supporters argue that a household who owns a home is invested in the local community and society more generally in a way that a renting family never could be. Indeed, many neighborhood revitalization programs consider the promotion of homeownership as one of their major objectives, arguing that neighborhood stability can never be achieved in areas without relatively high homeownership. Empirical evidence finds considerable support for an association between homeownership and an increasing investment in local public goods and institutions: “Homeowners accumulate wealth as the investment in their homes grows, enjoy better living conditions, are often more involved in their communities, and have children who tend on average to do better in school and are less likely to become involved with crime. Communities benefit from real estate taxes homeowners pay, and from stable neighborhoods homeowners create” (U.S. Department of Housing and Urban Development 2000). Several studies have investigated the social benefits of homeownership. Rossi and Weber (1996) found that owners tend to achieve a higher life satisfaction and self-esteem and are more likely
to be members of community improvement groups. Rohe and Stewart (2010) show how homeownership might affect various indicators of neighborhood stability. Several other studies have studied the positive effects of promoting homeownership on child development and outcomes (Boehm and Schlottman (1999); Aaronson (2000); Haurin, Parcel, and Haurin (2000)). Harkness and Newman (2003), however, argue that the potential positive effect of homeownership on child’ outcomes might be overestimated, since it varies depending on the type of neighborhood. For instance, policies designed to promote homeownership mainly affect low income households who are more likely to purchase homes in areas traditionally thought of as troubled or distressed.

Having said this, the recent financial crisis has drawn attention to the potential negative side of homeownership. In fact, purchasing a home could be viewed as an undiversified and risky investment as housing price crashes can dramatically wipe out a large fraction of household wealth. Moreover, high homeownership rates may decrease labor mobility, which could cause an increase in structural unemployment. Accordingly, one might suggest that policymakers should revise homeownership promoting policies in favor of renting in order to reduce financial distress risk and to lubricate labor markets.

Despite this policy debate, there exists a consensus that in the U.S. the user cost of owner occupied housing is lower than the rental price of housing services. Moreover, it has been often argued that homeownership helps households to accumulate wealth as it provides them protection against rent increases.

\footnote{Rosen 1979, Diaz and Luengo-Prado 2011.}
In fact, homeownership has been promoted by U.S. policymakers for many decades and through several means. Federal programs have been established to promote homeownership by increasing the ability of American households to afford houses and by encouraging them to choose homeownership over renting. Policymakers have used several mechanisms to promote homeownership, including Government Sponsored Entities (GSE) like Freddie Mac, Fannie Mae, which both fund and guarantee around 6.5 trillion of assets with the purpose of promoting homeownership. Homeowners are also eligible for tax deductions for mortgage interest payments on primary residences. Federal legislation has also contributed to promoting homeownership by enacting a law known as the Community Reinvestment Act, that encourages commercial banks and savings associations to help meet the needs of low and moderate-income potential borrowers. In fact, these homeownership promoting policies have led to the relaxation of lending standards, including the downpayment requirements.

Despite these homeownership promoting policies, many young households in the U.S. choose to rent rather than buy a house. In fact, homeownership rates among young households have not significantly increased during the last decades\textsuperscript{2}. The most commonly proposed explanation in the housing literature attributes this to the high downpayment requirements that young household face when buying their first houses. According to this hypothesis, young households, who are generally not very wealthy, have problems meeting the minimum downpayment requirements. Indeed, in the vast majority of macroeconomic models studying housing, authors tend to set a relatively high minimum downpayment requirement ratio of 20%, or even 25% in some cases.

\textsuperscript{2}Even though, the first time home-buyer affordability index (National Association of Realtors) has been increasing for the last decades.
However, this is not really in line with empirical evidence and several U.S. housing market facts. According to the American Housing Survey (AHS) of 2009, the average downpayment-price ratio is around 14.2% (13.7% according to "lendingtree" 2011). To the best of my knowledge, the highest average downpayment-price ratio (over the period 2001-2005) was of 21.1%, reported by Arslan, Guler and Taskin (2013). However, we should not forget that when we study housing tenure decision mechanism in a macroeconomic framework, we only care about modeling the minimum downpayment requirement parameter (i.e. borrowing constraint), which should be set at a lower value than the average downpayment-price ratio. Another important empirical fact that contradicts the above-mentioned hypothesis is the following: According to Wealth and Asset Ownership Survey of 2009, there are many young households who hold significant investments in different types of assets, yet, they choose to rent. Hence, there should be other reasons to explain the relatively low homeownership rates among young households other than the downpayment constraint.

One potential explanation, that I explore in the next chapter is geographic mobility. Purchasing a house typically represents a huge investment\(^3\) with high transaction costs, especially those associated with the illiquidity of owned housing. Since young households face a relatively high probability of moving, we might expect them to be more reluctant to make such investments, even if they do have the financial capacity to meet the downpayment requirements. Even though, geographic mobility seems to be a straightforward factor that may explain the low homeownership rate among young households, most housing tenure models in the literature have ignored it.

\(^3\text{Equity in own home presents 20\% of the total assets of households (American Community Survey 2011).}\)
In the next chapter, I build a life cycle model with uninsurable individual income risk, plausibly calibrated to match key features of the U.S. housing market and the earnings distribution, where households can decide on their housing tenure status. I also introduce mobility in order to assess its role in explaining the low homeownership rate among young households. Hence, the model incorporates the different factors that can, potentially, affect the decision of households on whether to own or to rent a house: downpayment constraints, income uncertainty, and geographic mobility. For the benchmark version of the model, I assume that homeowners are subject to mobility shocks that induce them to leave their current houses and rent (in a different location) for at least one period. These shocks are calibrated to match the actual geographic mobility rates in the U.S. between 2009 and 2010 (U.S. Census Bureau). According to the results, the low homeownership rate among young households is mainly due to a combination of their limited financial resources and their high geographic mobility, and not to the minimum downpayment constraints. In fact, the relaxation of the downpayment requirement does not seem to have any significant impact on homeownership rates. The model also provides a novel explanation to the long run increase in aggregate homeownership between 1993 and 2009. In fact, it has been often argued that this increase is due to mortgage market innovations and the relaxation of downpayment requirements. According to the counterfactual experiments that I run, this long run increase in aggregate homeownership is simply an implication of U.S. demographic evolution, most notably, population ageing (Shrestha and J.Heisler (2009)) and the decline in interstate migration as reported by Kaplan and Schulhofer-Wohl (2012).
In Chapter 3, I relax the mobility shock assumption by allowing for an endogenous moving decision so that both renters and owners receive offers to move. They can decide on whether to accept or reject this offer. Movers receive a bonus if they accept the offer, but they also incur a moving cost which simply consists of paying the housing transaction cost, since movers have to sell their houses before leaving. The relaxation of the mobility shock assumption provides a much more realistic environment to study the housing tenure decision. However, the main results of the benchmark model are quiet robust to this relaxation of the mobility shock assumption. Moreover, the new version of the model allows me to study the impact of income uncertainty (as well as the change in the income distribution) on the relation between homeownership and geographic mobility. The results show that an increase in income inequality could have a positive distributional effect on the geographic mobility of homeowners. In fact, the increase of the income inequality is equivalent to a rise in the income risk. Hence, households become less reluctant to purchase houses, which means that homeowners are more likely to be relatively richer. Hence, homeowners are more willing to accept offers and move.

In Chapter 4, I investigate another important aspect of the U.S. housing market; the impact of the relaxation of downpayment requirements on default rates (foreclosure rates). The bursting of the housing bubble is believed to be one of the primary causes of the 2007-2009 recession in the United States. Indeed, the steep increase in foreclosure rates in the mortgage market played an important role in the the U.S. financial crisis. Experts claim that all parties involved in the housing market were responsible for the 2007-2010 U.S. housing bubble from 'home buyers to Wall Street,
mortgage brokers to Alan Greenspan. Paul Krugman considers the Gramm-Leach-Bliley Act, that allowed commercial and investment banks to merge, to be the real detonator of the financial crisis. There is a consensus that the relaxation of mortgage loans standards and the deregulation of the bank system were the main causes of the financial crisis. In order to promote the financial stability of the United States (including reducing the default rates on mortgage loans), the Senate and House of Representatives of the United States of America enacted the Dodd-Frank Wall Street Reform and Consumer Protection Act, that was signed into federal law by President Barack Obama on July 21, 2010.

According to section IX.D of the Dodd-Frank Act: “securitizers are required to retain not less than 5% of the credit risk for an asset that is not a qualified residential mortgag”. Hence, the definition of the qualified residential mortgage, QMR, with regard to the minimum required downpayment-ratio is crucial for both lenders and borrowers. The definition of the QRM will eventually set the bar for mortgage-lending standards in the U.S. In fact, there is an ongoing debate as to whether to include a minimum downpayment requirement in the definition of the QRM. The original proposal published in 2011 included a minimum downpayment requirement of 20%. However, this proposal has been widely criticized, mainly because of the downpayment requirement that has been described as extremely restrictive, especially for low income households. Recently, a new Qualified Residential Mortgage rule has been jointly proposed by six government agencies. The new proposal received a relatively broad consensus among consumer advocates and mortgage industry members, as the

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5He has called Senator Phil Gramm “the father of the financial crisis” for his support of the act.
it does not include a minimum downpayment requirement. The proposal also includes an alternative definition (QM-plus) which includes a minimum downpayment requirement of 30%.

In order to assess the efficiency of such mortgage default prevention policies, I extend the model in Chapter 3 by allowing households to default on their mortgage loans. Defaulters are excluded from the mortgage loan markets for seven years. This default punishment strategy is consistent with U.S. banking standards as the bad credit flag stays, on average, for 7 years in the household’s credit history. Given its empirical success in matching U.S. life cycle homeownership curve, as well as in capturing the shift in the ownership curve between 1993 and 2009, the model represents a reasonable benchmark to analyze the welfare implications of including minimum downpayment requirements. According to the analysis conducted with this model, imposing a minimum downpayment requirement of 9.5% may be expected to improve welfare. This number should, however, be viewed with some caution, given that, in a steady state model, house prices turn out to be constant. According to my results, young households are more likely to default, not only because of their low income and their high earnings uncertainty, but also because of their high moving rates. Movers are more likely to default than stayers because of their relatively lower moving cost. Finally, I show that, even though the relaxation of downpayment requirement improves the average welfare of households, young agents are likely to experience a welfare loss due to their relatively high default rates

Although I am studying the U.S. housing market, the reported results also have
implications for Canadian housing policy. Before talking about these implications, it is important to give an overview of the structure of the Canadian housing market and finance system. Canadian Federal governments have promoted homeownership for decades, partly through the Canada Mortgage and Housing Corporation (CMHC), established in 1946. The CMHC’s main function is to promote the development of new housing by providing insurance for residential mortgage loans to Canadian home buyers. Typically, Canadian lenders require insurance for loans with downpayments less than 20%. In fact, with the CMHC loan’s insurance, a residential mortgage can cover up to 95% of the house price. There are also two other private insurers: Genworth and Canada Guarantee.

The Office of the Superintendent of Financial Institutions (OSFI) is an independent governmental agency that regulates the mortgage-insurance. Indeed, it is the principal tool that the Department of Finance uses to prevent housing bubbles and to stem the growth of Canadian consumers debts by tightening mortgages rules. The most recent policy change was last July (2013) and included cutting the maximum length of insured mortgages from 30 to 25 years. According to Canadian Bankers Association, the default rate on mortgage loans has never risen above 1% over the past 20 years. In fact, the credit culture in Canada is quite conservative compared to the U.S., and the consequences of a loan default are much more severe. It suffices to know that, in Canada, if someone defaults on his credit card, he will have to wait for at least 5 years in order to be eligible to apply for another one, even for a relatively small balance due.

Despite these differences, I think my results still have some implications for the Canadian housing market. First, based on Chapters 2 and 3’s results, I could interpret
the higher aggregate homeownership in Canada (70%) relatively to the U.S. (67%) as being partially due to the potentially lower mobility rates in Canada. Secondly and most importantly, in terms of housing policy, I would suggest to Canadian policymakers to revise their policy tool to promote homeownership. They should probably consider setting a minimum downpayment requirement on housing mortgage loans, instead of insuring mortgages with downpayments less than 20%. It is true that the actual default rate in Canada is quite low. However, in case of a housing bubble\footnote{As predicted by several Canadian housing market experts.} this rate may jump up. Under such scenario, the insurer (i.e. the Federal Government) will incur a huge default cost burden. Hence, requiring a relatively high downpayment might be an efficient measure that Canadian policymakers should consider in order to avoid high default rates\footnote{As defaulters are more likely to be the borrowers with the lowest downpayments} decrease mortgage loans costs (insurance premium), with no significant negative impact on the aggregate homeownership rate.

The next chapter investigates the impact of geographic mobility on the U.S. housing tenure decision mechanism. In Chapter 3, I investigate the robustness of Chapter 2’s results by relaxing the mobility shocks assumption, and I also study the impact of the income distribution on households moving decisions. Chapter 4 studies the tradeoff between promoting homeownership and increasing the default risk. Chapter 5 concludes. All proofs are relegated to Appendices A, B, and C.
Chapter 2

Renting Vs Buying a Home: A Matter Of Wealth Accumulation or of Geographic Stability?

2.1 Introduction

While there is ongoing debate on how to calculate the user cost of owner occupied housing, there exists a consensus that in the U.S. it is lower than the rental price of housing services\(^1\). Despite the low cost\(^2\) of owning relative to renting and the increasing first time home-buyer affordability index (National Association of Realtors), many young households choose to rent rather than buy a house.

A common explanation for low ownership rates among young households is the presumed high downpayment constraint that young adults face when they buy their

\(^1\)Rosen 1979, Diaz and Luengo-Prado 2011.

\(^2\)It is actually an post cost which doesn’t account for risk.
CHAPTER 2. RENTING VS BUYING A HOME: ...

first homes. Although most quantitative studies on housing assume relatively high minimum downpayment requirements\(^3\) (20% or 25%), they are not very successful in matching the U.S. life cycle ownership curve, especially for young households. It is also interesting to note that the majority of housing tenure decision models in the literature over-predict the difference in ownership rates between young and older agents (Iacoviello and Pavan 2011, Li and Yao 2006, etc).

According to the 2011 American Community Survey, households hold 37% of their total assets in real estate, of which home equity represents 55% . Hence, understanding these issues is important for both researchers and policy makers. Indeed, a realistic characterization of tenure decision mechanisms over the life cycle is crucial for obtaining accurate analysis and assessment of applied policies, social security reforms, public programs for promoting home-ownership, and welfare impacts for different age cohorts.

Another related issue has to do with asset holdings more generally. One of the key patterns of consumption and asset holdings over the life cycle is that young agents tend to have few liquid assets and hold most of their wealth in consumer durables. Indeed, according to the Wealth and Asset Ownership survey of 2009 (United Census Bureau), average rental property equity seems to be less correlated with age compared to home-own equity investments. Moreover, renters\(^4\) hold on average $135,000 in rental property equity, representing 25% of the average value for owners. Hence, it is very likely that renters, who are mainly young households, hold significant real estate equity.

\(^3\)Compared to what data on downpayment reveals: 14.2% according to U.S. Census 2009 American Housing Survey, and 13.76% according to lendingtree 2011...

\(^4\)Renters holding rental propriety investments.
As mentioned earlier, many researchers have argued that this phenomenon is simply a direct consequence of two important features characterizing the housing market: a high downpayment requirement combined with a minimum housing quantity constraint. According to this hypothesis, young households, who generally have relatively low income, cannot easily afford the required downpayment to purchase a house. However, this explanation is not in line with empirical evidence and several housing market facts. First, as I already mentioned, relatively wealthy young households are very likely to rent rather than own a house despite the fact that they have enough cash to meet the downpayment requirement. Second, the high minimum downpayment requirement of 20% to 25% commonly assumed in the literature, is not consistent with U.S. housing market financial data: While it is true that real estate experts and mortgage bankers recommend a downpayment of 20%, the effective downpayment paid by most American homeowners is much lower than that. In fact, more than 14 million (out of a total of 71 million owner-occupied homes covered by the 2009 survey) were bought with no downpayment. Moreover, according to the 2009 American Housing Survey, the effective average downpayment was around 14.2%. According to Arslan, Guler and Taskin (2013), the average downpayment ratio during the 2001-2005 period was 21.1%. However, we should not forget that the minimum downpayment requirement should be set at lower value that the average. According to the same survey, the median is less than 10% and 77% of owner occupied homes were bought with downpayments less than 20%. High downpayment assumptions are usually justified by existing norms on downpayment requirements, such as the Qualified Residential Mortgage. Yet, lenders often have programs that are flexible for different types of

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5The Qualified Residential Mortgage (QRM) is a requirement that allows the borrower to have the best rate on the mortgage since the loan will be exempt from the the Dodd-Frank Wall Street
borrowers and banks can offer loans with smaller downpayments and higher interest rates. There is also private insurance that can be purchased by borrowers in order to obtain lower downpayments.

Based on all these facts, it seems unlikely that the low ownership rates among young households are exclusively due to high downpayments requirements, especially, if we take into consideration the flexibility of the U.S. housing market regarding home prices. Indeed, according to the most well-known American real estate website Realtor, it is possible to buy a house for $30,000 or less. As reported in the 2009 American Housing Survey, 22% of owners have houses bought for less than 1.5 times their current income\(^6\) and around 15% of owner-occupied houses were bought for less than the national average income. While Iacoviello and Pavan (2011) assume a minimum house price set to 1.5 times the average annual pre-tax household income\(^7\) several other researchers have simply estimated this parameter to match data targets (Chambers Garriga and Schlagenhauf (2007), Silos (2007), etc.).

Besides this housing market evidence, there is also no clear conclusion about the quantitative and empirical importance of the impact of downpayment constraints on home ownership. Fisher and Gervais (2008) and Kiyotaki et al. (2007) argue that the relaxation of downpayment requirements was quantitatively small and had only

\(^6\)Reform that requires financial firms to retain 5 percent of the credit risk when they sell loans to investors (skin in the game).

\(^7\)Which seems to be consistent over time: 23% according to the 2003’s AHS: and 22% according to the 1982’s AHS.

\(^7\)In their paper, they refer to the 2009 American Housing Survey which reports that only 20 percent of total owner-occupied units have a ratio to current income less than 1.5. Yet, I do not think that this information is sufficient to assume that the minimum value of a house that an agent can buy is 1.5 times the "economy average income". On the contrary, I argue that the minimum size house is less than what was set by authors. In fact, more than 50% of households have an income lower than the average.
modest implications for the housing market. On the other hand, others researchers have found that borrowing constraints play an important role in explaining the low ownership rates among young households (Chambers et al (2005), Iacoviello and Pavan (2011), etc).

Finally, we can conclude that housing tenure decision models had limited success in revealing the real reasons behind the low home-ownership rates among young households and in replicating the actual U.S. life cycle home-ownership curve.

In this chapter, I study the housing tenure decision in an equilibrium life cycle model with uninsurable individual income risk, plausibly calibrated to match key features of the U.S. housing market, the earnings distribution and life cycle mobility rates. This framework is closely related to Hugget (1996)’s life cycle model. I explicitly distinguish owned from rented housing by modeling its collateral role and its illiquidity aspect and I allow for an endogenous housing tenure decision. I also introduce a mobility shock to capture geographical instability which can be thought as a potential explanation for the fact that many young, rich households in the U.S. prefer to rent. As expected, the data shows that mobility rates are negatively correlated with age.8

Given that my model incorporates several potential channels through which the housing tenure decision mechanism can be affected, I investigate the different popular explanations that have been proposed to explain the relatively low home ownership rate among young households. To do so, I attempt to accurately assess the role and the relative importance of financial constraints, earnings volatility and geographic mobility in explaining this apparent puzzle. I also build a simple yet rich framework in order to accurately replicate the U.S. life cycle home-ownership curve.

8See Figure 2.1
I find that geographic mobility has a significant and important impact on the tenure decision while the downpayment constraint has a small effect on the aggregate ownership rate. More specifically, young households are almost unaffected by changes in the downpayment parameter. Only old households are impacted by the relaxation or the tightening of the downpayment constraint. I also find that the shape of the life cycle ownership curve depends strongly on the idiosyncratic earnings risk variance. Indeed, with a plausible calibration that matches key U.S. housing market evidence and more importantly the U.S. earnings GINI coefficient, I am able to replicate the observed life cycle home-ownership curve very closely.

Based on counter-factual experiments, I am also able to shed new light on potential factors leading to the low ownership rate among young households: The high mobility of young adults is largely the reason why they are, in general, more willing to rent a house even if they have enough wealth to meet the downpayment requirement. That being said, the limited financial resources of young households plays an important role in explaining their low aggregate ownership rate. Finally, introducing mobility shocks improves the model’s ability in matching the U.S. ownership curve and the U.S. housing market ratios.

According to my findings, the long run increase in the ownership rate observed over the period 1993-2009 was not necessarily due to mortgage market innovations and the relaxation of downpayment requirements that have characterized the U.S. housing market over the last decades (Chambers and Garriga (2008), Ortalo-Magne and Rady (2006), etc ). Instead, it is simply an implication of U.S. demographic evolution, most notably, population ageing (Shrestha and J.Heisler (2009)) and the
decline in interstate migration, as reported by Kaplan and Schulhofer-Wohl (2012). In fact, The model is able to account for the actual rise in aggregate ownership rate and to accurately replicate the transition of the ownership distribution as a function of age, between 1993 and 2009.

Although geographical instability is a straightforward and intuitive potential factor that could affect household decisions regarding home-ownership, most housing tenure models in the literature have simply ignored it. To the best of my knowledge, the most closely related work to mine is Fisher and Gervais (2008), where they show that an increase in idiosyncratic income risk and marriage instability (delayed entry into and greater exit from marriage) are sufficient to account for most of the decline in young home ownership. My work differs from theirs in many aspects. Firstly, in their set up, geographic instability is exclusively determined by marital status changes, while in my case, mobility is more general and implicitly includes many other factors since it is consistent with actual data on U.S. life cycle geographic mobility. Secondly and most importantly, it is obvious that they are tackling a different issue associated with housing market dynamics.

The rest of the chapter is organized as follows. In the next section, I describe the environment; Section 3 defines the household’s problem ; Section 4 characterizes the stationary equilibrium. In section 5, I describe the model calibration in detail. Section 6 presents the results and analysis.
2.2 The Environment

The economy is a life cycle dynamic general equilibrium model with income uncertainty, extended to allow for housing investment, a rental market and collateralized debt. Time is discrete and there is a continuum of households of measure 1 at each date. Households are heterogenous due to their age \(a\) and cannot live more than \(T\) periods. Each household works until the retirement age, \(\hat{T}\) and subsequently receives a pension \(P\) until death. A household of age \(a\) survives from age \(a\) to age \(a + 1\) with probability \(\alpha_a\) where \(\alpha_0 = 1\) and \(\alpha_T = 0\). I assume a law of large numbers so that \(\alpha_a\) is also the deterministic fraction of households of the age cohort \(a\) that will survive to age \(a + 1\). Every period, a measure of newborns \(\mu_1\) enters the economy so that
the total population is constant. The fraction of people who belong to the age cohort \( a \in \{1...T\} \), is recursively defined as \( \mu_{a+1} = \alpha_a \mu_a \), where

\[
\mu_1 = \left( 1 + \sum_{i=1}^{T-1} \prod_{j=1}^{i} \alpha_j \right)^{-1}.
\]

(2.1)

2.2.1 Household Preferences and Endowments

Households receive utility from consumption \( c \) and housing services \( s \). They also value leaving housing and asset equities to their heirs. The momentary utility function is:

\[
U(c, s) = \log(c) + \chi \log(\theta s),
\]

(2.2)

Here \( \theta = 1 \) and \( s = h' \), if the household chooses to become (or remain) a homeowner and consumes a quantity \( h' \) of housing services. Otherwise, \( \theta < 1 \) and \( h' = 0 \) (the household rents \( s \) housing services). Hence, the household gains more utility from owning a home, as in Iacoviello and Pavan (2011), Rosen (1985) and Poterba (1992).

The assumption of additively separable logarithmic preferences over consumption and housing dramatically simplifies computations. Moreover, it is consistent with the findings of Davis and Ortalo-Magne (2011), according to which, the expenditure share on housing is roughly constant, over time and across U.S cities.

To capture the illiquid aspect of owned housing, I impose two restrictions. Firstly and most importantly, I assume that a homeowner has to pay a transaction cost
whenever he adjusts his housing stock\footnote{I assume that only home owners are responsible for paying transaction costs. However, in reality, both buyer and seller are supposed to pay a part of the total transaction costs. Having said this, in practice, those costs are negotiable and usually handled as a matter of local tradition. Overall, sellers cover an important part of the closing costs that buyer is responsible for (known as seller concessions or seller contributions).}

\[ \Lambda(h', h) = \psi h, \text{ if } |h' - h| > 0. \]

Secondly, I assume a minimum housing quantity, $h$, such that a renter who wants to become an owner has to purchase at least $h$ and an owner who wants to keep his tenure status unchanged, has to hold a minimum house size $h$.\footnote{When I numerically solve the model, I also impose a minimum housing adjustment quantity. Indeed, $h'$ is not treated as a continuous variable that can take any value, it is more a discrete variable: a small grid.} As in Gervais (2002) and Iacoviello and Pavan (2011), I do not impose such a restriction on renter units.\footnote{For instance, renters can share housing units. Overall, the rental housing supply is very flexible.}

Individuals are endowed with one unit of labor in each period which they supply inelastically in the labor market at a wage rate $w$. The labor productivity of an individual of age $a$ is $\epsilon_a z$, where $\{\epsilon_a\}_{a=1}^T$ is the deterministic age specific component, and $z$ is a labor efficiency shock following a Markov process: $z \in \{z_1, z_2, \ldots, z_N\}$ with transition probabilities $\pi(z'|z)$ and a stationary distribution $\Pi(z)$.

Pensions are fully financed by government revenues from a lump-sum tax $\tau$ collected from workers. I assume that a household starts his life with initial endowments of capital and housing $k_0 = h_0 = 0$. Accidental bequests are assumed to be uniformly distributed among all households currently alive. $B^k$ and $B^h$ denote, respectively, transfers of accidental bequests of capital and housing stock from deceased households in the last period. I assume that households receive the housing bequest transfers at no cost.
Mobility shocks:

I assume that homeowners are subject to taste shocks that induce them to leave their houses and rent for at least one period, otherwise their utility will be driven to $-\infty$. This taste shock is interpreted as a mobility shock that forces a household to leave the city where he lives to a new one. Since my model is a one city representative framework, I do not model the mobility shocks explicitly. However, in an environment with multiple cities, one could assume that a household is not allowed to have access to a housing market more than once in each period. Then, if a homeowner experiences a mobility shock, he will be deprived from purchasing housing during the first period in the new city. Renters will not be affected by these shocks since they can always buy a house if they want. Let $\lambda_a$ be the probability of experiencing the mobility shock for a household of age $a$.

2.2.2 Production

The production sector is relatively standard. The goods market is competitive and characterized by a constant returns to scale production function:

$$Y = AK^\alpha L^{1-\alpha},$$

(2.3)

Where $K$ and $L$ are aggregate inputs of capital and labor, respectively. The final good can be either consumed or costlessly transformed into new residential and non-residential capital. Given that the production technology exhibits a constant returns to scale, the number of firms in the equilibrium is indeterminate. Hence, without loss of generality, I assume that firms minimize their costs, $qK + wL$, subject to (2.3).
In equilibrium, free entry implies that goods prices adjust so that profits are zero. I assume that the price of the final good is normalized to 1. Thus, in a competitive equilibrium, the prices of all goods are all equal to one and the capital rent, $q$, and the labor wage, $w$ are defined as:

$$q = \alpha A \left( \frac{K}{L} \right)^{\alpha-1},$$  \hspace{1cm} (2.4)$$

$$w = (1 - \alpha) A \left( \frac{K}{L} \right)^{\alpha},$$  \hspace{1cm} (2.5)$$

### 2.2.3 Intermediate Financial and Housing Markets

There are two intermediate zero-profit markets:\[12\]

- **Competitive financial sector**: A representative financial agency collects deposits from households (investors) and uses these funds to make loans to firms and households (borrowers). In competitive equilibrium, the interest rate:

  $$r = q - \delta_k,$$  \hspace{1cm} (2.6)$$

  where $\delta_k$ is the depreciation rate of physical capital $k$.

- **Competitive housing rental market**: A representative real estate firm buys some of the final good, converts it into rental housing capital at no cost and rents it

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\[12\] In addition to the market for owner-occupied housing.
to tenants at the rental price $p$. The no arbitrage condition implies that:

$$p = \frac{r + \delta_h}{1 + r},$$

(2.7)

where $\delta_h$ is the depreciation rate of housing $h$.

Note that the present net cost of consuming one unit of housing services during a period via a housing purchase is $1 - \frac{1 - \delta_h}{1 + r} = \frac{r + \delta_h}{1 + r}$, which is exactly the same net cost of consuming one unit of housing services during a period via the rental market.\(^{14}\) However, renters can adjust their housing consumption without paying transaction costs. Moreover, relatively poor households can rent small units since there is no minimum size for rental units. On the other hand, owning has several advantages over renting. First, owning provides more satisfaction to the household than renting ($\theta < 1$). Second, housing can be used as collateral to borrow money (collateral value). Hence, both rental and purchasing housing demands can be non negative.

### 2.3 Household’s Problem

Given the absence of any aggregate uncertainty, I focus on a stationary equilibria in which prices, wages and interest rate are constant through time. The state variables of the model are: capital holdings $k$, housing wealth $h$, productivity $z$, and the mobility shock $m$. Letting $x = \{k, h, z, m\}$ denote the state vector, the problem of a household

\(^{13}\)The present value of investing one unit of capital in the rental housing market, $p + \frac{1 - \delta_h}{1 + r}$, should be equal to the present value of investing one unit of capital in financial market which is $\frac{1 + r}{1 + r} = 1$.

\(^{14}\)However, if we consider the fact that a household can die next period with a probability $\alpha_{a+1}$, the present net cost of owning one unit of housing will be slightly higher that the cost of renting: $p + \frac{(1 - \alpha_a)(1 - \delta_h)}{1 + r}$.
of age $a$ can be written recursively as:

$$W_a(x) = (1 - m) \cdot \left\{ \max_{D \in \{0,1\}} \{ D \, W^\omega_a(x) + (1 - D)W^r_a(x) \} \right\} + m \, W^r_a(x), \quad (2.8)$$

where $W^\omega_a$ and $W^r_a$ denote the value functions when the household of age $a$ owns and rents, respectively. The indicator variable $m$ takes the value 1 when the owner experiences a mobility shock requiring him to move to another city and takes the value 0 otherwise. For renters, $m$ is always 0. Hence, when $m=1$, the household (homeowner) sells his housing stock and rents for the current period. The variable $D$ is a choice variable that takes the value 1 when the household chooses to become (remain) a homeowner and 0 otherwise.

The net income of an agent of age $a$ is defined as $y_a = w \, \epsilon_a z - \tau$, for $a < \hat{T}$ and $y_a = P$, for $a \geq \hat{T}$. I also assume that agents cannot borrow when they reach the age $T$ so that $k' = 0$ for $a = T$. Households receive utility from discounted bequeathing wealth $Q_w$, where $\phi$ controls the strength of the bequest motive, $1 - \alpha_a$ is the probability that the household dies the next period and $\beta$, represents the time discount factor. The bequest motive is introduced in order to avoid a sharp decline in home-ownership late in life, which could represent a potential source of bias.

**Value of being a homeowner:**

The problem faced by a homeowner consists of choosing consumption, house size and savings, and can be expressed recursively as:

\textsuperscript{15}For $h=0$, $m$ is automatically set to 0.
A household can borrow up to a percentage \((1 - \kappa)\) of the value of his new housing stock, where \(0 \leq \kappa \leq 1\). Hence, this constraint can also be interpreted as a downpayment constraint for housing purchases which is equivalent to a fraction \(\kappa\) of the value of the home being purchased. The bequeathing wealth \(Q_w\) includes the net values of housing stock and capital holdings. To finance his consumptions spending, his capital investment, his housing investments and transactions costs (if any), a household uses his labor income, his return on invested capital, and the accidental bequest transfers. The indivisibility constraint implies that any house a household buys must have a minimum size of \(\bar{h}\). I implicitly assume that a household who chooses to purchase housing capital \(h'\), he begins enjoying housing services from it immediately.
CHAPTER 2. RENTING VS BUYING A HOME: ...

Value of renting:

The problem faced by a renter consists of choosing consumption, rental housing services and savings, and can be expressed recursively as:

\[
W_a^r(x) = \max_{c,k',s} \left\{ U(c, s) + \beta (1 - \alpha_a) \phi \log(Q_w) + \beta \alpha_a \sum_{z'} \pi(z' | z) \ W_{a+1}(k', 0, z', 0) \right\}
\]

(2.10)

\[
c + k' + p s + \Lambda(0, h) = y_a + (1 + r)(k + B_k) + (1 - \delta_h)(h + B_h)
\]

\[
k' \geq 0, \quad c \geq 0 \quad s \geq 0 \quad \text{and} \quad h' = 0.
\]

A renter has no collateral to obtain loans \((k' > 0)\). He pays the rental price \(p\) and may also pay the transaction cost if he was a homeowner the previous period \((h > 0)\). However, he will not be affected by mobility shocks next period and can potentially own a home, unlike a current owner who can find himself forced to rent the next period with probability \(\lambda_{a+1}\).

2.4 Stationary Equilibrium

Given that there is no aggregate uncertainty in the economy, I focus on a stationary equilibrium in which prices, wages and the interest rate are constant through time. At the beginning of each period a household is characterized by his capital holding \(k\), his housing stock \(h\), his age \(a\), labor productivity \(z\) and his owning taste shock (mobility shock) \(m\). In the stationary equilibrium, \(\Phi(k, h, a, z, m)\), the measure of
agents of type \((k, h, a, z, m)\), is constant.

**Definition**

A stationary equilibrium consists of a collection of value functions \(\{W_a(x), W_o(x), W_r(x)\}\), policy functions \((c, k', h', s, D)\), aggregate quantities \(L, K, H_o, H_r\), taxes \(\tau\), pensions \(P\), accidental bequest transfers \(\{B^k, B^h\}\), prices \(\{w, q, r, p\}\) and a law of motion \(\Gamma\) such that:

- All economic actors optimize their profits and utilities subject to \[2.4, 2.5, 2.6\] and \[2.7\].
- Labor is supplied inelastically in the model and satisfies:

\[
\int \epsilon_a z \, d\Phi = L, \tag{2.11}
\]

where \(L\) is the fixed labor supply.
- Markets clear:

Goods market clearing implies that:

\[
C + \delta_k K + \delta_h H_o + pH_r + \int \Lambda(k'(x, a), h) \, d\Phi = Y, \tag{2.12}
\]

where \(C, K, H_o,\) and \(H_r\) represent aggregate consumption, aggregate invested capital, aggregate owned housing stock, and aggregate rented housing stock, defined as:

\[
C = \int c(x, a) \, d\Phi, \tag{2.13}
\]
\[ K = \int k'(x, a) \, d\Phi, \quad (2.14) \]

\[ H^o = \int D(x, a)h'(x, a) \, d\Phi, \quad (2.15) \]

\[ H^r = \int [1 - D(x, a)]s(x, a) \, d\Phi, \quad (2.16) \]

\[ H = H^o + H^r, \quad (2.17) \]

- Accidental bequest transfers satisfy:

\[ B^k = \int [k'(x, a) - k] \, d\Phi, \quad (2.18) \]

\[ B^h = \int [h'(x, a) - h] \, d\Phi, \quad (2.19) \]

In the stationary equilibrium, the accidental bequest is simply the difference between the total capital at the end of last period and the total capital at the beginning of the current period.

- The government provides retirement benefits through a social security program, financed by taxes collected from working households. Government budget balance implies that:

\[ \sum_{a=1}^{\hat{T}} \omega_a \tau = \sum_{a=\hat{T}+1}^{T} \omega_a P \quad (2.20) \]
where \( \varpi_{\tilde{a}} = \int d\Phi(k, h, a = \tilde{a}, z, m) \).

- The measure \( \Phi \) satisfies: \( \Phi = \Gamma(\Phi) \), where \( \Gamma \) is the law of motion generated by policy functions \( h' \) and \( k' \), the transition probabilities \( \pi(z'|z) \) and the age dependent mobility probabilities \( \{\lambda_a\}_{a=1}^{T} \).

I compute the stationary equilibrium of the model using a standard backward induction method for solving overlapping generations models. However, I proceed with a new method on how to define the capital grid that allows households to borrow up to the limit \((1 - \kappa)h'\) when buying a house, without being forced to use a huge grid (See Appendix A for more details).

### 2.5 Calibration

I calibrate the baseline model to match some long-run averages of the U.S. economy as well as several demographic features. It is not trivial to precisely match all these targets at the same time. However, after performing a sensitivity analysis, I was able to identify which parameter(s) should be used to target each ratio.

#### 2.5.1 Demographics

The unit of time is one year. Households become economically active at the age of 20 and die no later than age 100. The deterministic age profile of the unconditional mean of labor efficiency for males aged 21-65 is taken from Hansen (1993) (see Figure 2.2). Population numbers and survival probabilities are from Faber (1982)(see Figure 2.3).
CHAPTER 2. **RENTING VS BUYING A HOME:**

Figure 2.2: Deterministic wage efficiency profile

Figure 2.3: Survival Probabilities
2.5.2 Macroeconomics Evidence

The parameter $\alpha$ is set at 0.3 to match the U.S. share of labor in total income of 70% while $\beta$ and $\delta_k$ are chosen to match a ratio of capital to output ($\frac{K}{Y}$) between 2 and 2.2\(^{[19]}\) and a steady state interest rate $r$ equal to 3%.

2.5.3 Housing

The parameters $\chi$ and $\delta_h$ are chosen to match a ratio of the housing stock to output ($\frac{H}{Y}$) of around 1.4 and a ratio of housing investment to the housing stock ($\frac{I_h}{H}$) of around 0.07\(^{[17]}\). The bequest motive parameter $\phi$ is calibrated so as to prevent any potential sharp decrease in ownership rates of the oldest agents. Indeed, when there are no bequest incentives, the oldest individuals would naturally prefer to sell their houses and increase their current and future consumption. However, this parameter seems to have a very small impact on the aggregate ownership rate. $\phi$ is set to match the slope of the ownership curve at the end\(^{[18]}\).

The owning utility parameter $\theta$ is set to obtain an adjusted aggregate ownership rate of 65%. The data on mobility and home-ownership rates (as a function of age)\(^{[19]}\) corresponds to the year 2009. However, I am using an age distribution that

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\(^{[16]}\)Iacoviello and Pavan (2011) and Silos (2007).

\(^{[17]}\)These values are in accordance with the National Income and Product Accounts and the Fixed Assets Tables.

\(^{[18]}\)The degree of the impact of $\phi$ on the shape of the last part of the ownership curve appears to be extremely unstable. Indeed, when $\phi = 0$, the curve steeply decreases after the age of 85 and for $\phi$ greater than 0.1, the ownership rates for old agents jump to unrealistically high values: 100%. However, any value between those two extreme cases generate almost the same ownership pattern for old agents.

\(^{[19]}\)Data on home-ownership rates as a function of age is obtained from United States Census Bureau (Table17: Housing Vacancies and Home-ownership (CPS/HVS))
corresponds to a different year (Faber 1982). Hence, I cannot simply target the reported aggregate ownership rate of 2009. For consistency purposes, I compute a new adjusted aggregate ownership rate target by weighting ownership rates of different age cohorts of 2009 by the same age distribution used in the model. The adjusted aggregate ownership target is around 65% instead of the actual one which is 67%.

These manipulations do not have a significant impact on my qualitative and even quantitative results since I am mainly interested in studying the life cycle impacts. Actually, when I use the U.S. Decennial life tables for 1989-1991 instead of Faber 1982, the results do not change. This is mainly because of the fact that the survival probabilities remained almost unchanged, except for a slight variation in the survival probabilities of the very old households. This, by the way, has no significant impact since the bequest motive parameter is calibrated to match the last part of the ownership curve.

The downpayment parameter is set at $\kappa = 0.15$. I will change this parameter in order to assess its impact on the ownership rate of different age cohorts and, more specifically, for young households.

The minimum house size available for purchase, $h$, costs 1.5 times the average annual pre-tax household income, as in Iacoviello and Pavan (2011). This parameter seems to have no impact on results. It is true that when I set it at lower values, the aggregate ownership rate increases but when I recalibrate $\theta$ to match the target, I end up with very similar results. The housing transaction cost is set at $\psi = 5\%$ of

---

20Which was also derived based on an estimation technique different from what is typically used for the computation of actual aggregate ownership rates.

21Hence, we might think that the increase in the U.S. population ageing is one of the reasons of the rise of the ownership rate in the United States. Indeed, this will be confirmed in section 6.5.

22The survival probabilities presented in those tables are based on age-specific death rates calculated using data from the 1990 census of population and deaths occurring in the United States in the 3 years proximate to the 1990 census (i.e., 1989-1991).
the value of housing (National Association of Realtors).

### 2.5.4 Geographic Mobility

Data on mobility is obtained from the United States Census Bureau (Table 1-01: Geographical Mobility: 2009 to 2010). The mobility rate, as a function of age, is calculated based on the proportion of movers belonging to the same age cohort.\[23\]

As may be seen in Figure 2.1, mobility is sharply decreasing in age, especially for households under 50 years. However, one can argue that mobility rates are relatively high for young households not because of their age but rather because of their housing tenure status. In fact, most young households are renters, which might explain why they have higher mobility rates. To address this issue, I use data from Table 7-01 of the same survey showing that the degree of mobility for young renters is much higher than it is for old renters (and the same is true for owners). Hence, there is no doubt that mobility does depend on age regardless of housing tenure status.

It is also true that, mobility rates for owners are clearly lower then those for renters of the same age. Having said that, the "opportunity" to move depends only on age and does not depend on tenure status. In fact, geographical mobility is mainly induced by new job offers and/or by new marital status. Such changes are more likely to affect young agents than old households. However, the acceptance of an "opportunity" does depend on tenure status; an owner may be less willing to accept an offer and move\[24\] while a renter is more likely to accept the offer. That’s why mobility is

---

\[23\] Moving includes moving toward a new county, a new state, a new division, a new region or abroad.

\[24\] Mainly because of the associated illiquidity cost of house selling. Moreover, owners have relatively high moving costs since they, usually, make important investments in furniture and other housing related assets.
higher for owners than it is for renters of the same age.

To relate this intuitive interpretation to my set up, we should remember that my model imposes an important restriction: Agents (renters and owners) have to move once they are subject to a mobility shock. In other words, they are not allowed to make decisions on whether to stay or move (accept the offer or reject it). In order to take this fact into account, I simply interpret the mobility shocks as the average mobility rates of owners and renters of the same age. Indeed, my model, by construction, does not allow me to study the tenure impact on geographic mobility.\footnote{I will vary this assumption later in Chapter 3}

\subsection*{2.5.5 The Earnings Process}

The idiosyncratic shock to labor productivity is specified as:

\begin{equation}
\log z_t = \rho_z \log z_{t-1} + \sigma_z \left(1 - \rho_z^2\right)^{\frac{1}{2}} \varepsilon_t, \quad \varepsilon_t \sim N(0, 1).
\end{equation}

This AR(1) equation can be approximated with an $N_z$-state Markov process. There is a vast literature on how to specify this process as well as on how to set the parameters. Researchers have used different values for the calibration of the unconditional variance $\sigma_z^2$ and the persistence parameter $\rho_z$. In the housing literature, authors usually refer to previous empirical studies on the wealth distribution, such as Hugget (1993) or Storesletten Telmer and Yaron papers (1994, 1999, 2001, 2004a, 2004b, 2007) or others. However, these papers do not necessarily use the same economic environment as I do (or as other housing papers do), and may use different estimation strategies (different age-dependent component, variables included in the estimation
Hence, it is not always appropriate to simply use their estimated parameters and impose them into any model. In this regard, recall that one of my main objectives in this project is to accurately replicate the actual data on homeownership. Thus, I calibrate $\sigma_z$ so that the earnings GINI coefficient implied by the model matches its counterpart in the data (0.404).\textsuperscript{27} It is worth noting that when I use the same grid and the same transition matrix used in Fernandez-Villaverde and Krueger (2005) to approximate the labor productivity process, the implied earnings GINI coefficient drops to 0.29 which is significantly lower than the real one.

The calibration of the persistence parameter $\rho_z$ is less challenging given that the unconditional variance is fixed. Nevertheless, recent empirical studies have been in favor of using a higher persistence parameter. Indeed, some studies have not rejected the hypothesis of a unit root. Yet, as the process becomes more persistent and closer to a unit root, the accuracy of the Markov approximation deteriorates. I chose $\rho_z$ so that the fraction of liquidity constrained households is not below 20%.\textsuperscript{28} An approximation with a large state space would be desirable, though it would have high computational costs. After several computational exercises, I choose to set $N_z = 5$.\textsuperscript{29}

Having said this, in reality, households of different ages do not necessarily face the same labor income shocks (age-invariant persistence and variance). Indeed, young households are more likely to face less persistent income shocks due to their high job

\textsuperscript{26}For instance, Storesletten Telmer and Yaron (2007) used a regime-switching conditional model, which is not the case for most of housing models
\textsuperscript{27}U.S. Census Bureau: Table IE-2:Measures of Individual Earnings Inequality for Full-Time, Year-Round Workers by Sex: 1967 to 2010
\textsuperscript{28}Hall (2011) and Iacoviello and Pavan (2011)
\textsuperscript{29}I will increase the number of states $N_z$ to 11 in Chapter 3.
mobility. However, the variance of these moderate persistent shocks is expected to be relatively high given their high wage growth rates. In fact, Karahan and Ozkan (2012) argue that the standard specification in the literature that assumes age-invariant persistence and variance of income shocks cannot capture the earnings dynamics of young workers. Indeed, they find that young workers face moderately persistent earnings shocks and that the variance of income shocks exhibits a U-shaped profile over the life cycle.

Based on these results, I could have calibrated the income process for each age cohort (young, middle aged, and old) to match the corresponding earnings GINI coefficient. However, I think this will have little effect on my results. In fact, the model, already, perfectly replicates the U.S. ownership curve. Moreover, according to my findings, young households are not very influenced by changes in income risk. Based on these results, I could have calibrated the income process for each age cohort (young, middle aged, and old) to match the corresponding earnings GINI coefficient. However, I think this will have little effect on my results. In fact, the model, already, perfectly replicates the U.S. ownership curve. Moreover, according to my findings, young households are not very influenced by changes in income risk. Based on these results, I could have calibrated the income process for each age cohort (young, middle aged, and old) to match the corresponding earnings GINI coefficient. 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There are many methods to approximate the process (Tauchen’s (1986), Tauchen and Hussey’s (1991), Rouwenhorst (2010) etc.). Based on simulation tests, the Markov method turns out to be the most efficient procedure for my case. This is in line with Floden (2007)’s findings that suggests using Tauchen’s (1986) method in the case of highly persistent processes.

\[^{30}\text{See 2.6.4.}\]
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Table 2.1: Calibration

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival probabilities</td>
<td>$\alpha_a$</td>
<td>Figure 2.3</td>
</tr>
<tr>
<td>Deterministic age specific component</td>
<td>$\epsilon_a$</td>
<td>Figure 2.2</td>
</tr>
<tr>
<td>Capital share</td>
<td>$\alpha$</td>
<td>0.3</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>0.9758</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>$\delta_k$</td>
<td>0.094</td>
</tr>
<tr>
<td>Weight on housing in utility</td>
<td>$\chi$</td>
<td>0.16</td>
</tr>
<tr>
<td>Housing depreciation rate</td>
<td>$\delta_h$</td>
<td>0.043</td>
</tr>
<tr>
<td>Bequest motive parameter</td>
<td>$\phi$</td>
<td>0.055</td>
</tr>
<tr>
<td>Housing transaction cost</td>
<td>$\psi$</td>
<td>5%</td>
</tr>
<tr>
<td>Utility parameter (Renting Vs Owning)</td>
<td>$\theta$</td>
<td>0.76</td>
</tr>
<tr>
<td>Downpayment parameter</td>
<td>$\kappa$</td>
<td>0.15</td>
</tr>
<tr>
<td>Minimum size house available for purchase</td>
<td>$h$</td>
<td>1.5 Avg inc</td>
</tr>
<tr>
<td>Mobility shock probabilities</td>
<td>$\lambda_a$</td>
<td>Figure 2.1</td>
</tr>
<tr>
<td>Unconditional standard deviation of $\log(z_t)$</td>
<td>$\sigma_z$</td>
<td>0.637</td>
</tr>
<tr>
<td>Persistent parameter of $\log(z_t)$</td>
<td>$\rho_z$</td>
<td>0.925</td>
</tr>
</tbody>
</table>

2.6 Results

2.6.1 Baseline Model (Figure 2.4)

Table 2.2 compares the the baseline model with the data, where the variables in the bottom are obtained by calibration.
### Table 2.2: Baseline Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>0.95</td>
<td>-</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.76</td>
<td>-</td>
</tr>
<tr>
<td>Constr$_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>1.1%</td>
<td>-</td>
</tr>
<tr>
<td>Liquid$_f$</td>
<td>Fraction of liquidity constrained households</td>
<td>29.37%</td>
<td>20% or more</td>
</tr>
<tr>
<td>Ownership$_y$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>42.66%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Ownership$_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>74.11%</td>
<td>73.83%</td>
</tr>
<tr>
<td>Ownership$_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>82.40%</td>
<td>80.8%</td>
</tr>
<tr>
<td>$O/\text{Ownership}$</td>
<td>Ratio of the owned housing stock to the rented one</td>
<td>3.9</td>
<td>3</td>
</tr>
<tr>
<td>$r$</td>
<td>Aggregate ownership rate</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>Equilibrium interest rate</td>
<td>3%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>$H/Y$</td>
<td>Ratio of housing to output</td>
<td>1.53</td>
<td>[1.4, 1.55]</td>
</tr>
<tr>
<td>$K/Y$</td>
<td>Ratio of capital to output</td>
<td>2.4</td>
<td>[2, 2.5]</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td><strong>0.404</strong></td>
<td>0.404</td>
</tr>
</tbody>
</table>

I will start first by defining some of the variables in Table 2.2. The fraction of financially constrained house buyers is the percentage of buyers who borrow exactly a fraction $(1 - \kappa)$ of the value of the house being purchased. It does not include owners who upgrade their housing stock.

The fraction of liquidity-constrained households is the percentage of households in the economy who are liquidity constrained. Following Hall (2011) and Iacoviello and Pavan (2011), I consider a household to be liquidity constrained if his holdings of net liquid assets are less than two months (16.67% on an annual basis) of income, where liquid assets are defined as: $(1 - \kappa)h' + k'$.

According to The Berkeley Electronic Press (2007), the average ratio of the stock of residential capital that is owned to that which is rented in the U.S. economy during the period 1987-2005, $O/H_r$, is around 3.
Figure 2.4 compares the home-ownership curve as a function of age predicted by the baseline model to that implied by the data. Note that here and for the rest of this chapter, panel (a) in figures with two panels reports the life cycle curves of the exact values predicted by the model, while panel (b) reports the smoothed versions. Given the heavy computational cost of using a higher value of $N_z$, the ownership curves, especially for the first age cohorts, show some undesirable fluctuations. In order to obtain smoother curves, I perform a simple moving average filter on the simulated rates. This manipulation does not seem to have a big impact on the predicted rates nor on the general curve shapes.

According to Table 2.2 and Figure 2.4, the baseline model does a very good job in replicating the life cycle ownership rates. The differences between age cohorts rates are close to their empirical counterparts. Despite the fact that I have only targeted the aggregate ownership rate, the model’s accuracy in matching the life cycle ownership rates is outstanding and can be considered as a novel achievement. Having said this, the baseline model overpredicts the ratio of the owned housing stock to the rented one (3.9 vs 3).

\(^{31}\)More specifically for Figures 2, \{4,8,9,11,13 and 14\}. 
Figure 2.4: Ownership rate: Model (Baseline Calibration) Vs Data
• **Life cycle patterns:** Figures 2.5 and 2.6 plot individual life-cycle profiles for a typical middle class household and for a random rich household (owners). A typical middle class household is assumed to always earn the median income given the age group to which he belongs. The simulated patterns are very realistic: A typical middle class household buys his first (and last) house at the age of 32 and finishes repaying his loan (60% of the house value) at the age 41. Then, he increases his savings until the retirement age when he starts to increase his consumption and decreases his savings until he becomes liquidity constrained (borrows up to 85% of the value of his small house). The rich household starts his life as a renter and increases his savings until he buys his first house at the age of 25 (with a loan equivalent to 65% of the home price). The rich household increases his housing stock twice during his life, at the age 34 and 52. At age 84, he sells his large house and buys a smaller one. Obviously, the poorest households in this economy remain renters and never have the opportunity to own a house.
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Figure 2.5: A Typical Life-cycle Profile

(a) Housing

(b) Debt

Figure 2.5: A Typical Life-cycle Profile
Figure 2.6: A Typical Life-cycle Profile: A rich household


2.6.2 Is Mobility Important?

2.6.2.1 Experiment: Baseline model without mobility (Figure 2.7)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr_f</td>
<td>Fraction of financially constrained house buyers</td>
<td>37.79%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Liquid_f</td>
<td>Fraction of liquidity constrained households</td>
<td>29.68%</td>
<td>29.37%</td>
</tr>
<tr>
<td>Ownership_y</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>61.63%</td>
<td>42.66%</td>
</tr>
<tr>
<td>Ownership_m</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>83.72%</td>
<td>74.11%</td>
</tr>
<tr>
<td>Ownership_o</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>89.28%</td>
<td>82.40%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>77.23%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Geographic mobility affects the household’s tenure decision through two different channels. The first effect is related to the transaction costs that a homeowner would pay when experiencing a mobility shock forcing him to move and sell his house. The second effect consists in the fact that the same homeowner will be also deprived from the option of buying a house during the first period following the shock. Thus, removing mobility shocks will certainly encourage homeownership.

According to Table 2.3 and Figure 2.7, geographic mobility has, indeed, a significant impact on the aggregate ownership rate. In fact, without mobility shocks, the aggregate rate of ownership rises from 65% to 77.23%.

32Beside this endogenous impact of mobility on home ownership, there exists another effect which is more mechanical and straightforwardly related to the assumption made on mobility. Indeed, when a homeowner experiences a mobility shock, he is obliged, by assumption, to rent for one period. Then, all else equal, if mobility shocks are removed from the economy, there will be less renters in the steady state. Hence, by construction, mobility has a mechanical negative impact on ownership rate, regardless of any other endogenous implication. To assess the relative importance of this effect, I compute new ownership rates by, simply, treating the forced renters (owners being hit by mobility shock) as if they remain owners. Even in this case, the endogenous impact of mobility is still significant and it is slightly more important than the mechanical one.

In the real world, some owners are, indeed, obliged to rent after moving from a city (or a state) to another due to the illiquidity aspect of housing. However, the fraction of these "temporary renters" could be less than what it is implied by the model.
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Figure 2.7: Ownership rate: Model (Without Mobility) Vs Baseline
It is important to note that the impact of mobility on the housing tenure decision is asymmetric with regard to the household’s age. The largest impact is seen in households aged between 20 and 41: their aggregate ownership rate increases from 42.66% to 61.63%. The intuition is straightforward; mobility rates are higher for young agents. This rise in ownership rates of young agents will be partially transmitted to older generations. The important rise in ownership rates explains the steep increase in the fraction of constrained house buyers from 1.1% to 37.79%.

Thus, geographic instability is an important reason that may explain why proportionately more young households choose to rent rather than to buy a house.

2.6.2.2 New Calibration Without Mobility: Model II (Figure 2.8)

In this section, I calibrate a new version of the model without mobility shocks in order to assess the relative importance of geographic instability in matching the data with a high level of accuracy. I also investigate whether or not the downpayment constraint can explain the low ownership rates among young households in an environment without mobility shocks.

If we compare Figures 2.4 and 2.8, we can conclude that the baseline model is more effective in matching the U.S. ownership rate curve, than model II. Although the difference between the two simulated curves is not that big, except for young households, Model II predicts an owned-rental housing stock ratio $H_o/H_r = 4.9$, which is relatively far from the data, compared to the baseline model (3.9). Hence, the baseline model is also more effective in matching the U.S. housing evidence.

It is also worth noting that the calibration process becomes extremely difficult. Indeed, I was not able to exactly match the aggregate ownership rate (65%) despite

---

$^{33}$Long term impact (stationary equilibrium).
many attempts to reach the target. It seems that the tenure decision is very sensitive to $\theta$. Apparently, when the ownership premium is too low, the tenure decision becomes more sensitive and less robust. Indeed, in the case of no mobility shocks, I had to increase $\theta$ to a high value, close to one, in order to get an aggregate ownership rate of around 65%. Intuitively, we can conclude that ignoring geographic mobility can lead to the underestimation of the homeownership premium $(1 - \theta)$.

- **Model II: No downpayment requirement** $(\kappa = 0\%)$ (**Figure 2.9**)

This experiment consists in setting the downpayment parameter to zero, which means that households are now allowed to borrow up to 100% of the value of the purchased house.

---

With $\theta = 0.92489577$, the aggregate rate is 64.31% and with $\theta = 0.92489578$, it jumps to 65.8%. Even when I use a bigger capital grid, the calibration remains extremely difficult.
Figure 2.8: Ownership rate: Model II (Calibration without mobility) Vs Data
**Table 2.5: Model II ($\kappa = 0\%$)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Model II</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Constr}_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>$\text{Liquid}_f$</td>
<td>Fraction of liquidity constrained households</td>
<td>25.43%</td>
<td>26.63%</td>
</tr>
<tr>
<td>$\text{Ownership}_y$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>45.33%</td>
<td>42.65%</td>
</tr>
<tr>
<td>$\text{Ownership}_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>75%</td>
<td>74.36%</td>
</tr>
<tr>
<td>$\text{Ownership}_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>84.96%</td>
<td>79.75%</td>
</tr>
<tr>
<td>$\text{Ownership}$</td>
<td>Aggregate ownership rate</td>
<td>67%</td>
<td>64.31%</td>
</tr>
</tbody>
</table>

Despite the absence of any financial constraint to buy a house, the aggregate ownership rate only increases by 2.7%. In particular, the aggregate ownership rate of households aged between 20 and 41 has increased from 42.65% to 45.33%. Hence, I do not find the downpayment constraint to be an important reason for the relatively low ownership among young households.

In conclusion, geographic mobility seems to play a crucial role in explaining the low ownership rate among young agents. Modeling geographic instability is also important to accurately match the U.S. ownership rates’ curve.

![Figure 2.9: Ownership rate: Model II (Zero downpayment) Vs Model II](image-url)
2.6.3 The Downpayment Requirement Impact (Figure 2.10)

In this section, I perform several counter-factual experiments on the baseline model in order to assess the impact of the downpayment parameter on home-ownership rates.

<table>
<thead>
<tr>
<th>Description</th>
<th>$\kappa = 0%$</th>
<th>$\kappa = 25%$</th>
<th>$\kappa = 50%$</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of financially constrained house buyers</td>
<td>1.69%</td>
<td>11.36%</td>
<td>18.63%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Fraction of liquidity constrained households</td>
<td>27.31%</td>
<td>30.31%</td>
<td>31.2%</td>
<td>29.37%</td>
</tr>
<tr>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>42.7%</td>
<td>42.18%</td>
<td>37.42%</td>
<td>42.66%</td>
</tr>
<tr>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>74.3%</td>
<td>74.07%</td>
<td>71.51%</td>
<td>74.11%</td>
</tr>
<tr>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>91.82%</td>
<td>79.32%</td>
<td>72.23%</td>
<td>82.40%</td>
</tr>
<tr>
<td>Aggregate ownership rate</td>
<td><strong>67.67%</strong></td>
<td><strong>63.92%</strong></td>
<td><strong>59.26%</strong></td>
<td><strong>65%</strong></td>
</tr>
</tbody>
</table>

The first counter-factual experiment consists in assuming that there is no borrowing constraint faced by households who want to buy a house ($\kappa = 0$). Despite this fact, the aggregate ownership rate rises from 65% to 67.67% which is a small increase relative to what many might expect. However, recalling Table 2.2, such a slight increase was predictable since the fraction of financially constrained house buyers in the baseline model was only 1.01%. In fact, lowering the downpayment requirement should not be expected to have a big impact since there was only a very small percentage of borrowing constrained home buyers when the downpayment was 15%. Moreover, relaxing the downpayment constraint has an effect only on old households. Indeed, ownership rates for young and middle-aged households remain almost unchanged.

When the downpayment constraint becomes tighter ($\kappa = 25\%$), ownership rates remain almost unchanged for young and middle-aged households and decrease for old households (from 82.40% to 79.32%). However, the fraction of financially constrained
house buyers clearly increases from 1.1% to 11.36%. In the third experiment, I increase $\kappa$ to an unrealistically large value of 50%. As expected, the aggregate ownership rate decreases by around 6%. The biggest impact is on old agents, then the young households and finally the middle-aged.

Figure 2.10: Downpayment impact: $\kappa = \{0\%, 15\%, 25\%, 50\%\}$
To understand the intuition behind all these results, I need to analyze and track the effective downpayment paid by each age cohort. In order to avoid any potential bias that could be caused by home buyers who purchase a house after being subject to mobility shocks (which tends to amplify the average downpayment), I will focus on the minimum downpayment paid by every age group. We should also remember that the ownership curve always peaks before the retirement age. In such cases, the minimum downpayment paid by old households corresponds to the housing purchases made by elderly owners who had experienced a mobility shock during the previous period and were forced to rent. This explains the high minimum downpayments for this category of households.\footnote{For all the model versions, home purchases made by retired households correspond to the case of owners who experienced a mobility shock and had to rent for a period then buy a new house (except the case where $\kappa = 0$).}

According to Figure 2.11, I can conclude that, for the baseline case, most working households optimally choose to pay a downpayment higher than the minimum required. Hence, when $\kappa$ decreases, these agents are not influenced. After retirement age, renters do not generally invest in housing because of their low income since they receive the same relatively low pension $P$ for the rest of their lives. Indeed, an old poor renter is not ready to give up a significant quantity of his actual goods consumption in order to become a homeowner, given his low wealth and his relatively high probability of death. However, when the downpayment constraint is amply relaxed, many old poor renters, who, by construction, do not face any future earning uncertainty are better off borrowing almost all the money needed to buy a house without
being obliged to significantly decrease their current consumptions.\footnote{36} It is worth noting that a poor young or middle-aged household with the same wealth would prefer to rent and wait for a good earnings shock to buy a house. This explains the rise in the old households’ ownership rates and the decrease in the minimum downpayment paid by this category of households.

For the second experiment, the same intuition is still valid for young and middle-aged households. In fact, households who previously paid a downpayment less than 25% will simply increase their upfront cash to the new minimum required level and won’t change their decisions to become owners. Hence, we can conclude that the housing tenure decision for these two categories of household does not depend much on the downpayment constraint, but rather on risk factors like geographical instability and/or future income risk.\footnote{37} For retired households, an increase in the downpayment constraint is equivalent to a decline in the house value. Indeed, retired owners mainly use houses as collateral to borrow money in order to smooth their consumptions given their low income. Therefore, when $\kappa$ decreases, the amount that they can borrow also decreases, as well as the period over which they can smooth their consumption before becoming financially constrained. This explains why some relatively old poor owners sell their houses.

For the last case, the huge increase in $\kappa$ obviously affects ownership rates for all age categories. However, this impact remains small relatively to the sharp increase in the downpayment requirement.

\footnote{36}However, the poorest old renters do not change their tenure status. Indeed, the rental housing is more convenient for an extremely poor retired as he can choose to live in a relatively small house and spend less money compared to the case where he purchases a house given the minimum housing quantity constraint.

\footnote{37}Tenure decision of any household obviously depends also on his wealth.
I can conclude from all these results that the downpayment constraint is not a very important factor affecting a household’s decision to buy a house. Hence, the low ownership rates among young agents in the U.S. is not necessarily related to the downpayment requirement.

Figure 2.11: Minimum Downpayment as function of age: $\kappa = \{0\%, 15\%, 25\%, 50\%\}$

2.6.4 Earnings Uncertainty Impact

- Reducing the earnings standard deviation, $\sigma_z$, from 0.6371 to 0.5.  
  \((Figure 2.12)\)

The last counter-factual experiment consists in decreasing the earnings variance from
0.406 (Baseline model) to 0.25 in order to analyze the impact of a lower income risk on ownership rates.

Table 2.7: Baseline model ($\sigma_z^2 = 0.25$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr$_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>4.05%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Liquid$_f$</td>
<td>Fraction of liquidity constrained households</td>
<td>26.94%</td>
<td>29.37%</td>
</tr>
<tr>
<td>Ownership$_y$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>45.83%</td>
<td>42.66%</td>
</tr>
<tr>
<td>Ownership$_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>82.69%</td>
<td>74.11%</td>
</tr>
<tr>
<td>Ownership$_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>88.09%</td>
<td>82.40%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>70.77%</td>
<td>65%</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td>0.345</td>
<td>0.404</td>
</tr>
</tbody>
</table>

A decline in the individual earnings variance is equivalent to a decrease in the households’ income risk. Such a change makes households more willing to buy a large asset that is costly to change, relative to a world with higher income risk. In fact, households become less inclined to delay their switch from renting to owning. The intuition is straightforward: as the earnings variance declines, the utility cost of a negative idiosyncratic income shock decreases. Thus, households tend to buy their first houses at younger ages.

Beside this endogenous impact on the household’s tenure decision, the income variance could also have a direct impact on the aggregate ownership rate. Indeed, the decline of the earnings variance affects the earnings GINI coefficient; as $\sigma_z^2$ decreases, the income inequality decreases as well. However, all else equal, the change in the income distribution does not seem to have a very significant impact on the aggregate ownership rate. In fact, the decrease in income inequality implies that some categories of households will simply disappear; namely, the extremely rich and the extremely poor households. Being extremely or moderately rich, should not affect the tenure choice of being homeowner. Similarly, if a very poor household becomes slightly
wealthier, it is unlikely that he will change his tenure choice, especially, if we know that most of house buyers were not financially constrained.

The only remaining channel through which income inequality can affect the aggregate ownership rate is the implied change in the income distribution across households. Actually, there exists an earnings productivity cut-off value for each group of households of the same age and holding the same housing and capital stocks, such that any household experiencing a productivity shock higher than this critical value is better off owning than renting a home. The direction of the impact of the earnings’ variance on the proportion of homeowners for a specific households’ group depends on whether the corresponding cut-off value is greater or lower than the earnings shocks average.\footnote{In fact, the change in the income distribution will affect the proportion of households with earnings shocks greater than their corresponding cut-off values. For instance, if the cut-off values are lower than the earnings shocks average, all else equal, a decline in the variance of the earnings shocks distribution would increase the proportion of homeowners, and vice-versa.}

For the baseline model, these cut-off values are, in most cases, equal or lower than the earnings shocks average (except for very young and relatively poor households groups). Hence, all else equal, a decline in the income inequality is expected to have a small positive impact on the aggregate ownership rate.\footnote{However, since in this model the continuous earnings process is approximated with a $N_z$ discrete state Markov process, the effect described previously will be certainly underestimated. In order to accurately assess the impact of a change in the income distribution on the aggregate ownership rate, I need to substantially increase $N_z$, which would eventually incur extremely high computational costs. Even in a such case, the net impact of income inequality on ownership might be ambiguous and would depend on the household’s age and wealth (see Chapter 3).}

As one might expect, the aggregate ownership rate increases from 65% to 70.77%. The middle-aged households seem to be the the most influenced by the decline in income risk. In fact, their aggregate ownership rate increases from 74.11% to 82.69%, while the aggregate ownership for young households rises by only around 3%, which explains the relatively small increase in the fraction of financially constrained home
buyers. In fact, given the significant negative impact of geographic mobility on young households decisions to become homeowners, only the wealthiest among them choose to buy houses. Hence, it is not at all surprising that the decline in the income risk has no significant impact on the ownership rates of this category of young households.

Given that the income of retired households is constant, they are unaffected by the decrease in $\sigma_z$. Thus, the increase in their aggregate ownership rate is simply due to the transmitted rise in ownership rates of younger generations.

I therefore conclude that the low ownership rates among young households is mainly due to their limited financial resources as well as to their high mobility rates. On the other hand, the housing tenure decision for middle-aged households is strongly influenced by future income risk. As for retired households, they do not usually invest in housing; they would rather keep their housing stock constant or decrease it if they have large houses. The only case where they buy houses is when the downpayment constraint is amply relaxed.
Figure 2.12: Ownership rate: Baseline Model with Lower Earnings Variance Vs Baseline Model
2.6.5 Shift in the Homeownership Curve: 1993 VS 2009

Based on the previous findings, I propose a novel explanation for the long run increase in ownership rates over the last two decades. Contrary to what is commonly believed, the rise of the U.S. aggregate homeownership rate is not necessarily due to mortgage market innovations and the relaxation of downpayment requirements. Instead, it could simply be an implication of the demographic evolution of the U.S. society, most notably, population ageing and the decline in geographic mobility. Empirical evidence on mobility and U.S. population distribution are in line with this hypothesis. This is demonstrated in Figures 2.13 and 2.14 which illustrate mobility rates and population distributions, respectively, for 1993 and 2009. Obviously, there has been a shift in the U.S. population distribution toward older ages; a decline in the proportion of young households and a rise in the proportion of the population that is elderly. More importantly, geographical mobility in the U.S. has significantly declined, especially for young households.

This brings up the following question: To what extent can the U.S. population ageing and the decrease in geographical mobility together, explain the rise in the aggregate ownership rate between 1993 (64.5%) and 2009 (67.4%), given the increase in income risk that has also been noticed over the same period? To answer this question, I calibrate a version of the model using 1993’s data on mobility and population distribution, to match an aggregate ownership rate of 64.5% and an earnings GINI coefficient of 0.389, for that year. Then, I conduct a counter-factual experiment by using 2009’s data on mobility, population distribution and income risk.

40The population distributions are derived based on the Life Tables for males: U.S. Department of Health and Human Services
CHAPTER 2. RENTING VS BUYING A HOME: ...

Figure 2.13: Age Distribution: 1993 VS 2009

Figure 2.14: Mobility Rates: 1993 VS 2009
According to the experiment results, the simulated aggregate ownership rate has increased from 64.5% to 66.6%. Hence, the population ageing and the decline in mobility can, together, account for almost 70% of the total increase in the U.S. homeownership rate between 1993 and 2009. Of these two factors, geographic mobility seems to be the main reason for the reported rise in homeownership, while the population ageing explains about 25% of this increase.\footnote{When I use the same age distribution for both calibrations (1993 and 2009), the aggregate ownership rate increases from 64.5% to 66.7% instead of 67.1%, which represents 83% of the total simulated increase.}

Figures 2.15 and 2.16 show the simulated and the actual transitions of the ownership distribution, respectively, between 1993 and 2009\footnote{Smoothed versions}. Interestingly, the shapes of the simulated and the actual transitions are very similar. In particular, the rise in ownership rates has been mainly noticed among young and retired households while the ownership rates of middle-aged households have remained almost unchanged. Indeed, as mentioned earlier, the tenure decision of middle-aged households is influenced by the income risk more than any other factor including geographical mobility which seems to play the main role in the long run increase of ownership rates in the U.S. over the period 1993-2009. For this category of households, the positive effect of lower mobility rates on homeownership was fully offset by the negative impact of the relatively small increase in income risk.
CHAPTER 2. RENTING VS BUYING A HOME: ...

Figure 2.15: Ownership distributions of 1993 and 2009: Actual data

Figure 2.16: Ownership distributions of 1993 and 2009: Model predictions


2.7 Sensitivity Analysis

In this section, I consider three alternative calibrations of the model in order to check the robustness of the model results to changes in the income process parametrization, the mobility rates calibration and the minimum housing quantity constraint $h$. In the fourth subsection, I study the impact of an increase and a decrease in the housing transaction cost parameter.

2.7.1 Model III: F-Villaverde and Krueger (2005) income process parametrization (Figure 2.17)

As I have mentioned, most previous work on housing has had limited success in replicating the U.S. homeownership curve. In particular, they tend to over-predict the differences in rates between young and old households. I suspect the underestimation of the income risk to be a potential reason behind this common bias. Indeed, we already know that the earnings variance has a significant impact on the ownership curve.

To investigate this hypothesis, I calibrate a new version of the model using exactly the same earnings productivity grid vector and the same transition probability matrix used in F-Villaverde and Kruegers (2005) to approximate the earnings process:

$$z = [0.57, 0.93, 1.51]$$
\[
\pi = \begin{pmatrix}
0.75 & 0.24 & 0.01 \\
0.19 & 0.62 & 0.19 \\
0.01 & 0.24 & 0.75
\end{pmatrix}.
\]

The implied standard deviation and persistence of the earnings process are: \(\sigma_z \approx 0.38\) and \(\rho_z \approx 0.75\). It is clear that this approximation implies a significantly lower income risk (from 0.637 to 0.38) and less persistent income process (from 0.925 to 0.75). I call the new calibrated version: model III (No mobility shocks).

Table 2.8: Model III

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>7.48</td>
<td>-</td>
</tr>
<tr>
<td>(\theta)</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.97515</td>
<td>-</td>
</tr>
<tr>
<td>Constr(_f)</td>
<td>Fraction of financially constrained house buyers</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>Liquid(_f)</td>
<td>Fraction of liquidity constrained households</td>
<td>12.07%</td>
<td>20% or more</td>
</tr>
<tr>
<td>Ownership(_y)</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>26.97%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Ownership(_m)</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>83.76%</td>
<td>73.83%</td>
</tr>
<tr>
<td>Ownership(_o)</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>90.19%</td>
<td>80.8%</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td>0.293</td>
<td>0.404</td>
</tr>
<tr>
<td>(H_oh/H_r)</td>
<td>Ratio of the owned housing stock to the rented one</td>
<td>2.6</td>
<td>3</td>
</tr>
<tr>
<td>Ownership(_r)</td>
<td>Aggregate ownership rate</td>
<td>64.85%</td>
<td>65%</td>
</tr>
<tr>
<td>(r)</td>
<td>Equilibrium interest rate</td>
<td>3.45%</td>
<td>3%</td>
</tr>
<tr>
<td>(H/Y)</td>
<td>Ratio of housing to output</td>
<td>1.47</td>
<td>[1.4, 1.55]</td>
</tr>
<tr>
<td>(K/Y)</td>
<td>Ratio of capital to output</td>
<td>2.33</td>
<td>[2, 2.5]</td>
</tr>
</tbody>
</table>

According to Table 2.8 and Figure 2.17, we can see that model III’s performance in replicating data on ownership rates has dramatically deteriorated. Moreover, it underpredicts the fraction of liquidity constrained households, which is, in large part, due to low persistent parameter \(\rho_z\).
### Figure 2.17: Model III (New calibration: Lower earnings variance and less persistent process) Vs Data

- **(a) Original version**
- **(b) Smoothed version**
It is clear that Model III overpredicts the differences in rates between young and older households. Indeed, the simulated aggregate ownership rate for young agents is significantly less than its empirical counterpart (26.97% vs 44.3%), while the opposite is true for middle-aged and retired households. These observations remind us the results usually reported in the literature. Hence, it is very likely that the underestimation of the earnings variance is the main reason why many models overpredict the differences in ownership rates between age cohorts. Indeed, the GINI coefficient drops from 0.404 (data) to 0.293.

The intuition here is related to the previous result on how income risk effects on ownership. In fact, we now know that middle-aged households are more influenced by the decrease in income risk than young households. Thus, they will have more incentive to own. Yet, I need to recalibrate $\theta$ in order to match the adjusted aggregate ownership rate (65%). So, the increase of $\theta$ will affect young households more than the others.

### 2.7.2 Model IV: Owners Mobility Rates (Figure 2.18)

In this subsection, I use the mobility rates of owners instead of the average mobility rates as in the baseline model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Error$</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>0.74</td>
<td>-</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.865</td>
<td>-</td>
</tr>
<tr>
<td>$Liquid_f$</td>
<td>Fraction of liquidity constrained households</td>
<td>27.51%</td>
<td>20% or more</td>
</tr>
<tr>
<td>$Ownership_y$</td>
<td>Aggregate ownership rate for hh between 20 and 41</td>
<td>43.17%</td>
<td>44.3%</td>
</tr>
<tr>
<td>$Ownership_m$</td>
<td>Aggregate ownership rate for hh between 41 and 60</td>
<td>74.54%</td>
<td>73.83%</td>
</tr>
<tr>
<td>$Ownership_o$</td>
<td>Aggregate ownership rate for hh older than 61</td>
<td>81.26%</td>
<td>80.8%</td>
</tr>
<tr>
<td>$H_o/H_r$</td>
<td>Ratio of the owned housing stock to the rented one</td>
<td>4.47</td>
<td>3</td>
</tr>
<tr>
<td>$Ownership$</td>
<td>Aggregate ownership rate</td>
<td>65%</td>
<td>65%</td>
</tr>
</tbody>
</table>
As shown in Figure 2.18 and Table 2.9, the resulting model IV predicts an ownership curve very similar to the baseline case. However, the ratio of the owned housing stock to the rented one ($H_o/H_r$) jumps to 4.5 instead of 3.9 (baseline model), which is relatively far from the data. In fact, given that mobility rates of owners are significantly low, the number of relatively rich homeowners who are forced to rent for a period decreases as well. Therefore, the total rented housing stock goes down since rich owners are those who usually rent important housing quantities.

(a) Original version

(b) Smoothed version

Figure 2.18: Model IV (New calibration: Owner Mobility Rates) Vs Data
2.7.3 Model V: Higher minimum housing quantity constraint $h$ (Figure 2.19)

As mentioned before, the U.S. housing market is sufficiently flexible with regard to home prices that it is possible to buy a house at a very low price. However, it would be interesting to increase the minimum housing quantity constraint ($h = 2 \times \text{Avg inc}$), and see if the relaxation of the downpayment constraint would have any significant impact on homeownership, in particular, for young households, as it has been often argued.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.54</td>
<td>-</td>
</tr>
<tr>
<td>$\text{Constr}_{f}$</td>
<td>Fraction of financially constrained house buyers</td>
<td>3.78%</td>
<td>-</td>
</tr>
<tr>
<td>$\text{Liquid}_{f}$</td>
<td>Fraction of liquidity constrained households</td>
<td>29.59%</td>
<td>20% or more</td>
</tr>
<tr>
<td>$\text{Ownership}_{y}$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>44.88%</td>
<td>44.3%</td>
</tr>
<tr>
<td>$\text{Ownership}_{m}$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>73.75%</td>
<td>73.83%</td>
</tr>
<tr>
<td>$\text{Ownership}_{o}$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>80.26%</td>
<td>80.8%</td>
</tr>
<tr>
<td>$H_{o}/H_{r}$</td>
<td>Ratio of the owned housing stock to the rented one</td>
<td>4.25</td>
<td>3</td>
</tr>
<tr>
<td>$\text{Ownership}$</td>
<td>Aggregate ownership rate</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>$\text{Gini}$</td>
<td>Earnings GINI coefficient</td>
<td>0.404</td>
<td>0.404</td>
</tr>
</tbody>
</table>

According to Table 2.10 and Figure 2.19, Model V does a good job in replicating the real U.S. ownership curve. Indeed, the simulated curve is very close to the one implied by the baseline model. Hence, the change in the calibration of $h$ does not have a significant impact on the model’s ability to predict ownership rates. However, the ratio $H_{o}/H_{r}$ rises to 4.25 which is a direct implication of the increase in the minimum housing quantity.
Figure 2.19: Model V (New calibration: Minimum Housing $= 2 \times \text{Avg inc}$) Vs Data
As in the baseline model, setting the minimum downpayment constraint $\kappa$ to zero does not have a significant impact on housing tenure decisions for young and middle-aged households (Figure 2.20).

Table 2.11: Model V (No downpayment requirement)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>$\kappa = 0%$</th>
<th>$\kappa = 15%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>1.09</td>
<td>0.84</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>Constr$_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>0.14%</td>
<td>3.78%</td>
</tr>
<tr>
<td>Liquid$_f$</td>
<td>Fraction of liquidity constrained households</td>
<td>25.57%</td>
<td>29.59%</td>
</tr>
<tr>
<td>Ownership$_g$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>44.9%</td>
<td>44.88%</td>
</tr>
<tr>
<td>Ownership$_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>73.66%</td>
<td>73.75%</td>
</tr>
<tr>
<td>Ownership$_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>82.76%</td>
<td>80.26%</td>
</tr>
<tr>
<td>$H_o/H_r$</td>
<td>Ratio of the owned housing stock to the rented one</td>
<td>5.26</td>
<td>4.25</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>65.75%</td>
<td>65%</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td>0.404</td>
<td>0.404</td>
</tr>
</tbody>
</table>

The relaxation of the downpayment constraint only has an impact on the homeownership of retired households. However, the increase in the aggregate ownership rate of retired households is small relative to the baseline case. In fact, with a higher $h_l$ it becomes more difficult for poor retired households to buy houses given the higher interest paid on the borrowed funds. Thus, even if I increase the minimum housing quantity to a relatively high value, the model’s results with regard to the downpayment do not change significantly.
Figure 2.20: Model V (Zero downpayment) Vs Model V
2.7.4 Housing Transaction Costs

I consider two extreme cases; zero and high transaction costs. Table 2.12 reports the corresponding results. With no transactions costs, housing investment becomes less risky. Therefore, the aggregate homeownership rate increases from 65\% to 71.7\%. With a higher transaction cost of 10\%, the aggregate ownership rate decreases from 65\% to 54.7\%. It is interesting to note that the decrease of the aggregate ownership rate is due largely to the drop in the ownership rates of young households. Indeed, their aggregate rate sharply falls from 42.66\% to 18.28\%, while the aggregate rates of the other age cohorts remain relatively close to those reported for the baseline model. Hence, we can conclude that young households are the most influenced by the illiquidity costs of housing. In fact, this is mainly due to the fact that mobility rates for young households are very high compared to those of other households. As, I already mentioned, one of the costs incurred by geographical mobility is directly related to the housing transaction costs.

Table 2.12: Housing transaction costs sensitivity analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\psi = 5%$</th>
<th>$\psi = 0%$</th>
<th>$\psi = 10%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
</tr>
<tr>
<td>Constr$_f$</td>
<td>1.1%</td>
<td>19.32%</td>
<td>0%</td>
</tr>
<tr>
<td>Liquid$_f$</td>
<td>29.37%</td>
<td>28.79%</td>
<td>29.26%</td>
</tr>
<tr>
<td>Ownership young</td>
<td>42.66%</td>
<td>52.34%</td>
<td>18.28%</td>
</tr>
<tr>
<td>Ownership middle-aged</td>
<td>74.11%</td>
<td>80.67%</td>
<td>71.38%</td>
</tr>
<tr>
<td>Ownership old</td>
<td>82.40%</td>
<td>85.56%</td>
<td>80.82%</td>
</tr>
<tr>
<td>$H_o/H_r$</td>
<td>3.9</td>
<td>5.32</td>
<td>2.25</td>
</tr>
<tr>
<td>Ownership</td>
<td>65%</td>
<td>71.71%</td>
<td>54.67%</td>
</tr>
<tr>
<td>Gini</td>
<td>0.404</td>
<td>0.404</td>
<td>0.404</td>
</tr>
</tbody>
</table>
2.8 Concluding Remarks

According to my results, the relatively low ownership rate of young households is mainly explained by their high geographic mobility. Downpayment constraints have minor quantitative implications on ownership rates, except for retired households. Having said this, the short term impact of downpayments on housing dynamics is still an open question. I also find that idiosyncratic earnings uncertainty has a significant impact on ownership rates. In particular, middle-aged households are the most influenced by changes in income risk.

My framework provides an explanation for the long term increase in ownership rates observed over the period 1993-2009. According to the model’s results, this was not necessarily due to the mortgage market innovations and the relaxation of the downpayment requirements that characterized the U.S. housing market during the same period. Instead, it was simply an implication of U.S. demographic evolution, most notably the decline in interstate migration and, less importantly, population ageing. This hypothesis is empirically confirmed. In fact, the model is able to account for the actual rise in the aggregate ownership rate and to accurately replicate the transition pattern of the ownership distribution between 1993 and 2009 with a high degree of accuracy.

In this chapter, I study the housing tenure decision in the context of a life cycle model. The simulated life cycle ownership curve is very realistic and close to data. One of the most important key elements of this quantitative success is the accurate parametrization of the earnings process (earnings GINI coefficient). Indeed, I believe that the underestimation of the income variance is the main reason why most previous life cycle studies of housing overpredict differences in rates between households
An interesting extension to this model is to allow households to make decision on whether to move or to stay. In fact, the relaxation of the mobility shocks assumption by endogenizing moving decision makes the model more realistic and, hence, allows us to check the robustness of the reported results. Moreover, in a such framework, I can also study the feedback effects of homeownership on mobility.
Chapter 3

Income Distribution, Homeownership and Geographic Mobility

3.1 Introduction

Despite the empirical success of Chapter 2’s model in matching the U.S. life cycle homeownership curve as well as in capturing the shift in the ownership curve between 1993 and 2009, the nature of mobility shocks imposes strong restrictions on the relation between homeownership and geographical mobility. One could argue that, the significant impact of geographic mobility on homeownership reported in Chapter 2 depends strongly on the assumption that households who experience a mobility shock must move. A goal of this chapter is to check the robustness of Chapter 2’ results when households choose whether or not to move in response to opportunities. In this chapter, both renters and owners receive opportunities to move, which they can accept
or reject. A mover receives a moving premium during the first period after his move, and the moving costs consist simply of the housing transactions costs. In Chapter 2, the impact of geographic mobility on homeownership is captured by the negative utility cost associated with the fact of being forced to leave the house and rent for at least one period, when hit by a mobility shock, regardless of the income level of the homeowner. However, in this chapter, the impact of mobility on homeownership is captured by the opportunity cost that a homeowner faces if he receives an offer to move. Indeed, a household should take into account the fact that if he chooses to become owner, he may have to sacrifice the moving premium because of the moving costs (i.e., housing transactions costs). Clearly, this set up is much more realistic in capturing the relationship between homeownership and geographical mobility.

Moreover, the fact that, in this extended model, both housing tenure decisions and geographical mobility are endogenous allows me to investigate another interesting aspect of the relationship between homeownership and geographical mobility. So far, we have only studied the impact of mobility on homeownership, but, it is also interesting to investigate the impact of homeownership on mobility. Obviously, in my model, homeowners are, by construction, less inclined to move than renters, which is consistent with the evidence that homeowners are less mobile than renters even after controlling for specific characteristics of both households and locations (Boheim and Taylor, 2002). In fact, the other main contribution of this chapter consists in investigating the impact of the income process on the relationship between homeownership and geographical mobility. In the literature, most closely related papers have studied the relationship between homeownership, geographical mobility and labor outcome.
Head and Lloyd-Ellis (2011) use an economy with heterogeneous locations, endogenous construction and search frictions in both labour and housing markets to study the interactions among geographical mobility, unemployment and homeownership. They argue that homeowners accept job offers from other cities at a lower rate than do renters, generating a potential link between home-ownership and aggregate unemployment. They find that homeownership impact on the aggregate unemployment is small. Winklery (2010) examines the effect of homeownership on mobility and labor income in a context of a structural dynamic model of housing choices, migration decisions and labor market outcomes. He finds that homeownership has a large and significant negative impact on the probability of a household to move in response to a labor market shock, and a small negative effect on labor income. Bernstein (2009) examines the impact of homeownership on mobility and the labor market. He argues that the recession and housing price decrease of 2008 made Americans less likely to relocate and this effect was larger for homeowners than for renters.

My framework is consistent with these results in the sense that homeownership has, by construction, a large negative impact on mobility. In this chapter, however, I tackle a different issue. To the best of my knowledge, my work is the first to study the impact of income inequality (as well as income shock persistence) on the relationship between homeownership and mobility. According to my findings, the qualitative results reported in Chapter 2, do not depend on the assumptions regarding mobility shocks. The magnitude of the impact of geographical mobility on homeownership decreases somewhat, but is still quite significant. My model predicts that an increase in
income risk (i.e. higher income inequality) has a positive impact on geographical mobility of young households. The intuition here is straightforward: with higher income risk, only very rich, young households purchase houses. The richer a household is, the more likely he will accept an offer and move. The model also predicts that a less persistent income process has a negative impact on mobility, in particular for young homeowners (who are obviously rich), as they are more worried about their future income. The previous results provide a better understanding of the relationship between income, homeownership and mobility, which is important for both researchers and policymakers. For instance, many papers investigating the relationship between housing and labour market suggest that high homeownership rates are associated with higher unemployment.\footnote{Oswald (1996) Blanchflower and Oswald (2013), Coulson and Fisher (2009), Costain and Reiter (2008), etc.} According to this hypothesis, homeowners, who are less mobile than renters, have lower probability of employment. In other words, the decrease in labour mobility related to a rise in homeownership rate implies a higher unemployment rate. My results suggest that, given the increasing inequality in the U.S, young homeowners are less affected by the labour market inefficiency associated with homeownership. Moreover, according to my model, if the income inequality in the U.S. continues to increase, homeownership will decrease, in particular for middle-aged households, while the mobility rates of young homeowners will go up.

The rest of the chapter is organized as follows. In the next section, I describe the environment; Section 3 defines the households problem and Section 4 characterizes the stationary equilibrium. In section 5, I describe the details of the model’s calibration and Section 6 presents the results and analysis.
3.2 The Environment

The environment in this chapter builds on that described in section 2.2 of Chapter 2. The economy is a life cycle dynamic general equilibrium model with income uncertainty, extended to allow for housing investment, a rental market and collateralized debt. Households receive utility from consumption $c$ and housing services $s$. They also value leaving housing and asset equities to their heirs. Individuals are endowed with one unit of labor each period which they supply inelastically in the labor market at a wage rate, $w$. The goods market is competitive and characterized by a constant returns to scale production function.

**Endogenous Geographic Mobility:**

In the previous chapter, I assumed that whenever a homeowner is subject to a mobility shock, he has no choice but to move. In fact, he has to sell his house and rent for at least one period. Clearly, this assumption may overstate the impact of mobility on homeownership since mobility shocks will, by construction, have a negative mechanical impact on the aggregate homeownership rate given the unrealistically large number of moving renters.

In this chapter, I assume that both owners and renters receive offers to move. A household who has the opportunity to move can reject the offer or accept it. A

---

22See equation 2.2
3See equation 2.5
4See equation 2.3
5In reality, the fraction of movers who decide to rent during the first period is relatively lower than what the model implies.
mover can choose to rent or to own regardless of his initial housing tenure status. I assume that a household receives a moving bonus whenever he accepts the offer and moves. This bonus is implemented as an age-depending utility premium that a household receives only during the first period after his move. This can be interpreted as the actualized total benefits of moving, which could include wage premium, location preference, etc. The cost of moving consists of the transaction costs that a mover-owner would incur when he sells his house before moving ($\phi \ast h$). In the previous baseline model, a homeowner who does not adjust his housing stock does not have to pay any transaction cost since he will be staying in the same house. However, in this extension, a mover-homeowner has to pay a transaction cost even if he keeps the same housing stock level (h) as he has to sell his house before moving to the new location. Hence, while renters will never reject the offer to move, since they do not incur any moving costs, a homeowner can reject the offer, or accept it and either remain an owner, or become a renter.

### 3.3 Household’s Problem

Now, the household has to make two decisions if he has the opportunity to move: whether to move or to stay and whether to rent or to own.

The problem of a household of age $a$ can be written recursively as:

$$W_a(x) = (1 - m) \ W_a^{Stay}(x) + m \ [\max \{W_a^{Stay}(x), W_a^{Move}(x)\}]$$

(3.1)
where:

\[ W_{a \text{Stay}}(x) = \max_{D \in \{0, 1\}} \{ D \, W_{a \text{Stay}}^{o,s}(x) + (1 - D) \, W_{a \text{Stay}}^{r,s}(x) \} \]  

(3.2)

\[ W_{a \text{Move}}(x) = \max_{D \in \{0, 1\}} \{ D \, W_{a \text{Move}}^{o,m}(x) + (1 - D) \, W_{a \text{Move}}^{r,m}(x) \} \]  

(3.3)

Here \( W_a \) is the value function of a household of age \( a \) with a state vector \( x = \{k, h, z, m\} \) where the indicator \( m \) takes the value 1 when the household has an offer to move. \( W_{a \text{Stay}}^{Stay} \) is the value function of a stayer and \( W_{a \text{Move}}^{Move} \) is the value function of a mover. Both mover and stayer have to choose between renting and owning given the value function of each option \( (W_{a \text{Stay}}^{o,s}, W_{a \text{Stay}}^{r,s}, W_{a \text{Move}}^{o,m}, W_{a \text{Move}}^{r,m}) \). If \( m = 1 \), the household can choose between moving and staying. Otherwise he will simply stay. Again, the variable \( D \) is a choice variable that takes the value 1 when the household chooses to be a homeowner and 0 otherwise.

**Value of being a stayer-homeowner: \( W_{a \text{Stay}}^{o,s} \)**

The problem of a stayer-homeowner consists of choosing consumption, house size and savings to solve:

\[ W_{a \text{Stay}}^{o,s}(x) = \max_{c,k',h'} \left\{ U(c, h') + \beta (1 - \alpha_a) \phi \log(Q_w) \right. \]

\[ + \beta \alpha_a \sum_{z'} \pi(z' | z) \left\{ (1 - \lambda_{a+1}) \, W_{a+1}(k', h', z', 0) + \lambda_{a+1} \, W_{a+1}(k', h', z', 1) \right\} \}

(3.4)

\[ Q_w = (1 - \delta_h) \, h' + (1 - \delta_k) \, k', \]

\[ c + k' + h' + \Lambda(h', h) = y_a + (1 + r)(k + B_k) + (1 - \delta_h)(h + B_h) \]
where \( \lambda_{a+1} \) is the probability of receiving an offer next period. This is exactly the same as the homeowner’s problem in Chapter 2. However, the homeowner no longer faces the risk of being induced to leave the house next year and rent for at least one period, since he can simply reject the offer to move. Hence, the impact of mobility on homeownership is quite different from the previous chapter, where this impact was tightly related to the negative utility cost of being hit by a mobility shock. In this new context, it is more about the opportunity cost faced by homeowners. In fact, being an owner may induce the household to reject the offer because of the associated moving costs.

**Value of being a stayer-renter: \( W_{r,s}^a \)**

The problem of a stayer-renter consists of choosing consumption, rental housing services and savings to solve:

\[
W_{r,s}^a(x) = \max_{c,k',s} \left\{ U(c,s) + \beta (1 - \alpha_a) \phi \log(Q_w) \\
+ \beta \alpha_a \sum_{z'} \pi(z' | z) \{(1 - \lambda_{a+1}) W_{a+1}(k', 0, z', 0) + \lambda_{a+1} W_{a+1}(k', 0, z', 1)\} \right\}
\]

\[(3.5)\]

\[
c + k' + p s + \Lambda(0, h) = y_a + (1 + r)(k + B_k) + (1 - \delta_h)(h + B_h) \\
k' \geq 0, \quad c \geq 0 \quad s \geq 0 \quad \text{and} \quad h' = 0.
\]
In this version of the model, a mover, whether he is a renter or an owner, receives a bonus. Hence, the value function of an actual renter takes into account the future probability of receiving an offer, unlike in the baseline model where only owners are concerned about mobility shocks.

**Value of being a mover-homeowner: \( W_{a,m}^{o,m} \)**

The problem of a mover-homeowner consists of choosing consumption, house size and savings to solve:

\[
W_{a,m}^{o,m}(x) = \max_{c,k',h'} \left\{ U(c, h') + \left[ P_a + \beta (1 - \alpha_a) \phi \log(Q_w) \right. \right. \\
\left. \left. + \beta \alpha_a \sum_{z'} \pi(z' | z) \{ (1 - \lambda_{a+1}) W_{a+1}(k', h', z', 0) + \lambda_{a+1} W_{a+1}(k', h', z', 1) \} \right] \right\}
\]

\[
(3.6)
\]

\[
Q_w = (1 - \delta_h) h' + (1 - \delta_k) k',
\]

\[
c + k' + h' + \Lambda(h) = y_a + (1 + r)(k + B_k) + (1 - \delta_h)(h + B_h)
\]

\[
k' \geq -(1 - \kappa)h', \quad c \geq 0 \quad \text{and} \quad h' \geq h
\]

where \( P_a \) is the premium or the bonus that a household of age \( a \) receives when he accepts the offer and moves. It is calibrated so that the predicted owners’ mobility rates match their empirical counterparts[^6]. The moving cost consists of paying the housing transaction cost \( \Lambda(h) = \psi h \). Clearly, a mover-homeowner pays a housing transaction cost even if he keeps the same housing stock level \( h \), since he has no choice.

[^6]: See the calibration section for more details
other than selling his house.

Note that if \( h = 0 \) or \( |h' - h| > 0 \), \( W^{a,m}_a(x) = W^{a,s}_a(x) + P_a \), since \( \Lambda(h) = \Lambda(h', h) \).

**Value of being a mover-renter: \( W^{r,m}_a \)**

The problem of a mover-renter consists of choosing consumption, rental housing services and savings to solve:

\[
W^{r,m}_a(x) = W^{r,s}_a(x) + P_a,
\]

It is obvious that a mover-renter will make the same decisions as a stayer-renter. In fact, if a stayer finds it optimal to rent, he will definitely choose to move and rent if he receives an offer.

It is worth noting that a household who would optimally choose to rent if he is a stayer (even if he is an actual owner), will definitely move if he receives an offer.

Obviously, renters will always move if they have the opportunity, since \( \Lambda(h) = 0 \).

The same intuition is valid for an owner who would optimally choose to adjust his housing stock if he does not have the opportunity to move. Such a homeowner will definitely accept an offer, if any, and move since he won’t incur any extra housing transaction costs compared to the situation where he rejects the offer.

The only case where the decision of the household on whether to accept or to reject the offer is uncertain is when the household is a homeowner who would optimally choose to remain an owner and keep the same housing stock level, if he has no offer. In this case, the household has three options:

1. Reject the offer and stay.

---

7Because: \( W^{r,m}_a(x) = W^{r,s}_a(x) + P_a > W^{r,s}_a(x) > W^{a,s}_a(x) \), and \( W^{r,m}_a(x) = W^{r,s}_a(x) + P_a > W^{a,s}_a(x) + P_a > W^{a,m}_a(x) \), \( \Lambda(h) = 0 \Lambda(h', h) = 0 \Lambda \).

8\( \Lambda(h) = 0 \Lambda(h', h) = 0 \Lambda \).
2. Accept the offer and own.

3. Accept the offer and rent.[9]

### 3.4 Stationary Equilibrium

Given that there is no aggregate uncertainty in the economy, I focus on a stationary equilibrium in which prices, wages and the interest rate are constant through time. At the beginning of each period a household is characterized by his capital holding \( k \), his housing stock \( h \), his age \( a \), labor productivity \( z \), and his offer status (whether or not he has an offer to move) \( m \). In the stationary equilibrium, \( \Phi(k, h, a, z, m) \), the measure of agents of type \((k, h, a, z, m)\), is constant.

**Definition**

A stationary equilibrium consists of a collection of:

Value functions \( \{ W_a(x), W^{o,s}_a(x), W^{r,s}_a(x), W^{o,m}_a(x), W^{r,m}_a(x) \} \), policy functions \( (c, k', h', s, M, D) \), aggregate quantities \( L, K, H, H^o \) and \( H^r \), taxes \( \tau \), pensions \( P \), accidental bequest transfers \( \{ B^k, B^h \} \), prices \( \{ w, q, r, p \} \), and a general law of motion \( \Gamma \) such that:

- All economic actors optimize their profits and utilities subject to 2.4, 2.5, 2.6, and 2.7.
- Labor is supplied inelastically in the model and satisfies:

\[
\int \epsilon_a z \, d\Phi = L, \tag{3.7}
\]

[9]In fact, a mover-homeowner may find it optimal to move and rent even if an identical stayer-homeowner would optimally choose to remain owner.
where $L$ is the fixed labor supply.

- Markets clear:

Goods market clearing implies that:

\[
C + \delta_k K + \delta_h H^o + pH^r + \int (1-M(x,a)) \Lambda(h'(x,a),h) \, d\Phi + \int M(x,a) \Lambda(h) \, d\Phi = Y, 
\]

(3.8)

where $C$, $K$, $H^o$, and $H^r$ represent aggregate consumption, aggregate invested capital, aggregate owned housing stock, and aggregate rented housing stock, defined as:

\[
C = \int c(x,a) \, d\Phi, \quad (3.9)
\]

\[
K = \int k'(x,a) \, d\Phi, \quad (3.10)
\]

\[
H^o = \int D(x,a)h'(x,a) \, d\Phi, \quad (3.11)
\]

\[
H^r = \int [1 - D(x,a)]s(x,a) \, d\Phi, \quad (3.12)
\]

\[
H = H^o + H^r, \quad (3.13)
\]

The last two expressions of the left hand side of the goods market clearing condition take into consideration the fact that a mover faces a different transactions costs function.
Accidental bequest transfers satisfy:

\[ B^k = \int [k'(x, a) - k] \, d\Phi, \quad (3.14) \]

\[ B^h = \int [h'(x, a) - h] \, d\Phi, \quad (3.15) \]

In the stationary equilibrium, the accidental bequest is simply the difference between the total capital at the end of the last period and the total capital at the beginning of the current period.

The government provides retirement benefits through a social security program, financed by taxes collected from working households. Government budget balance implies that:

\[ \sum_{a=1}^{\hat{T}} \varpi_a \tau = \sum_{a=\hat{T}+1}^{T} \varpi_a P \quad (3.16) \]

where \( \varpi_{\hat{a}} = \int d\Phi(k, h, a = \hat{a}, z, m) \).

The measure \( \Phi \) satisfies: \( \Phi = \Gamma(\Phi) \), where \( \Gamma \) is the law of motion generated by policy functions \( h' \) and \( k' \), the transition probabilities \( \pi(z'|z) \) and the age dependent mobility probabilities \( \{\lambda_a\}_{a=1}^{a=\hat{T}} \).

I compute the stationary equilibrium of the model using an extension of the backward induction method used in Chapter 2 (See Appendix B for more details).
3.5 Calibration

The moving offer rates are calibrated to match the empirical renter geographic mobility rates. Hence, the predicted renters’ actual moving rates are, by construction, equal to their empirical counterparts, since renters, in my model, do not incur any moving costs. The age-specific moving bonus $P_a$ (see Figure 3.1) is calibrated so that the predicted homeowners mobility rates match their empirical counterparts (see Figure 3.3). In other words, differences in moving rates between renters and owners of the same age are assumed to be, exclusively, due to housing transaction costs. The calibration of the remaining structural parameters is similar to Chapter 2’s parametrization. However, in this version of the model, I have increased $N_z$, the number of Markov process states used to approximate the income process, from 5 to 11 in order to study the impact of income distribution on both, homeownership and moving decisions.

---

Figure 3.1: Calibration of the Moving Premium as Function of Age

---

10. I, implicitly, assume that the rate of turning down offers for reasons other than housing transaction costs, are similar for renters and owners at the same age.

11. Hence, the income process parametrization should be updated: $\sigma_z = 0.629$, and $\rho_z = 0.95$


### 3.6 Results

#### 3.6.1 New Baseline Model

Table 3.1 compares the new baseline model with the data, where the variables in the bottom section are obtained by calibration.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>0.87</td>
<td>-</td>
</tr>
<tr>
<td>Constr$f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>0.1%</td>
<td>-</td>
</tr>
<tr>
<td>Ownership$p$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>42.94%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Ownership$m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>74.52%</td>
<td>73.83%</td>
</tr>
<tr>
<td>Ownership$o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>81.57%</td>
<td>80.8%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td>0.404</td>
<td>0.404</td>
</tr>
<tr>
<td>$r$</td>
<td>Equilibrium interest rate</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Figure 3.2 compares the home-ownership curve as a function of age predicted by the new baseline model to that implied by the data. According to Table 3.1 and Figure 3.2, the new baseline model does a very good job in replicating the life cycle ownership rates, even better than the previous baseline model. This is because of the relatively high Markov states number used to approximate the income process ($N_z = 11$).

Figure 3.3 reports the empirical life cycle mobility rates for renters (blue curve) between 2009 and 2010 that are used as a proxy for the moving offer rates. It also compares the predicted owners mobility rates (green curve) to their empirical counterpart (red curve).
CHAPTER 3. INCOME, HOMEOWNERSHIP AND GEOGRAPHIC MOBILITY

Figure 3.2: Life Cycle Homeownership Curve (New Baseline Model)

Figure 3.3: Mobility Rates
3.6.2 Mobility Impact

One motivation for the relaxation of the mobility shock assumption is to have a more accurate and realistic assessment of the impact of geographical mobility on the housing tenure decision over the life cycle.

Table 3.2: New Baseline model without mobility

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr</td>
<td>Fraction of financially constrained house buyers</td>
<td>31.32%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ownershipy</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>55.26%</td>
<td>42.94%</td>
</tr>
<tr>
<td>Ownershipm</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>78.96%</td>
<td>74.52%</td>
</tr>
<tr>
<td>Ownershipo</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>86.92%</td>
<td>81.57%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>72.57%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Table 3.2 reports the results of a version of the model where there is no moving cost. Hence, by construction, any household who receives an offer to move will accept it.

Figure 3.4: Ownership Rates: Model (Without Moving Cost) Vs New Baseline Model
According to Figure 3.4 and Table 3.2, we can conclude that the impact of geographic mobility is still important and that young households are, still, the most influenced age group. However, the magnitude of the geographic mobility impact has decreased compared to previous results, which is not surprising since in this new context, there are no forced renters.

3.6.3 Zero Downpayment

The experiment consists of relaxing the downpayment requirement to $\kappa = 0$ in order to assess its impact on the decision of a household to buy or rent a house. I would like to investigate to what extent the previous results, regarding the impact of the downpayment constraint on homeownership, are affected by the relaxation of the mobility shocks assumption.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr_f</td>
<td>Fraction of financially constrained house buyers</td>
<td>0.42%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ownership_y</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>42.42%</td>
<td>42.94%</td>
</tr>
<tr>
<td>Ownership_m</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>74.24%</td>
<td>74.52%</td>
</tr>
<tr>
<td>Ownership_o</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>84.89%</td>
<td>81.57%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>65.65%</td>
<td>65%</td>
</tr>
<tr>
<td>r</td>
<td>Equilibrium interest rate</td>
<td>3.11%</td>
<td>3%</td>
</tr>
</tbody>
</table>

According to Table 3.3 and Figure 3.5, the relaxation of the minimum downpayment requirement does not have a significant impact on the life cycle homeownership curve, except for old households. Having said that, the slight decrease in homeownership rates for non-retired households is explained by the small increase of the interest rate. Obviously, new old owners would borrow in order to finance their home
purchases. The increase in the aggregate borrowing demand implies a higher interest rate, which makes several poor working households more reluctant to take a relatively more costly mortgage loan.

![Figure 3.5: Ownership Rates: New Baseline Model with Zero Downpayment (κ = 0) Vs New Baseline Model](image)

3.6.4 Impact of Income Uncertainty

In this counter factual experiment, I decrease the income variance so that the GINI coefficient falls from 0.404 to 0.33 ($\sigma z = 0.47$).

As expected the aggregate ownership rate increases by 7.5%, as well as the fraction of financially constrained house buyers (See Table 3.4 and Figure 3.6). Again, middle-aged households seem to be the most influenced by the decline in income risk. However, the homeownership rates of very young households have slightly decreased, unlike the baseline model. This new result is not related to the relaxation of the
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Table 3.4: New Baseline model with lower GINI

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr(_f)</td>
<td>Fraction of financially constrained house buyers</td>
<td>8.7%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ownership(_vy)</td>
<td>Aggregate ownership rate for hhs between 20 and 26</td>
<td>17.51%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Ownership(_y)</td>
<td>Aggregate ownership rate for hhs between 26 and 41</td>
<td>46.01%</td>
<td>42.94%</td>
</tr>
<tr>
<td>Ownership(_m)</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>80.98%</td>
<td>74.52%</td>
</tr>
<tr>
<td>Ownership(_o)</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>86.72%</td>
<td>81.57%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>69.84%</td>
<td>65%</td>
</tr>
</tbody>
</table>

mobility assumption, but rather to the fact of increasing \(N_z\) from 5 to 11. Actually, when we significantly increase the number of Markov states, we expect to get a much more accurate approximation of the income process. Hence, the impact of income distribution on homeownership is more likely to be noticed, in particular for young households.\(^{12}\) In fact, when income inequality decreases, the fraction of relatively rich young households, who can potentially buy houses, decreases as well. This negative effect of reduced inequality seems to dominate the positive impact of the decrease in income uncertainty on homeownership for very young households.

Based on the previous results, we can conclude that the key results of Chapter 2 do not seem to depend much on the assumption made about mobility shocks.

However, the relaxation of this assumption makes the model more consistent with the reality. Indeed, in this new environment, I can study the impact of the homeownership status on the decision of moving. Something that I was not able to investigate in Chapter 2’s context.

\(^{12}\)See section 2.6.4.
3.6.5 Income and Homeowner’s Geographical Mobility

So far, I have only studied the impact of geographic mobility on homeownership. It is also interesting to investigate the impact of housing tenure status on mobility. Obviously, being a homeowner makes the household more reluctant to move given the relatively high associated costs. In this section, I investigate the impact of income uncertainty (as well as the change in the income distribution) on the relationship between homeownership and geographic mobility.

3.6.5.1 Accept or Reject the Offer?

In order to accurately assess the impact of income on the geographic mobility of homeowners, there is one key issue to consider: What really determines the decision
of a homeowner to move or not? It seems that the owner’s income level is the main determinant of the moving decision. In fact, homeowners receiving an offer to move could be sorted into five groups, from poor to richer:

1. Very poor homeowners who would sell their houses and return to the rental market even if they get no offer. Such homeowners would definitely accept the offer and rent.

2. Relatively poor homeowners who would keep their housing status unchanged in the case where they receive no offer to move. Yet, because of their relatively low income, they would accept the offer, if any, and then rent. Such homeowners are willing to increase their consumption and decrease their housing spending. In other words, they will prefer to move, get the bonus, rent and may stay renters until they will become wealthier. Hence, the moving offer accelerates the decision of those homeowners to switch from owning to renting.

3. Homeowners who are relatively richer than the previous ones, yet not very rich. These homeowners are satisfied with their current situation, and they would simply reject the offer and stay. In fact, given their relatively moderate income, they are not willing to sacrifice a significant part of their consumption due to the moving transaction costs. Obviously, these homeowners are not willing to move, rent for period, and then become a homeowner again, because of the relatively high utility loss associated with this decision as well as the transaction cost incurred when selling their houses.

4. Moderately rich homeowners who are willing to accept the offer (move) and stay

\[13\text{Without loss of generality, I assume that these homeowners live in a minimum size house } h.\]
as owners. Indeed, for this category of owners, the bonus received when accepting the offer is higher than the utility loss related to the current consumption decline associated with the moving costs.

5. Significantly rich homeowners (i.e. the richest homeowners category) who would upgrade their housing services if they don’t receive any offer. Such homeowners would certainly be better off accepting the offer and moving, since moving has no cost for them: they would sell their houses anyway.

It is worth noting that the fraction of homeowners of types 1, 2 and 5 is very small compared to homeowners of types 3 and 4, who, actually, represent the vast majority of homeowners receiving offers to move, in particular for young homeowners. Hence, the richer the homeowner, the more likely he is going to accept the offer and move.

### 3.6.5.2 Impact of Income on Homeowners Mobility

Income can affect the mobility of homeowners through two different channels: a distributional effect that affects the average wealth of homeowners, and an endogenous impact related to income uncertainty, and more specifically to the owners’ beliefs about their future income shocks.

#### 3.6.5.2.1 Income Distribution Effect

The experiment consists in increasing the earnings variance so that the earnings GINI coefficient rises from 0.404 to 0.52.

---

\[\text{It is obvious that the consumption is highly correlated with the income level. Hence, as the income level increases, the marginal utility loss of a consumption decline, decreases.}\]
Table 3.5: New Baseline model ($\sigma_z = 0.9$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr$_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>0.0003%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ownership$_y$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>36.86%</td>
<td>42.94%</td>
</tr>
<tr>
<td>Ownership$_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>65.61%</td>
<td>74.52%</td>
</tr>
<tr>
<td>Ownership$_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>88.65%</td>
<td>81.57%</td>
</tr>
<tr>
<td>Ownership$_{eq}$</td>
<td>Aggregate ownership rate</td>
<td>61.66%</td>
<td>65%</td>
</tr>
<tr>
<td>$r$</td>
<td>Equilibrium interest rate</td>
<td>2.22%</td>
<td>3%</td>
</tr>
</tbody>
</table>

It is not surprising that the aggregate homeownership rate declines when income risk increases.\footnote{The decline in homeownership rates has been also noticed among the very young households, which means that the income risk impact on homeownership is more important then the distributional effect. We can conclude that, for relatively high earnings variance, the negative impact of income uncertainty on homeownership of young households dominates the income distribution effect.} However, according to Table 3.5 and Figure 3.7, homeownership rates of old households have significantly increased. Obviously, retired people are not influenced by income risk since they receive a fixed pension until they die. Moreover, the steep increase in income uncertainty presents a precautionary saving motive, which drives the interest rate down\footnote{The equilibrium interest rate $r$ dramatically falls from 3% to 2.22% (see Table 3.5).} (i.e. increase in the savings demand side). This substantial decrease in the interest rate makes mortgages relatively less costly for retired households, which explains the sharp increase in homeownership rates for very old households.

According to Figure 3.8, the actual homeowners moving rates have increased overall. One might think that when income risk increases, homeowners would be less willing to move. This would be perfectly true if we did not take into account the implied change in the wealth distribution of homeowners. Firstly, holding everything else constant, as the income risk increases, households, in particular the young, become more reluctant to buy a house, which means that only the wealthiest among them would decide to become homeowners.
CHAPTER 3. INCOME, HOMEOWNERSHIP AND GEOGRAPHIC MOBILITY

Figure 3.7: Life Cycle Homeownership Curve: New Baseline Model VS New Baseline Model with Higher Income Variance

Figure 3.8: Mobility Rates: New Baseline Model New Baseline Model with Higher Income Variance
Secondly, a higher income inequality implies a significantly higher average wealth for young homeowners. Thus, the average income (wealth) of homeowners will go up significantly, in particular for young households, who are now relatively richer compared to the case where income variance is lower. We already know that the richer the homeowner is, the more likely he is willing to accept the offer and move. Hence, higher income inequality implies higher mobility rates, especially for young homeowners.

3.6.5.2.2 Income Shock Persistence Effect The expectations of households about their future income strongly depend on the earnings shock persistent parameter \( \rho_z \). In fact, holding the earnings unconditional variance fixed \( (\sigma^2_z) \), a higher \( \rho_z \) implies lower short run income uncertainty for the households since their future income states will be much more correlated with their current states\(^{17} \) and vice versa. In what follows, I decrease the earnings shock persistent parameter \( \rho_z \) from 0.95 to 0.88.

Impact on Homeownership

As the unconditional income variance is held constant (i.e. same earnings GINI coefficient), I expect that the impact of changing the earnings shock persistence on the household’s housing tenure decision would exclusively depend on his current income, and consequently on his age.

\(^{17}\)It is true that when I increase the earnings persistence parameter and hold the unconditional income variance constant, households become less uncertain about their near future income. However, in aggregate terms, a higher income persistence implies a higher income inequality.
CHAPTER 3. INCOME, HOMEOWNERSHIP AND GEOGRAPHIC MOBILITY

Table 3.6: New Baseline model \((\rho_z = 0.88)\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Baseline model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constr(_f)</td>
<td>Fraction of financially constrained house buyers</td>
<td>0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ownership(_y)</td>
<td>Aggregate ownership rate for hhs between 20 and 31</td>
<td>25.42%</td>
<td>29.07%</td>
</tr>
<tr>
<td>Ownership(_m)</td>
<td>Aggregate ownership rate for hhs between 31 and 60</td>
<td>76.45%</td>
<td>68.52%</td>
</tr>
<tr>
<td>Ownership(_o)</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>90.23%</td>
<td>81.57%</td>
</tr>
<tr>
<td>Ownership</td>
<td>Aggregate ownership rate</td>
<td>71%</td>
<td>65%</td>
</tr>
<tr>
<td>(r)</td>
<td>Equilibrium interest rate</td>
<td>2.85%</td>
<td>3%</td>
</tr>
<tr>
<td>Gini</td>
<td>Earnings GINI coefficient</td>
<td>0.404</td>
<td>0.404</td>
</tr>
</tbody>
</table>

According to Table 3.6 and Figure 3.9, the homeownership rates of very young households (aged between 20 and 31 years old) have slightly decreased. It is true that this decline is relatively small, yet, it is quite significant. To understand this result, we should remember that young homeowners are exclusively the richest people of their age groups. As \(\rho_z\) decreases, some moderately rich young households, who, previously, were willing to buy a house, are now more concerned about their future income given the lower income persistence. Indeed, future negative income shocks are more likely to occur for those households. Thus, it is not surprising that a significant fraction of these moderately rich young households becomes more reluctant to buy houses.

For older households, the story is different. In fact, households who start to be interested in purchasing houses for the first time at old ages, are more likely to be not wealthy and have, generally, relatively low income. Hence, as \(\rho_z\) decreases, those people are more likely to receive positive income shocks in the future compared to the case where income process is more persistent. Thus, they become less reluctant to buy a house, which explains the steep rise in the homeownership rates among these categories of households.
Impact on Homeowners Mobility

As I already showed, a less persistent income shock process makes young homeowners more concerned about their future income, which explains the important decline in their mobility rates (See Figure 3.10). Indeed, young homeowners become less willing to accept offers and move.

For older households, the impact of higher income persistence on their mobility rates can be ambiguous. In fact, for these age groups, homeowners are more heterogeneous in terms of income and wealth levels. Thus, the impact of a lower $\rho_z$ depends on the income class to which the homeowner belongs. Rich homeowners’ mobility will decrease, while the mobility of poor homeowners will go up. Overall, the magnitude of the decline in owners mobility decreases as we move along the mobility life cycle curve.
CHAPTER 3. INCOME, HOMEOWNERSHIP AND GEOGRAPHIC MOBILITY

Figure 3.9: Life Cycle Homeownership Curve: New Baseline Model VS New Baseline Model with Lower Income Persistence

Figure 3.10: Mobility Rates: New Baseline Model New Baseline Model with Lower Income Persistence
3.7 Concluding Remarks

In this model, I extend the framework developed in Chapter 2 by allowing households to decide on whether to move or to stay. I find that the assumption previously made on mobility shocks does not have a significant impact on the key results of the model. In fact, when I relax this assumption, qualitatively, the results do not change much, although the magnitude of the impact of geographical mobility on homeownership decreases. I use the extended model to study the impact of the income distribution on the relationship between homeownership and mobility. Overall, mobility rates of young homeowners seem to be quite sensitive to the income process, while those of older households do not change significantly. In fact, I show that an increase in income inequality could have a positive effect on geographic mobility, especially for young homeowners. The model also predicts that a less persistent income process has a negative impact on mobility, in particular for young homeowners (who are obviously rich), as they become more worried about their future income. These results shed new light on the mechanisms underlying the relationship between income inequality, homeownership and mobility. One implication of these findings is related to the well documented positive correlation between the rate of homeownership and unemployment. In fact, my results suggest that young homeowners are less affected by the negative impact of homeownership on employment, especially when we take into account the recent rise in U.S. income inequality. Moreover, my model predicts a decrease in homeownership rates, in particular for middle-aged households, and an increase in the mobility rates of young homeowner, given the recent rise in the U.S.'s GINI coefficient.
An interesting extension to this model is to allow households to default on their mortgage loans. The fact that the impact of the relaxation of the downpayment requirement on homeownership is not significant, does not necessarily mean that it won’t have an effect on the default rate.
Chapter 4

Downpayment, Homeownership and Default

4.1 Introduction

The relaxation of downpayment requirements has been promoted for decades as it is believed by many to be an efficient homeownership promoting policy, particularly for young households. However, there has never been an agreement on the efficiency of such policies, and the debate is still open as to whether the relaxation of downpayment requirements has a significant impact on homeownership. In fact, there is no clear conclusion about the quantitative and empirical importance of this impact. Fisher and Gervais (2008), Kiyotaki et al. (2007) argue that the impact of relaxing downpayment requirements is quantitatively small and has only modest implications for the housing market.

There is an ongoing debate in the U.S. as to whether or not to include a minimum
downpayment requirement in the definition of the Qualified Residential Mortgage (QRM). The QRM is a set of loan standards designed to reduce the risk of default. If a mortgage loan meets the QRM criteria, it will be exempt from the Dodd-Frank Wall Street Reform that requires financial firms to retain 5 percent of the credit risk when they sell loans to investors. This gives lenders a powerful incentive for making loans that meet QRM criteria, given the higher percentage of mortgages that they can sell into the secondary market, thereby reducing their long-term risks. At the same time, a borrower is better off meeting the QRM guidelines, otherwise he will have a harder time finding a loan, and will most likely end up paying a higher interest rate. Consequently, the definition of the QRM will eventually set the bar for mortgage-lending standards in the U.S. In the original proposal made in 2011, the QRM criteria included a downpayment requirement of at least 20%, for the loan to be considered a qualified residential mortgage. However, this proposal was highly criticized by mortgage industry advocates who argued that such a requirement could seriously restrict credit for certain borrowers and would do more harm than good. In the latest proposal issued in August 2013, the 20% downpayment requirement was dropped. Indeed, the six federal agencies who are finalizing the definition of QRM have proposed to align it with the QM (Qualified Mortgage) definition which requires the borrowers to have a total debt-to-income (DTI) ratio less than 43%.\footnote{Regulators have also considered an alternative proposal, the QM-plus which includes a minimum downpayment requirement of 30%.

In this chapter, I use an extended version of Chapter 3’s framework as a benchmark}

\footnote{The QM definition requires loans to meet other characteristics (maximum loan horizon of 30 years; regular periodic payments that are substantially equal, no negative-amortization, interest-only, or balloon features; total points and fees should not exceed 3% of the total loan amount...)}
to shed light on the efficiency of mortgage default prevention policies by assessing the potential impacts of introducing minimum downpayment requirement on homeownership, default rates, and welfare.

My analysis is most closely related to work by Hatchondo et al. (2011), who study the impact of downpayment requirements on homeownership and default rates in the context of a standard life-cycle incomplete markets model with housing. They show that a calibrated version of the model matches non targeted moments such as the distribution of downpayments and hence a plausible borrowing behavior. They also argue that the introduction of minimum downpayments or income garnishment benefits a majority of the population. Another related study to this chapter is a recent work by Arslan, Guler, and Taskin(2013). Unlike Hatchondo et al. (2011) where the house prices are assumed to follow a stochastic process, Arslan, Guler, and Taskin(2013) assume that house prices are constant in the steady state and change only when an aggregate interest rate shock hits the economy. They also argue that a macroprudential policy (20 percent minimum downpayment requirement) would make the economy, especially the foreclosures, more stable.

My work differs from these related articles in four key respects. Firstly, in these papers, house size is assumed to be fixed regardless of whether it is rented or owned. In my model, both owner and renter can adjust their housing services. I believe this is a crucial difference since assuming fixed housing space implies that the homeownership premium is constant and does not depend on the income level, which could represent a potential source of bias. A second crucial difference is related to the way the cost of
defaulting is modeled. In Hatchondo et al. (2011), when a homeowner defaults, the lender is allowed to garnish the defaulters’ income, while in Arslan, Guler, and Taskin (2013), a defaulter is only allowed to purchase a house with an exogenous probability. In my model, when a homeowner defaults, he will be deprived of borrowing for 7 years after his default. This is consistent with U.S. banking standards, where a bad credit flag stays, on average, 7 years in the credit history of the household. As in Livshits, MacGee, and Tertilt (2007), I assume that debtors can discharge all their debt via default (bankruptcy) and do not assume any life-long liability for loans.

The fact that I need to keep track of the defaulter for 7 years represents a significant computational burden. Having said this, the potential benefit of such implementation is very important, especially, if we want to have a relevant and realistic assessment of the impact of downpayments on the default rate. In fact, the exclusion of a household, who is expecting a significant income increase, from the mortgage market for many years should be associated with a relatively important utility loss. However, if I simply assume a fixed income garnishmant as default punishment for all defaulters regardless of their actual and future income (as in Hatchondo et al. (2011)), the model could imply exactly the opposite. This also represents a potential source of bias in capturing the difference in utility cost incurred by defaulters belonging to different age groups. Thirdly, in my model, mobility and defaulting are both endogenous so that I can investigate the potential impact of geographic mobility on the decision to default. As I will show later, mobility is one of the trigger factors for default. In fact, young households are more likely to default not only because of their low income but also, potentially, because of their high willingness to move. Hence, the endogeneity of both

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2 This is consistent with key features of Chapter of the U.S. bankruptcy code.
3 Livshits, MacGee, and Tertilt (2007) refer to this as ”Fresh Start” system, as opposed to the ”No Fresh Start” system, where consumer bankruptcy restructures the consumer’s debt payments.
moving and default decisions represents a key feature of the model. Arslan, Guler, and Taskin (2013) assume that in each period homeowners receive an exogenous moving shock forcing them into the rental market. With such an assumption, we cannot study the feedback between default and moving decisions.\textsuperscript{4} Fourthly, most of the related works are not fully equilibrium models in the sense that prices and interest are not determined endogenously.\textsuperscript{5} For instance, a model with an exogenous interest does not allow to account for the potential equilibrium feedback between the relaxation of the downpayment requirement and the interest rate. Indeed, one could expect the interest rate to go up when the downpayment constraint is relaxed as the borrowing demand is expected to increase. Omitting such an effect could be a source of bias in the welfare analysis.

Despite these differences, my results are consistent with the findings of Arslan, Guler, and Taskin (2013) and Hatchondo et al. (2011), in the sense that they are all in favor of conducting a macroprudential policy which specifies downpayment requirements. However, as far I know, none of the previous works have suggested an optimal minimum downpayment requirement. They simply report the welfare implications of different counterfactual experiments.\textsuperscript{6}

In my model, a homeowner can find it optimal to default because of the accumulation of interest on the mortgage loan, the depreciation of the housing stock, and housing transaction costs. According to my results, only extremely poor households are likely to default. Yet, if I impose a downpayment-ratio constraint of at least

\textsuperscript{4}Hatchondo et al. (2011) do not allow for geographic mobility.

\textsuperscript{5}Arslan, Guler, and Taskin (2013) assume a constant supply of rental and owner-occupied units as well as an exogenous interest rate. Hatchondo et al. (2011) assume a constant rental price normalized to zero to ensure that agents are always able to afford renting.

\textsuperscript{6}The high computational costs may be the main reason.
15%, the default rate falls to zero, since the poorest households would never have the chance to own houses. When the minimum downpayment requirement is relaxed, the default rate increases while the average downpayment decreases. This results is consistent with the fact that in the U.S: mortgage defaults and delinquencies are particularly concentrated among borrowers whose mortgages are classified as sub-prime or near-prime, targeted to borrowers who have tarnished credit histories and little savings available for downpayments. When determining the appropriate minimum downpayment requirement, policymakers face a trade-off between promoting homeownership and the risk of increasing the default rate. According to my welfare analysis, imposing a minimum downpayment requirement of 9.5% seems to maximize the average welfare. Accordingly, I would suggest that policymakers (regulators) include a requirement on the downpayment of around 9.5%, in the new definition of the QRM. However, we should view this number with some caution, given that, my model represents a steady state economy where house prices are constant.

4.2 The Environment

The environment in this chapter is very close to the one described in section 2.2 of Chapter 2 (as well as section 3.2 of Chapter 3). In this version of the model, as in Chapter 3, households receive offers to leave their city and move to another location. Those who accept the offer and move, will receive a moving bonus $\text{Premium}$. The cost of moving consists of the transactions costs that a mover-owner would incur when he sells his house before moving $(\bar{\Lambda}(h) = \psi h)$. 
**Default Decision:**

Borrowers have the option to default on the mortgage and return to the rental market. A defaulter has no obligation; he does not have to pay the outstanding mortgage debt nor even the transaction costs. Obviously, a defaulter will loose his house as it will be seized and transferred to the property of the lender. As a punishment, a defaulter will be deprived of borrowing for 7 years after his default. I also assume that the total default losses of lenders are uniformly distributed among all living households in the economy. For simplicity, I assume that the outstanding mortgage debts \( K_d \) and the seized houses \( H_d \) are added to the the accidental bequests of capital \( B^k \) and of housing \( B^h \). In other words, lenders do not incur the losses associated with the unpaid balances of defaulters, which is consistent with the fact that there is no risk premium included in the interest rate, to take into account the borrowers’ default risk.

### 4.3 Household’s Problem

In addition to the standard decisions on consumption, housing services and savings, a household makes up to three other strategic decisions. First, all households have to decide whether to rent or to own a house. Secondly, a household who receives an offer to move must also decide whether to accept this offer and move. Finally, if the household is a borrower, he also has to decide whether or not to default.
The problem of a household of age $a$ can be written recursively as:

$$W_a(x) = (1 - m) W_{a, Stay}(x) + m \left[ \max_{M \in \{0, 1\}} \left\{ (1 - M) W_{a, Stay}(x) + M W_{a, Move}(x) \right\} \right]$$

where:

$$W_{a, Stay}(x) = \max_{F \in \{0, 1\}} \left\{ F W_{a, d,s}(x) + (1 - F) \max_{D \in \{0, 1\}} \left\{ D W_{a, o,s}(x) + (1 - D) W_{a, r,s}(x) \right\} \right\}$$

$$W_{a, Move}(x) = \max_{F \in \{0, 1\}} \left\{ F W_{a, d,m}(x) + (1 - F) \max_{D \in \{0, 1\}} \left\{ D W_{a, o,m}(x) + (1 - D) W_{a, r,m}(x) \right\} \right\}$$

and if $k < 0$, $F \in \{0, 1\}$; otherwise, $F = 0$. Here $W_a(x)$ is the value function of a household of age $a$ with a state vector $x = \{k, h, z, m, cd\}$, where $k$ is capital holdings, $h$ is housing wealth, $z$ is the productivity shock, $m$ is an indicator variable that takes the value 1 when the household has an offer to move, and $cd \in \{0, 1, 2...6\}$ is a variable that keeps track of the credit history of the household. It indicates the number of years for which the household will be excluded from the borrowing market. For those who had defaulted more than 6 years ago (or have never defaulted), $cd$ takes the value 0. Based on this credit history variable, I introduce an indicator variable $df$ that takes the value 1, if $cd > 0$ (i.e. the household has defaulted within the last 6 years) and 0, otherwise.\(^7\)

\(^7\)Given that default losses are not incurred by lenders (i.e. no default risk premium), I do not need to keep track of the fraction of defaulters in the economy. In a dynamic model with risk premia included in the mortgage interest rates, one would introduce variables that measure the fractions of different defaulters categories in order to capture the impact of the default risk on mortgage loan interest rates.
(M = 1) or to reject it (M = 0), otherwise he will be a stayer. The value functions of a stayer and a mover are $W_{a}^{Stay}$ and $W_{a}^{Move}$, respectively. The choice variable $F$ takes on the value 1 if the household (a borrower) defaults on his mortgage loan. In this case, he will have to rent for at least one period.\footnote{A defaulter will leave his house and rent for one period. Then, he can buy a house but he won’t be eligible for a loan for 7 years.} Both mover and stayer, given that they do not default, have to choose between renting and owning; D takes the value 1 when the household chooses to be a homeowner, and 0 otherwise.

The net income of an agent of age $a$ is defined as $y_a = w \epsilon_a z - \tau$, for $a < \hat{T}$ and $y_a = P$, for $a \geq \hat{T}$. I also assume that agents cannot borrow when they reach the age T so that $k' = 0$ for $a = T$. Households receive utility from bequeathing wealth $Q_w$, where $\phi$ controls the strength of the bequest motive, $1 - \alpha_a$ is the probability that the household dies the next period and $\beta$, represents the time discount factor. The bequest motive is introduced in order to avoid a sharp decline in home-ownership late in life, which could represent a potential source of bias.

All these decisions depend on the value functions of each option ($W_{a}^{o,s}, W_{a}^{r,s}, W_{a}^{o,m}, W_{a}^{o,r},$ and $W_{a}^{d,s}(x)$). We discuss each of these in turn:

**Value of being a stayer-homeowner: $W_{a}^{o,s}$**

The problem faced by a stayer-homeowner consists of choosing consumption, house size and savings. The problem can be expressed recursively as:
CHAPTER 4. DOWNPAYMENT, HOMEOWNERSHIP AND DEFAULT

\[ W_{a,s}^{o,s}(x) = \max_{c,k',h'} \left\{ U(c,h') + \beta (1 - \alpha_a) \phi \log(Q_w) \right. \]

\[ + \beta \alpha_a \sum_{z'} \pi(z' \mid z) \left\{ (1 - \lambda_{a+1}) W_{a+1}(k', h', z', 0, df') + \lambda_{a+1} W_{a+1}(k', h', z', 1, df') \right\} \}

subject to

\[ Q_w = (1 - \delta_h) h' + (1 - \delta_k) k', \]

\[ c + k' + h' + \Lambda(h', h) = y_a + (1 + r)(k + BB_k) + (1 - \delta_h)(h + BB_h) \]

\[ k' \geq -(1 - \kappa) h' \times (1 - df), \quad c \geq 0 \quad \text{and} \quad h' \geq h \]

where \( \lambda_{a+1} \) is the probability of receiving an offer next period. If \( df = 1 \), the household is not allowed to borrow given that he has defaulter in the last 6 years. The variables \( BB_k \) and \( BB_h \) are the adjusted transfers of accidental bequests of capital and the housing stock.

A household can borrow up to a percentage \( (1 - \kappa) \) of the value of his new housing stock, where \( 0 \leq \kappa \leq 1 \). Hence, this constraint can also be interpreted as a downpayment constraint for housing purchases which is equivalent to a fraction \( \kappa \) of the value of the home being purchased. Obviously, the stayer-homeowner does not receive the moving premium.

**Value of being a stayer-renter:** \( W_{a,r,s} \)

The problem faced by a stayer-renter consists of choosing consumption, rental housing
services and savings, and can be expressed recursively as:

\[
W^{r,s}(x) = \max_{c,k',s} \left\{ U(c, s) + \beta (1 - \alpha_a) \phi \log(Q_w) + \beta \alpha_a \sum_{z'} \pi(z' \mid z) \{(1 - \lambda_{a+1}) W_{a+1}(k', 0, z', 0, df') + \lambda_{a+1} W_{a+1}(k', 0, z', 1, df')\} \right\}
\]

(4.5)

\[
c + k' + p \times s + \Lambda(0, h) = y_a + (1 + r)(k + BB_k) + (1 - \delta_h)(h + BB_h)
\]

\[
k' \geq 0, \quad c \geq 0 \quad s \geq 0 \quad \text{and} \quad h' = 0.
\]

A renter has no collateral to obtain loans \((k' > 0)\). He pays the rental price \(p\) and may also pay the transaction cost if he was a homeowner the previous period \((h > 0)\).

**Value of being a stayer-defaulter: \(W^{d,s}_a\)**

The problem faced by a stayer-defaulter consists of choosing consumption, and rental housing services:

\[
W^{d,s}_a(x) = \max_{c,k',s} \left\{ U(c, s) + \beta (1 - \alpha_a) \phi \log(Q_w) + \beta \alpha_a \sum_{z'} \pi(z' \mid z) \{(1 - \lambda_{a+1}) W_{a+1}(k', 0, z', 0, 1) + \lambda_{a+1} W_{a+1}(k', 0, z', 1, 1)\} \right\}
\]

(4.6)

\[
c + (k'=0) + p \times s + 0 \times \Lambda(0, h) = y_a + (1 + r)(0 \times k + BB_k) + (1 - \delta_h)(0 \times h + BB_h)
\]
\[ k' = 0, \quad c \geq 0 \quad s \geq 0 \quad \text{and} \quad h' = 0. \]

For simplicity, I assume that a defaulter is not allowed to invest in the same period in which he defaults on his mortgage (\(k' = 0\))\(^9\). A defaulter does not pay his outstanding debt and does not incur any transactions costs. Yet, his house will be seized, and he will be excluded from the mortgage market (\(cd' = 6\)) for 7 years.

**Value of being a mover-homeowner:** \(W_{a,m}^{o,m}\)

The problem faced by a mover-homeowner consists of choosing consumption, house size and savings.

\[
W_{a,m}^{o,m}(x) = \max_{c,k',h'} \left\{ U(c,h') + P_a + \beta (1-\alpha_a) \phi \log(Q_w) \right. \\
+ \beta \alpha_a \sum_{z'} \pi(z' | z) \left\{ (1 - \lambda_{a+1}) W_{a+1}(k', h', z', 0, df') + \lambda_{a+1} W_{a+1}(k', h', z', 1, df') \right\} \\
Q_w = (1 - \delta_h) h' + (1 - \delta_k) k', \\
c + k' + h' + \bar{\Lambda}(h) = y_a + (1+r)(k+BB_k) + (1 - \delta_h)(h+BB_h) \\
k' \geq -(1-\kappa)h' \times (1-df), \quad c \geq 0 \quad \text{and} \quad h' \geq h, \\
\]

A homeowner of age \(a\) receives the moving premium \(P_a\) as he accepts the offer and moves. The moving cost consists of paying the housing transaction cost \(\bar{\Lambda}(h) = \psi h\). Clearly, a mover-homeowner pays a housing transaction cost even if he keeps the same housing stock level \(h\), since he has no choice other than selling his house.

\(^9\)Even if I relax this assumption, defaulters would always choose \(k' = 0\), given their very limited income.
CHAPTER 4. DOWNPAYMENT, HOMEOWNERSHIP AND DEFAULT

Value of being a mover-renter: $W_{a}^{r,m}$

The problem faced by a mover-renter consists of choosing consumption, rental housing services and savings. Given that a renter does not pay any transaction cost, he will obviously make the same decisions as a stayer-renter. In fact, if a stayer finds it optimal to rent, he will definitely choose to move and rent if he receives an offer.

$$W_{a}^{r,m}(x) = W_{a}^{r,s}(x) + P_{a},$$

Value of being a mover-defaulter: $W_{a}^{d,m}$

Since a defaulter does not pay any moving cost, the mover-defaulter would choose the same optimal consumption level and savings position as the the stayer. Hence, any stayer household who would to choose default, would certainly accept the offer, if any.

$$W_{a}^{d,m}(x) = W_{a}^{d,s}(x) + P_{a},$$

In this version of the model, a household who would default if he has no offer, will always accept the offer if he has the opportunity to. A homeowner who would decide to stay owner if he has no offer, may choose to move and default.

4.4 Stationary Equilibrium

Given that there is no aggregate uncertainty in the economy, I focus on a stationary equilibrium in which prices, wages and the interest rate are constant through time. At the beginning of each period a household is characterized by his capital holding $k$, his housing stock $h$, his age $a$, labor productivity $z$, his offer status (whether or not he has an offer to move) $m$, and his credit history $cd$. In the stationary equilibrium,
Φ(k, h, a, z, m, cd), the measure of agents of type (k, h, a, z, m, cd), is constant.

**Definition**

A stationary equilibrium consists of a collection of:

Value functions \( \{W_a(x), W^a,s(x), W^r,s(x), W^{d,s}(x), W^{a,m}(x), W^{r,m}(x), W^{d,m}(x)\} \), policy functions (\( c, k', h', s, M, D, F \)), aggregate quantities \( L, K, H, H^o \) and \( H^r \), taxes \( \tau \), pensions \( P \), net accidental bequest transfers \( \{BB^k, BB^h\} \), accidental bequest transfers \( \{B^k, B^h\} \), outstanding mortgage debts \( K_d \), seized houses \( H_d \), prices \( \{w, q, r, p\} \), a law of motion of the credit history variable \( cd \), and a general law of motion \( \Gamma \) such that:

- All economic actors optimize their profits and utilities subject to 2.4, 2.5, 2.6, and 2.7.
- Labor is supplied inelastically in the model and satisfies:
  \[
  \int \epsilon_a z \, d\Phi = L, \tag{4.8}
  \]
  where \( L \) is the fixed labor supply.
- Markets clear:

Goods market clearing implies that:

\[
C + \delta_k K + \delta_h H^o + pH^r + \int (1-M(x,a)) \Lambda(h'(x,a), h) \, d\Phi + \int M(x,a) \overline{\Lambda}(h) \, d\Phi = Y, \tag{4.9}
\]
where $C$, $K$, $H^o$, and $H^r$ represent aggregate consumption, aggregate invested capital, aggregate owned housing stock, and aggregate rented housing stock, defined as:

$$C = \int c(x,a) \, d\Phi,$$

(4.10)

$$K = \int k'(x,a) \, d\Phi,$$

(4.11)

$$H^o = \int D(x,a)h'(x,a) \, d\Phi,$$

(4.12)

$$H^r = \int [1 - D(x,a)]s(x,a) \, d\Phi,$$

(4.13)

$$H = H^o + H^r,$$

(4.14)

The last two expressions of the left hand side of the goods market clearing condition take into consideration the fact that a mover faces a different transactions costs function.

- Adjusted accidental bequest transfers satisfy:

$$BB^k = \int [k'(x,a) - k] \, d\Phi,$$

(4.15)

$$BB^h = \int [h'(x,a) - h] \, d\Phi,$$

(4.16)

In the stationary equilibrium, the adjusted accidental bequest is simply the
difference between the total capital at the end of the last period and the total capital at the beginning of the current period.

\[ BB^k = B^k + K_d, \text{ and } BB^h = B^h + H_d. \]

where \( K_d \) and \( H_d \) are the total unpaid debt and the aggregate seized housing stock, respectively, defined as:

\[ K_d = \int F(x,a) k \, d\Phi, \text{ and } H_d = \int F(x,a) h \, d\Phi. \]

- The government provides retirement benefits through a social security program, financed by taxes collected from working households. Government budget balance implies that:

\[
\hat{T} \sum_{a=1}^{\tau} \varpi_a \tau = \sum_{a=\tau+1}^{T} \varpi_a P \tag{4.17}
\]

where \( \varpi_{\tilde{a}} = \int d\Phi(k,h,a = \tilde{a}, z, m). \)

- Law of motion of \( cd \):

  - If \( cd = 0 \), then:
    * If \( F(x,a) = 1 \) (household defaults on his mortgage), then \( cd' = 6 \).
    * Otherwise, \( cd' = 0 \).
  
  - Otherwise (\( cd > 0 \)), then \( cd' = cd - 1 \)

- The measure \( \Phi \) satisfies: \( \Phi = \Gamma(\Phi) \), where \( \Gamma \) is the law of motion generated by policy functions \( h' \) and \( k' \), the transition probabilities \( \pi(z'|z) \) and the age dependent mobility probabilities \( \{\lambda_a\}_{a=1}^{T} \).

I compute the stationary equilibrium of the model using an extension of the backward induction method used in Chapter 3 (See Appendix C for more details).
4.5 Calibration

I calibrate the baseline model to match some long-run averages of the U.S. economy as well as several demographic features. The parametrization is quite similar to Chapter 2 (see section 2.5), with few exceptions. I set the minimum house size available for purchase, $h$, costs 1.9 times the average annual pre-tax household income. This parameter seems to have no significant impact on the results. It is true that when I set it at lower values, the aggregate ownership rate increases but when I recalibrate $\theta$ to match the target, I end up with very similar results. However, it seems that setting $h$ to 1.9 times average income implies a slightly better fitting of the life cycle homeownership curve.

The moving offer rates are calibrated to match the empirical renter geographic mobility rates. Hence, the predicted renters’ actual moving rates are, by construction, equal to their empirical counterparts, since renters, in my model, do not incur any moving costs. The age-specific moving bonus $P_a$ (see Figure 4.1) is calibrated so that the predicted homeowners mobility rates match their empirical counterparts (see Figure 4.3). In other words, differences in moving rates between renters and owners of the same age are assumed to be, exclusively, due to housing transaction costs.

The idiosyncratic shock to labor productivity is specified as:

$$\log z_t = \rho_z \log z_{t-1} + \sigma_z (1 - \rho_z^2)^{1/2} \varepsilon_t, \quad \varepsilon_t \sim N(0, 1). \quad (4.18)$$

This AR(1) equation is approximated with an $N_z$-state Markov process ($N_z = 11$). I calibrate $\sigma_z$ so that the earnings GINI coefficient implied by the model matches its
counterpart in the data (0.404).

Table 3.1 summarizes the parametrization for the model.

Table 4.1: Calibration

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival probabilities</td>
<td>$\alpha_a$</td>
<td>Figure 2.3</td>
</tr>
<tr>
<td>Deterministic age specific component</td>
<td>$\epsilon_a$</td>
<td>Figure 2.2</td>
</tr>
<tr>
<td>Moving premium</td>
<td>$P_a$</td>
<td>Figure 4.1</td>
</tr>
<tr>
<td>Moving offer rates</td>
<td>$\lambda_a$</td>
<td>Figure 4.3</td>
</tr>
<tr>
<td>Real owners mobility rates</td>
<td>-</td>
<td>Figure 4.3</td>
</tr>
<tr>
<td>Capital share</td>
<td>$\alpha$</td>
<td>0.3</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>0.9758</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>$\delta_k$</td>
<td>0.094</td>
</tr>
<tr>
<td>Weight on housing in utility</td>
<td>$\chi$</td>
<td>0.16</td>
</tr>
<tr>
<td>Housing depreciation rate</td>
<td>$\delta_h$</td>
<td>0.043</td>
</tr>
<tr>
<td>Bequest motive parameter</td>
<td>$\phi$</td>
<td>0.265</td>
</tr>
<tr>
<td>Housing transaction cost</td>
<td>$\psi$</td>
<td>5%</td>
</tr>
<tr>
<td>Utility parameter (Renting Vs Owning)</td>
<td>$\theta$</td>
<td>0.7</td>
</tr>
<tr>
<td>Downpayment parameter</td>
<td>$\kappa$</td>
<td>0.15</td>
</tr>
<tr>
<td>Minimum size house available for purchase</td>
<td>$h$</td>
<td>1.9 $Avg\ inc$</td>
</tr>
<tr>
<td>Unconditional standard deviation of $\log(z_t)$</td>
<td>$\sigma_z$</td>
<td>0.629</td>
</tr>
<tr>
<td>Persistent parameter of $\log(z_t)$</td>
<td>$\rho_z$</td>
<td>0.95</td>
</tr>
</tbody>
</table>
Figure 4.1: Calibration of the Moving Premium in function of Age
4.6 Results

4.6.1 Baseline Model (Figure 4.2)

The baseline model will be used as a benchmark to assess the impact of the relaxation of the downpayment constraint on homeownership and default rates for households of different age cohorts. In this version of the model, I set the minimum downpayment requirement $\kappa$ to 15%, as in Chapters 2 and 3. Later, I will change this parameter when performing the counterfactual analysis.

Table 4.2 compares the baseline model with the data, where the variables in the bottom section are obtained by calibration.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Error$</td>
<td>Sum of absolute values of errors (Model Vs Data)</td>
<td>0.78</td>
<td>-</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Utility parameter (Renting Vs Owning)</td>
<td>0.703</td>
<td>-</td>
</tr>
<tr>
<td>$Constr_f$</td>
<td>Fraction of financially constrained house buyers</td>
<td>0.71%</td>
<td>-</td>
</tr>
<tr>
<td>$Default_r$</td>
<td>Aggregate default rate</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>$Ownership_g$</td>
<td>Aggregate ownership rate for hhs between 20 and 41</td>
<td>43.33%</td>
<td>44.3%</td>
</tr>
<tr>
<td>$Ownership_m$</td>
<td>Aggregate ownership rate for hhs between 41 and 60</td>
<td>74.53%</td>
<td>73.83%</td>
</tr>
<tr>
<td>$Ownership_o$</td>
<td>Aggregate ownership rate for hhs older than 61</td>
<td>81.19%</td>
<td>80.8%</td>
</tr>
<tr>
<td>$Ownership_r$</td>
<td>Aggregate ownership rate</td>
<td>65.03%</td>
<td>65%</td>
</tr>
<tr>
<td>$r$</td>
<td>Equilibrium interest rate</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>$H/Y$</td>
<td>Ratio of housing to output</td>
<td>1.403</td>
<td>[1.4, 1.55]</td>
</tr>
<tr>
<td>$K/Y$</td>
<td>Ratio of capital to output</td>
<td>2.407</td>
<td>[2, 2.5]</td>
</tr>
<tr>
<td>$Gini$</td>
<td>Earnings GINI coefficient</td>
<td>0.404</td>
<td>0.404</td>
</tr>
</tbody>
</table>

The fraction of financially constrained house buyers is the percentage of buyers who borrow exactly a fraction $(1 - \kappa)$ of the value of the house being purchased. It does not include owners who upgrade their housing stock.
Figure 4.3 reports the empirical life cycle mobility rates for renters (blue curve) between 2009 and 2010 that are used to proxy for the moving offer rates. It also compares the predicted owners mobility rates (green curve) to their empirical counterpart (red curve). Figure 4.2 compares the home-ownership curve as a function of age predicted by the baseline model to that implied by the data.

Clearly, the baseline model does a very good job in replicating life cycle ownership rates, and predicts a zero default rate. As we will see in the next sections, the default rate will increase as I relax the downpayment requirement.

Before analyzing the tradeoff between promoting homeownership and increasing the default risk, I will investigate the reasons that make borrowers choosing to default instead of selling their houses and, hence, avoiding the punishment.
CHAPTER 4. DOWNPAYMENT, HOMEOWNERSHIP AND DEFAULT

Figure 4.2: Life Cycle Homeownership Curve (Baseline Model)

Figure 4.3: Mobility rates
4.6.2 When Do Borrowers Default?

One could wonder why a borrower would default in a context where house prices are assumed to be constant, and where a minimum downpayment is required. In such an environment, the housing stock \( (h) \) will be always greater than the loan principal \((−k)\), since \( k' > = (1 - \kappa)h' \). However, as we will see later, when the downpayment requirement is relaxed, some poor owners (those with the highest debt levels and negative home equity) may find themselves better off defaulting than selling their houses. To understand this behavior, one must recall that, every period, the housing stock depreciates by a fraction \( \delta_h \). At the same time, the outstanding balance of the mortgage increases due to the accumulated interest. In other words, even if \( h' > k' \), next period, the net household housing wealth \((1 - \delta_h)h\) may not cover the outstanding debt balance \(-(1 + r)k\)\(^{10}\). Moreover, a defaulter will avoid the transaction costs that a seller would incur if he sells his house.\(^{11}\)

Figure 4.4(a) displays the default choice as a function of income and the mortgage debt ratio, for an individual at the age of 30 who does not receive an offer to move, when the minimum downpayment requirement is relaxed to 5%. First, the borrower never defaults when his debt ratio is sufficiently small (i.e. positive home equity), given that he can simply sell his house, if he chooses to rent. As debt ratio increases, the borrower is more likely to default on his loan given his negative home equity. However, this does not mean that all borrowers with negative home equity will choose to default. In fact, a borrower with a small negative home equity and relatively high income might not choose to default, and might simply sell his (underwater) house or

---

\(^{10}\)This is true even if \( \delta_h = 0 \).

\(^{11}\)I assume that banks do not pay transaction costs on seized houses.
keep it, and incur the capital loss. This is because of the default cost, related to the fact of being excluded from the mortgage market for seven years. However, as the income decreases, the homeowner is more likely to default on his mortgage loan.

Figure 4.4(b) is similar to figure 4.4(a), yet, this time the homeowner receives an offer to move. The default probability of a mover (blue surface) is significantly bigger than the stayer’s one. Indeed, for some households with a relatively high income and a high debt ratio, stayer-owner would not default, whereas the mover-owner decisions may be different. In fact, having the opportunity to move, increases the value of the default decision, given that a mover-defaulter will avoid the transaction cost that a non-defaulter would incur when moving.

Thus, we can conclude that both income and moving offers are the main trigger factors for default, given that house prices are constant. Figure 4.5 plots the share of each age group in the total number of defaulters in the economy. As may be seen, the vast majority of defaulters belongs to the youngest age groups, which is not surprising since young households are those who have the lowest income and the highest mobility rates.
(a) Stayer

(b) Mover

Figure 4.4: Default Decision: 30 years Old Borrower
4.6.3 Minimum Downpayment Requirement: Welfare Analysis

In this section, I conduct a welfare analysis to determine the steady state, average welfare maximizing minimum downpayment requirement.\textsuperscript{12} Table 4.3 reports the impact of changing the downpayment requirement on the economy. For every value of $\kappa$, I compute the average welfare gain, the implied aggregate default rate, the average downpayment ratio, and the aggregate homeownership rate. The welfare gain is measured in terms of consumption compensations (in percentage) that would make the average household in steady state indifferent between the zero downpayment economy ($\kappa = 0$) and the economies with different minimum downpayment requirements.

\textsuperscript{12}Which does not necessarily account for the welfare implications of transitional dynamics.
CHAPTER 4. DOWNPAYMENT, HOMEOWNERSHIP AND DEFAULT

Table 4.3: Results

<table>
<thead>
<tr>
<th>Minimum Downp</th>
<th>Welfare Gain</th>
<th>Default Rate</th>
<th>Average Downp</th>
<th>Aggregate Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0%</td>
<td>0.2163</td>
<td>0.1036</td>
<td>0.6192</td>
</tr>
<tr>
<td>0.025</td>
<td>1.41%</td>
<td>0.1612</td>
<td>0.1415</td>
<td>0.6474</td>
</tr>
<tr>
<td>0.05</td>
<td>2.48%</td>
<td>0.0936</td>
<td>0.2359</td>
<td>0.6489</td>
</tr>
<tr>
<td>0.075</td>
<td>3.11%</td>
<td>0.0172</td>
<td>0.3432</td>
<td>65.01</td>
</tr>
<tr>
<td>0.09</td>
<td>3.29%</td>
<td>0.0012</td>
<td>0.3871</td>
<td>0.6533</td>
</tr>
<tr>
<td>0.0925</td>
<td>3.33%</td>
<td>0.0010</td>
<td>0.3892</td>
<td>0.6541</td>
</tr>
<tr>
<td><strong>0.095</strong></td>
<td><strong>3.36%</strong></td>
<td>0.0009</td>
<td>0.3865</td>
<td>0.6554</td>
</tr>
<tr>
<td>0.0975</td>
<td>3.34%</td>
<td>0.0003</td>
<td>0.3968</td>
<td>0.6534</td>
</tr>
<tr>
<td>0.1</td>
<td>3.33%</td>
<td>0.0003</td>
<td>0.3961</td>
<td>0.6533</td>
</tr>
<tr>
<td>0.105</td>
<td>3.328%</td>
<td>0.0001</td>
<td>0.3975</td>
<td>0.6530</td>
</tr>
<tr>
<td>0.115</td>
<td>3.32%</td>
<td>0</td>
<td>0.3994</td>
<td>0.6524</td>
</tr>
<tr>
<td>0.15</td>
<td>3.22%</td>
<td>0</td>
<td>0.4038</td>
<td>0.6503</td>
</tr>
<tr>
<td>0.2</td>
<td>2.86%</td>
<td>0</td>
<td>0.3972</td>
<td>0.6467</td>
</tr>
<tr>
<td>0.25</td>
<td>2.58%</td>
<td>0</td>
<td>0.4045</td>
<td>0.6420</td>
</tr>
</tbody>
</table>

It is not surprising that when I relax the downpayment constraint, the homeownership rate increases. However, when $\kappa$ is amply relaxed, the ownership rate can decline. This is because of the relatively big increase in default rates, and consequently, the large number of households deprived of the option of being owners for many years, given the 7 years punishment period. This explains why, for extremely low minimum downpayment parameters, the aggregate ownership rate may decline.\footnote{For instance, when the downpayment is relaxed from 9% to 5%, the aggregate homeownership rate decreases from 65.33% to 64.89%.}

Unlike Chapters 2 and 3, where borrowers are committed to pay their debts, in this chapter’s framework, the average downpayment can be significantly influenced by the relaxation of the minimum downpayment requirement, in particular, for low values of $\kappa$. In fact, when the minimum downpayment is significantly relaxed, several relatively poor households would just borrow up to the limit to purchase a home. In the worst case scenario (i.e. several consecutive negative income shocks), they can...
simply default on their mortgages. This explains the increase in the default rate when the minimum downpayment requirement is sufficiently relaxed. Indeed, the decline in the default rate goes along with a sharp decline in the average downpayment ratio. Those who borrow up to the limit are more likely to default than others. Hence, defaulters are those with the lowest downpayment and the highest debt ratios.

One could think that when we relax the downpayment requirement, the total welfare should always increase, even in a context where households are allowed to default. In fact, households are supposed to make decisions that maximize their value functions which depends, exclusively, on their current and future utility functions. Moreover, we know that that the future probabilities (income shocks, moving offers, survival probabilities), that are taken into account by households when maximizing their value functions, are nothing but the proportions of households. Thus, we may expect that the relaxation of any constraint should have a positive impact on the total welfare, since the latter is simply the sum of the utility functions of all households. However, we should also remember, that when a household makes a decision, he only cares about his own objective function, which doesn’t value the future as it values the present ($\beta < 1$). Hence, when I relax the downpayment constraint, the total welfare can decrease (many households in the punishment zone).

According to Table 4.3, for certain values of the minimum downpayment parameter $\kappa$, we can have the following phenomena: A relaxation of the downpayment requirement generates an increase in the aggregate ownership. Yet, the total welfare, surprisingly, declines.\footnote{For instance, if I relax the minimum downpayment requirement from 20\% to 5\%, the aggregate...}
It seems that the welfare improvement, resulting from the increase in new owners, who are mainly poor households, is dominated by the decline in the total welfare caused by the fact that many households are deprived of the option of borrowing loans to buy a house. Hence, there are many moderately rich households who cannot buy a house because they are not allowed to borrow. It follows that we will end up with a housing market with many poor owners and few relatively richer renters. In terms of utility, it is seems that the welfare gain of the poor owners is dominated by the welfare loss of the richer renters.

Finally, according Figure 4.6, we can see that the shape of total welfare as a function of the minimum downpayment requirement is concave. Hence, there exists an optimal downpayment requirement that maximizes the total welfare of the households resulting from the tradeoff between promoting homeownership and increasing the risk of default. This optimal downpayment requirement is 9.5%. We should view this number with some caution. Indeed, in this model, the interest rate and house prices are constant. However, these two factors may have significant impacts on default rates. Thus, we should expect the model to predict default rates that are relatively low in comparison with the real world.

\[ ownership \text{ rates increases slightly by } 0.34\%, \text{ and the total welfare declines by } 0.37\% \]

\[ ^{15} \text{During the 7 years punishment period, a poor household can get several good income shocks and become wealthier.} \]
However, even in this case, the minimum downpayment requirement will also play an important role in amplifying or shrinking the impact of interest rates and house prices dynamics, on the likelihood of default; as the minimum downpayment requirement is relaxed, the debt level increases (-k), so that the probability of being in a distressed financial state goes up as well.

So far, I have only investigated the aggregate welfare implications of different downpayment requirement policies. It is also interesting to analyze the respective welfare changes for each age group. Table 4.4 reports the welfare gain/loss for young (aged between 20 and 40), middle-aged (aged between 41 and 60), and old households (older than 60), for different values of the downpayment requirement parameter $\kappa$. 

Figure 4.6: Welfare Analysis
Again, the zero downpayment case is used as reference economy to measure the percentage change of the equivalent consumption compensation.

Table 4.4: Welfare Gain by Age Group

<table>
<thead>
<tr>
<th>$\kappa$</th>
<th>All Households</th>
<th>Young Households</th>
<th>Middle-aged Households</th>
<th>Old Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0.025</td>
<td>1.41%</td>
<td>0.87%</td>
<td>1.59%</td>
<td>2.09%</td>
</tr>
<tr>
<td>0.05</td>
<td>2.48%</td>
<td>1.81%</td>
<td>2.65%</td>
<td>3.09%</td>
</tr>
<tr>
<td>0.075</td>
<td>3.11%</td>
<td>2.55%</td>
<td>3.11%</td>
<td>3.33%</td>
</tr>
<tr>
<td>0.09</td>
<td>3.29%</td>
<td>2.93%</td>
<td>3.18%</td>
<td>3.42%</td>
</tr>
<tr>
<td>0.0925</td>
<td>3.33%</td>
<td>2.96%</td>
<td>3.22%</td>
<td>3.45%</td>
</tr>
<tr>
<td><strong>0.095</strong></td>
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Table 4.4 shows that the overall optimal minimum downpayment requirement ($\kappa = 9.5\%$) is also socially optimal for both middle-aged and old households. Old households seem to be the biggest beneficiaries of the relaxation of downpayment requirement. Indeed, retired households have relatively low income and do not expect any future earnings increase. Hence, a relaxation of the downpayment requirement allows many relatively poor retired households to own houses. At the same time, the default rate for this category of households will not significantly increase since they face no income uncertainty as they receive the same fixed pension.

However, for young households, the optimal minimum downpayment requirement is different from the global one; it simply corresponds to the benchmark economy ($\kappa = 15\%$). In fact, when the downpayment requirement is relaxed, the aggregate welfare of young households decreases, unlike the case of the other age groups. To
understand this result, we should remember that young households are more likely than others to default, giving their low income, their high future earnings uncertainly, and their high moving rates. Hence, as the minimum downpayment constraint is relaxed, a significant number of young households will default, which explains the decline in the aggregate welfare for this category of households.

4.7 Concluding Remarks

In this chapter I study the impact of relaxing downpayment requirements on the homeownership rate and default risk. Given its quantitative success in matching the U.S. homeownership curve, my model represents a reasonable benchmark to assess the efficiency of mortgage default prevention policies. I find that both income and mobility are the main trigger factors for default decisions. In fact, a borrower who has the opportunity to move has a higher default probability than a stayer. According to my welfare analysis, I suggest that policymakers include a minimum downpayment requirement of 9.5% in the new definition of the QRM. However, this number should be viewed with some caution, since in a steady state model, house prices turn out to be constant. Yet, house price fluctuations represent an important factor influencing the default rate. Potentially, the optimal minimum downpayment requirement should be set at higher value than 9.5%.

In order to get more accurate results regarding the optimal minimum downpayment requirement, I should extend model by introducing aggregate shocks which affect both, house prices and the interest rate.
Chapter 5

Summary and Conclusions

Most housing experts argue that the relatively low homeownership rate among young households is mainly due to high downpayment requirements. Consequently, in order to promote homeownership, particularly for young households, policymakers have put different measures in place to relax the downpayment constraints, and facilitate the access of these households to the mortgage market. The main objective of this dissertation is to consider the effects of a specific class of polices, chosen for their realism, on homeownership (specifically the age profile); mobility, default rates, and ultimately welfare. In this context, I build a stylized, yet rich framework that incorporates several potential channels through which the housing tenure decision mechanism can be affected. The model does a very good job in matching the U.S. life cycle homeownership curve as well as in capturing the shift in the ownership curve between 1993 and 2009. Based on my quantitative analysis, I argue that the low homeownership rates among young households are not only due to their limited financial resources but also their high geographic mobility. However, the downpayment requirement does not seem to have significant impact on homeownership rates. Indeed, given the high
future income uncertainty and the high moving rates of young households, only the richest among them decide to purchase houses. Consequently, the relaxation of down-payment requirements does not really have significant implications for this category of households.

In Chapter 3, I investigate whether or not the key results reported in Chapter 2 regarding the impact of geographical mobility on homeownership depend on the nature of the assumption made about mobility shocks. To do so, I assume that households receive offers to move which they can reject or accept, depending on how they value each of two options. A homeowner who has an opportunity to move faces a trade-off between receiving a moving premium and incurring the moving cost which simply consists in paying the housing transactions costs. According to my findings, the results on the impact of mobility on homeownership reported in Chapter 2, are quite robust to the mobility shocks assumption. The new framework also allows me to investigate the impact of the income process on the relationship between homeownership and mobility. My model predicts that an increase in income risk (i.e. higher income inequality) has a positive impact on geographical mobility of young households. The model also predicts that a less persistent income process has a negative impact on mobility, in particular for young homeowners, as they become more worried about their future income. Overall, mobility rates of young homeowners seem to be more sensitive to income process changes than those of old homeowners. These findings have important implications for both researchers and policymakers. In fact, many argue that higher homeownership rates are associated with higher unemployment, since homeowners are less mobile than renters, which can affect their flexibility and, hence, decrease their chances of getting a job. According to my results,
the negative impact of homeownership on labour market efficiency is relatively less important for young homeowners, especially when we take into account the recent increase in income inequality in the U.S. Hence, policymakers and researchers should be aware that the degree of the impact of homeownership on labour market efficiency can differ from one age group to another. Moreover, my model predicts that the rise in income inequality in the U.S. will have a negative impact on homeownership rates, especially for middle-aged households, and a positive impact on young households’ mobility rates.

In Chapter 4, I extend the model by allowing borrowers to default on their mortgage loans in order to come up with suggestions to U.S. regulators with regard to the definition of the QRM, and to assess the efficiency of the mortgage default prevention policies more broadly. Based on my welfare analysis, I suggest that U.S. regulators include a minimum downpayment requirement of 9.5%. However, we should view this number with some caution, given that house prices in my model are constant. I also argue that, even though the relaxation of downpayment requirements can raise average social welfare, young households can experience a welfare loss. Since young households are more likely to default than others, the relaxation of the downpayment requirement implies that their default rate increases. This result is important for policymakers in the sense that the relaxation of the downpayment requirement is, usually, not socially beneficial for young households. Accordingly, policymakers should no more view the downpayment requirement as a tool to promote homeownership. Instead, they should consider it as an effective default prevention measure.

Having said this, in order to provide accurate assessment of the efficiency of any
housing or mortgage market policy, we need to use a realistic macroeconomic framework that captures the key features characterizing the housing market. In future work, I plan to introduce both, a house price and an interest rate aggregate shocks in order to get more accurate results with regard to the socially optimal minimum downpayment requirement, and to study the short term dynamic implications of relaxing downpayment requirements. A second feature that my projected research agenda will address is the relationship between homeownership and labour outcome in an extended version of the Chapter 3’s model with heterogeneous locations and labour search frictions.
Bibliography


Appendix A

I compute the stationary equilibrium of the model using a standard computational method of solving overlapping generations models. However, I proceed with a new method on how to define the capital grid that allows households to borrow up to the limit \( (1 - \kappa)h' \) when buying a house, without being forced to use a huge grid.

A.1 State space discretization

I discretize the state space for housing stocks, asset holdings, productivity shocks and mobility shocks: \( S = \{h, h_1...h\} \times \{k, k_1...k\} \times \{z_1...z_5\} \times \{1, 2...100\} \times \{0, 1\} \). Hence, the total number of the state space is: \( N_h \times N_k \times N_z \times T \times 2 \). I should be careful when choosing the grids, because I can easily end up with an extremely high dimensional problem that could require weeks to be numerically solved (or even more). At the same time, using small grids has its own cost in term of results accuracy.

- The upper bounds on grids, \( \bar{h} \) and \( \bar{k} \), are chosen large enough so that when I increase one or both of them, the policy functions remain unchanged.

- The number of grid points are as follows: 5 values of the idiosyncratic shock, 8 points for the housing stock and 193 points for the asset holdings.
• I use a "new" method to build the capital grid (negative part) that allows to model agents to borrow up to the limit \((1 - \kappa)h\) when buying a house, without being forced to use a huge grid. In fact, grid steps depend on the downpayment parameter \((\kappa)\) and the minimum housing quantity \((h)\).

To build the negative interval of the capital grid, I use the following \textit{matlab} command loop:

\begin{verbatim}
*k_grid = 1: -1: 2;
*step = 40
* for i = 1: step;
* k_grid(step + 1 - i, 1) = -h * (1 - \kappa) * (i/step);
* end;

if step = n, then we will hit the borrowing constraint -(1-\kappa)\bar{h}, after n grid points
\end{verbatim}

\section*{A.2 Algorithm}

I solve the steady state equilibrium as follows:

1. Guess the interest rate \(r\) and the accidental bequest transfers \(B_k\) and \(B_h\).
2. Compute house rental price \(p\), capital rental price \(q\) and wage \(w\).
3. Compute aggregate labor and capital demands, average income, output, pension and tax transfers.
4. Given \( W_T(.) = 0 \), I solve the household’s problem by backward induction. I start first by solving the optimal policy functions \( k', c \) and \( h' \), for each of the points of the grid, for renter’s and the owner’s problems\(^1\). Then, based on \( W_o^a \) and \( W_r^a \), I derive the housing tenure policy function \( D \).

- I exploit the additively separable logarithmic preferences to simplify the renter’s problem. In fact, I can derive the consumption directly from the budget constraint:

\[
c = \frac{y_a + (1 + r)(k + B_k) + (1 - \delta_h)(h + B_h) - k' - \Lambda(0, h)}{1 + \chi}
\]

- The tenant per-period utility function simplifies to:

\[
U(k) = (1 + \chi) \log(c) + \chi \log \left( \frac{\theta \chi}{p} \right)
\]

- I exploit the strictly concavity of the value function in \( k' \) for the renter’s problem and in \( k' \) for a given housing choice \( h' \), for the owner’s problem.

- I also exploit the monotonicity of the the policy function function \( k' \) in \( k \) for the renter’s problem.

5. Given the transition probabilities \( \pi(z'|z) \) and the age dependent mobility probabilities \( \{\lambda_a\}_{a=1}^{T} \), I proceed with the same optimization routine described in step 4, for \( T-1 \).

\(^1\)For \( m = 1 \), I only solve the renter’s problem.
6. I repeat step 5 until the first period.

7. I compute the stationary distribution $\Phi$ given the policy functions and the transitions probabilities (productivity and mobility shocks) by forward induction starting from the first period. Since my model is an overlapping generations model where the total number of population is constant, I only need the initial distribution of capital and housing for the first generation (age = 1), to compute $\Phi$.

8. I compute the aggregate supplies: $Y$, $K$ and $H'$ and verify the market clearing conditions. If all markets clear, the equilibrium is solved, otherwise, I update $r$, $B_k$ and $B_h$ and I go back to step 1.
Appendix B

I use a very close computation method as described in Appendix A. However, the state space becomes: $S = \{0, h, h_1 \ldots h\} \times \{k_1 \ldots k\} \times \{z_1 \ldots z_{11}\} \times \{1, 2 \ldots 100\} \times \{0, 1\}$. Hence, the total number of the state space is: $N_h \times N_k \times N_z \times T \times 2$.

As for the algorithm, the step 4 is now more challenging as households who receive offers can decide on whether to accept or reject it.

1. If $m = 0$ (i.e. no offer), we just follow the step 4 as described in Appendix A.

2. If $m = 1$ (i.e receives an offer).

   (a) If the the household enters the current period as a renter, or if an identical household who doesn’t receive the offer chooses to rent, then the household always accepts the offer, and makes the same choices as the stayer.

   (b) Otherwise, I solve the mover-owner problem’s and compare the three values: $W_{o,m}^a$, $W_{o,s}^a$ and $W_{r,m}^a(x)^{[1]}$

---

$^1$A homeowner who would choose to stay homeowner if has no offer, can choose to move and rent if he receives an offer.
Appendix C

I compute the stationary equilibrium of the model using an extended version of the computational methods described in Appendices B and C. However, the state space substantively increases because of default history tracking.

I discretize the state space for housing stocks, asset holdings, productivity shocks, and credit history: $S = \{0, h, \bar{h}\} \times \{k, k_1 \ldots k\} \times \{z_1 \ldots z_{11}\} \times \{1, 2 \ldots 7\} \times \{1, 2 \ldots 100\} \times \{1, 2\}$.

- The upper bounds $\bar{k}$, is chosen large enough so that when I increase it, the policy functions remain unchanged.

- Given that the welfare analysis requires computing the equilibrium several times using different values of $\kappa$, I set $N_h = 3$. In other words, homeowners can buy a small or a big house. I choose $\bar{h}$ so that the results are not affected by this assumption.

- The number of grid points are as follows: 11 values of the idiosyncratic shock, 3 points for the housing stock and 429 points for the asset holdings.
C.1 Algorithm

I solve the steady state equilibrium as follows:

1. Guess the interest rate $r$ and the accidental bequest transfers $BB_k$ and $BB_h$.

2. Compute house rental price $p$, capital rental price $q$ and wage $w$.

3. Compute aggregate labor and capital demands, average income, output, pension and tax transfers.

4. Given $W_T(.) = 0$, I solve the household’s problem by backward induction. I start first by solving the optimal policy functions $k'$, $c$, and $h'$, for each of the points of the grid, for each category of households (stayer-renter, mover-renter, stayer-owner, mover-owner, stayer-defaulter, mover-defaulter). Given the different value functions $\{W_a(x), W^{r,s}_a(x), W^{r,s}_h(x), W^{d,s}_a(x), W^{d,m}_a(x), W^{d,m}_h(x)\}$, I derive the housing tenure policy function $D$, the moving policy function $M$, and the default policy function $F$.

   - I exploit the additively separable logarithmic preferences to simplify the renter’s problem. In fact, I can derive the consumption directly from the budget constraint:\(^1\)

   $$c = \frac{y_a + (1 + r)(k + BB_k) + (1 - \delta_h)(h + BB_h) - k' - \Lambda(0, h)}{1 + \chi}$$

\(^1\) For defaulter’s problem, $k = k' = h = 0$ and the moving cost is not payed. For mover’s problem, the moving cost function is $\Lambda(h)$. 
The tenant per-period utility function simplifies to:

\[ U(k) = (1 + \chi) \log(c) + \chi \log \left( \frac{\theta \chi}{p} \right) \]

- I exploit the strictly concavity of the value function in \( k' \) for the renter’s problem and in \( k' \) for a given housing choice \( h' \), for the owner’s problem.
- I also exploit the monotonicity of the the policy function function \( k' \) in \( k \) for the renter’s problem.

5. Given the transition probabilities \( \pi(z'|z) \) and the age dependent mobility probabilities \( \{\lambda_a\}_{a=1}^{T} \), I proceed with the same optimization routine described in step 4, for \( T-1 \).

6. I repeat step 5 until the first period.

7. I compute the stationary distribution \( \Phi \) given the policy functions and the transitions probabilities (productivity and credit history) by forward induction starting from the first period. Since my model is an overlapping generations model where the total number of population is constant, I only need the initial distribution of capital and housing for the first generation (age = 1), to compute \( \Phi \).

8. I compute the aggregate supplies: \( Y, K \) and \( H' \) and verify the market clearing conditions. If all markets clear, the equilibrium is solved, otherwise, I update \( r, BB_k \) and \( BB_h \) and I go back to step 1.
The algorithm describing step 4 is as follows:

1. If $m = 0$ (i.e. no offer).
   
   (a) if $k \geq 0$, I compare the three values: $W_{d,s}^{r}$, $W_{a}^{r,s}$ and $W_{a}^{m,s}$.
   
   (b) Otherwise, we compare $W_{a}^{r,s}$ and $W_{a}^{m,s}$.

2. if $m = 1$ (i.e receives an offer).
   
   (a) If the the household enters the current period as a renter, or if an identical household who doesn’t receive the offer chooses to rent or decide to default, then the household always accepts the offer, and makes the same choices as the stayer.
   
   (b) Otherwise, I solve the mover-owner problem’s and compare the four values: $W_{a}^{o,m}$, $W_{a}^{o,s}$, $W_{a}^{r,s}$ and $W_{a}^{d,m}$.

---

2 A homeowner who would choose to stay homeowner if has no offer, can choose to move and rent or even default, if he receives an offer.