

The Design of Foreclosures Punishments: You Just Cannot Walk Away!*

Carlos Garriga
Federal Reserve Bank of St. Louis

Don E. Schlagenhauf[†]
Florida State University

February 2009

Abstract

Foreclosure rates have soared during the recent housing crises in the United States. In this paper we argue that exploring the implications of the legal environment pertinent to foreclosure is very relevant to understand the macroeconomic transmission of financial crises. Foreclosure law is designed to allocate the deficit between the current value of the property and the outstanding debt. In the United States two different regimens coexist across states: no discharge and full discharge. The empirical evidence seems to suggest that states with full discharge exhibit foreclosure rates that are more sensitive to declines in house values. We study the quantitative importance of default punishments in the determination of foreclosure rates. We modify the housing model with default option developed in Garriga and Schlagenhauf (2008) to allow for different allocation of default deficits and severity of (present and future) punishments. The model generates testable implications for tenure, housing size, and portfolio allocations consistent with the empirical evidence. Preliminary findings suggest that the design of punishment can have important macroeconomic consequences.

Keywords: Secured credit, long-term mortgages, housing finance

J.E.L. codes: E2, E6

*We acknowledge the useful comments of Dirk Krueger. We are grateful to the financial support of the National Science Foundation for grant No SES-0649374. Carlos Garriga also acknowledges support from the Spanish Ministerio de Ciencia y Tecnología through grant No SEJ2006-02879. The views expressed herein do not necessarily reflect those of the Federal Reserve Bank of St. Louis nor those of the Federal Reserve System.

[†]Corresponding author: Don Schlagenhauf, Department of Economics, Florida State University, 246 Bellamy Building, Tallahassee, FL 32306-2180. E-mail: dschlage@fsu.edu.

1. Introduction

In the last 15 years the housing market in the United States has experienced a dramatic boom and bust cycle not seen since the 1950s. The boom started with a steady increase in the homeownership during the late nineties and followed rapid appreciation in home prices. During this initial period, there were substantial innovations in housing finance that modified the term structure and the downpayment requirements of mortgage loans. Lending became more sophisticated as lenders compete for customers.¹ The credit expansion and the increase in leverage has been critical to understand the dramatic effects of housing bust cycle associated to the sharp and large decline in home prices as well as the increase in foreclosures to new record highs not seen since the Great Depression.

The recent housing crises provide a laboratory to assess our understanding of the effects of long-term risky lending and its spread in the economy. One of the aspects that is often neglected is the legal environment pertinent to foreclosure. Foreclosure is usually initiated because there is a deficit between the current value of the property and the outstanding debt. The allocation of the deficit (between the borrower and the lender should have important implications for the incentives to default on the loan. In the United States there is no consensus on what the allocation of the deficit should be. In a reduced number of eight States (i.e. AK, AZ, CA, MN, MT, ND, OR, WT) the mortgage holder is not responsible for the deficit. These regime contrasts with the remaining States where the borrower is not discharged from the deficit. The allocation of the deficit and the design of future punishments should have important implications in the incentives to default on the loan. For example when the costs of exercising the option are low, homeowners are more likely to default. Considering the features of the legal environment is essential to understand the incentives the different households have to default.

The objective in this paper is to understand the quantitative importance of default punishments in the determination of foreclosure. In addition, we consider the impact of future consequences for those households that choose to default. We modify the housing model with default option developed in Garriga and Schlagenhauf (2008) to allow for different allocation of default deficits and severity of punishments. This framework has a number of important features that are not stressed in other models that generate testable implications for tenure, housing size, and portfolio allocations consistent with the empirical evidence.

The decision to foreclose a property requires the solution of a complex problem. The individual has to take into consideration current and future benefits and losses. In addition, when an individual chooses a particular mortgage loan, consideration must be given to the spread in mortgage rates that are due to the associated default risk. As a result, the choice

¹. For example the Government Sponsor Enterprises (i.e. Freddie Mac, and Fannie Mae) move into higher LTV loan products (i.e. no downpayment loans, interest only ARMs, and payment-option ARMS) combined with their expanded credit guide lines. The expansion of credit has resulted in a sizeable increase the stock of outstanding debt from 5.1 trillions in 1997 to 14.6 trillion in 2007. This increase results from highly leverage refinancing and cash-out refinancing. In addition, the composition of originations changed towards nontraditional loan products (i.e. IO and Hybrid ARMs).

of purchase a house and the type of mortgage loan are not independent of the decision to foreclose a property. The introduction of a default option limits the homeowners losses in the event of foreclosure and as a result should increase the incentives to participate in the owner-occupied housing market and to purchase large units. The design of default punishments in environment with incomplete markets has to trade off the efficiency gains associated with the option with the costs.

Understanding of the foreclosure decision requires bridging the housing literature with the literature that examines default on unsecured lending. The housing literature provides the foundation for the modeling of housing decisions whereas the default literature provide a price and formalize the default option (some relevant papers include Athreya (2002), Li and Sarte (2006), Livshits, MacGee, and Tertilt (2007), Chatterjee, Corbae, Nakajima, and Ríos-Rull (2005), Chatterjee, Corbae, and Ríos-Rull (2006), Athreya, Tam, and Young (2008), Sánchez (2008), Nakajima (2008)). The housing literature in the context of general equilibrium models has become quite extensive and includes Díaz and Luengo-Prado (2005), Davis and Heathcote (2006), Fernández-Villaverde and Krueger (2002), Gervais (2002), Kiyotaki, Michaelides, and Nikolov (2007), Li and Yao (2007), Nakajima (2004), Ortalo-Magne and Rady (2006), Sánchez-Marcos and Ríos-Rull (2008). The existing literature has some important limitations to understand the aforementioned events. One is that houses are financed with one-period collateralized loans, thus abstracting from longer-term mortgage choice. This assumption is critical because with short-term mortgages banks can reassess the characteristics of the borrower and potentially restrict credit when house prices are uncertain. A notable exception is Chambers, Garriga and Schlagenhauf (2007, 2008) that study the implications of long-term mortgages and the loan structure to understand an important contributor to the housing boom. The other limitation is that the default option is not available. The only paper that considers housing default with short-term mortgages is Jeske and Krueger (2005). They study the macroeconomic effects of the interest rate subsidy provided by government-sponsored enterprises (GSEs). Two limitations of their modeling approach are that the loan structure is irrelevant and housing is not subject to adjustment costs. As a result, households that face negative income shocks can downsize at no cost. In addition, the infinitely lived structure implies that mortgage loans are never repaid.

The rest of the paper is organized as follows. In Section 2 we review foreclosure legal environment in the United States and its implications. In section 3, we describe the main features of an equilibrium model of mortgage choice with default option and present some preliminary findings to illustrate the framework potential. In Section 4 we discuss additional extensions as well as questions we propose to examine. We summarize our findings and conclude in Section 5.

2. Foreclosure Punishments in the United States

The determination of the legal environment as it pertains to foreclosure is important to comprehend its implications in borrower decisions, the pricing of loans at the bank level,

and the aggregate economy. In this section, we briefly discuss the essential elements of the legal environment and will try to look for some evidence in the data.

Foreclosure is a legal proceeding in which a lender obtains a court ordered termination of the borrower's, or mortgagor's equitable right of redemption. The redemption is in the form of the asset used to secure the loan. Foreclosure allows the lender to foreclose the right of redemption which allows the borrower to repay the debt and redeem the property. Mortgage documents specify the period of time after which default occurs and thus foreclosure can be initiated. Foreclosure can be supervised by a court in which case is known as Judicial Foreclosure. If the courts do not supervise, then the sale of the property determines foreclosure. This is known as Foreclosure by Power of Sale. Formally, we default option can be defined as

$$V^D = \max(\Pi, k)$$

In general, we can write the immediate pay-off from foreclosing a property as $V^D = \max(\Pi, k)$ where the term $\Pi < 0$ represents some critical threshold where the has does not have any effective equity, and the default option $k \leq 0$ provides a lower bound on the deficit. Future consequences from foreclosing the property could imply some repayment obligations, temporary exclusion from housing and/or financial markets, and higher interest rate premiums. From a legal perspective the term $k \in (\Pi, 0)$ is represented by the concept in foreclosure law called *acceleration*. This term allows the lender to declare a partial or full amount of the debt of a defaulted mortgage due and payable. In other words, it decides the allocation of any deficit or losses between borrowers and lenders. In the United States the acceleration term is defined by the States and there is no consensus on what k should be. Interestingly we find two extreme cases. A reduced number of States (i.e. Alaska, Arizona, California, Minnesota, Montana, North Dakota, Oregon, Washington) apply the so-called Anti-Deficiency Law ($k = 0$). In these States the mortgage holder **is not** responsible for the deficit $\Pi < 0$. However, protection for secondary mortgages, home equity lines, or mortgages on non-primary residents is not provided. This regime contrasts with the remaining States that apply Deficiency Laws ($k < 0$) where the mortgage holder **is** responsible for the deficit.

If a lender chooses not to pursue a *deficiency judgment* because the borrower has insufficient assets or the mortgage is legally treated as a non-recourse debt, the debt write-off the borrower may have an income tax obligation on the remaining unpaid principal if it can be considered as "forgiven debt." Recently, the tax law has been changed on forgiven debt as it pertains to foreclosed property. For the period January 1, 2007 through December 31, 2009, homeowners are not obligated to pay tax on any debt on a primary residence that is cancelled.

With the formalization of the default option, the importance of the term k becomes apparent since partially determines the cost of default. Our intuition should suggest that low values of k should generate more incentives to purchase homes and foreclose whereas large values should suggest the opposite. In principle, the term k could take any value in this interval, but it could also be determined to socioeconomic characteristics such as age, income, or others.

A direct testable implication should be that States with Deficiency Laws should have lower foreclosure rates since the size of the punishment should matter. In Figure 1 we report the path of foreclosure rates for Deficiency and Anti-Deficiency States.

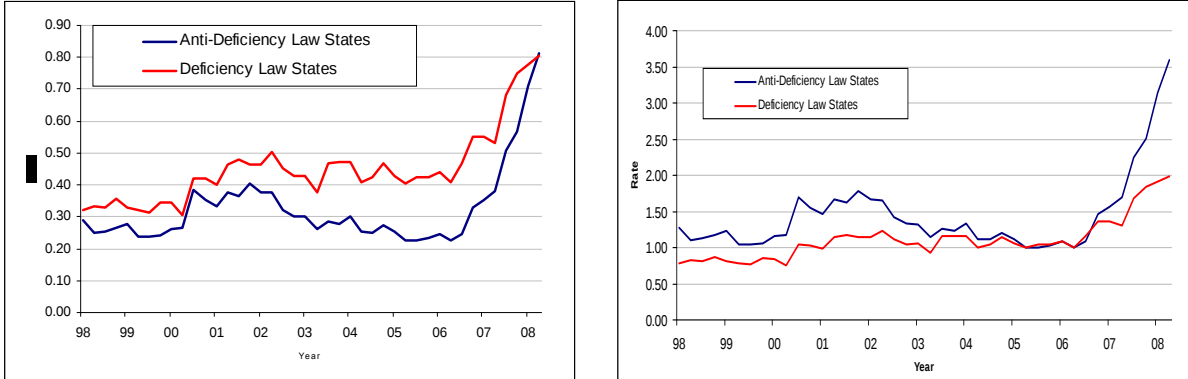


Figure 1: Foreclosure by Deficiency States

The evidence from the left panel of Figure that reports the time series for the levels of foreclosure rates does not seem to be very conclusive. Anti-deficiency states ($k = 0$) seem to have a lower level of foreclosures than deficiency states ($k < 0$). Our initial intuition that ignores additional factors could suggest the opposite, although other regional factors could be important to determine the levels (i.e. trend in house prices, income uncertainty, enforcement of contracts). In the right panel of Figure 4 we measure the rates of change of foreclosure. When we ignore the levels and only measure the rate of change we find that anti-deficiency states ($k = 0$) respond more than deficiency states ($k < 0$). Maybe the issue is not about levels rather rates of change.

In additional relevant factor could be due to the fact that the path of house price appreciation might be different in across these states. The empirical evidence seems to suggest that the volatility of foreclosures and house price appreciation seems to be higher in anti-deficiency states ($k = 0$) than in deficiency states ($k < 0$). Therefore, it is very difficult to determine which one is causing what. Are fast changes in the foreclosure rate responsible for the decline in house price appreciations? or is the other way around? Does the underlying structure of contracts and default punishments matter? Should future punishments matter for default?

3. Equilibrium Model of Mortgage Choice with Default Option

The basic model is an extension of the framework developed by Garriga and Schlagenhaut (2008). The model emphasizes two relevant factors that determine the evolution of foreclosure rates: the availability of mortgage choice with different levels of leverage and the riskiness of housing investment. That requires a set up with heterogeneous consumers and incomplete markets. In this arrangement, the decision to purchase a house is not deter-

mined by the household's permanent income, but rather the current income, and resources to meet a certain downpayment, and the menu of mortgage loans available. In addition, it is important for the model to capture relevant features on the U.S. housing markets such as the amount of homeowners, house size, and types of mortgage financing. In addition of households, the economy is also comprised of financial intermediaries or mortgage brokers, a construction sector, a goods sector, and a government. In this section, we sketch the model we have developed

3.1. Households' Problem

We consider an overlapping generation structure where a newborn cohort is born at every period and lives a maximum of J periods. Survival each period is subject to mortality risk. The probability of surviving from age j to age $j + 1$ is denoted by $\pi_{j+1} \in (0, 1)$ and there is population growth. the household preferences are represented by a momentary utility functions are defined over consumption of goods, c_j , and housings services or dwelling size, d_j . The period utility function is neoclassical and satisfies the standard properties of continuity and differentiability $u : \mathfrak{R}_2 \rightarrow \mathfrak{R}$, and $u' > 0$ and $u'' < 0$. Individuals can invest in two assets to smooth income uncertainty; a riskless financial asset a that yields a return r , and a risky housing good that provides utility.

Housing: The characteristics of housing are very different from other consumption goods and assets. It is important to be very precise the nature of houses in our model since it differs from a standard durable good economy. We model a house as an asset tree where the tree represents the investment component of the house, h , and the fruit produced at every period represent the flow of housing services the owner is entitled, d . The housing stock is mapped into services according to a constant returns to scale technology, $d = g(h) = h$. Houses come in different sizes (lumpy and indivisible investment) restricted by the set $\mathcal{H}$ where $\mathcal{H} \equiv \{0\} \cup \{\underline{h}, \dots, \bar{h}\}$ where $\underline{h}$ is the smallest housing investment and $\bar{h}$ represents the largest. The cost economy cost of purchasing a house of a given size is ph where p represents the price per unit size (i.e. price per square feet or square meter). The indivisibility of housing $\underline{h} > 0$ forces some individuals to rent property since the cost of purchasing the smallest house size $p\underline{h}$ might be too expensive. An important element to generate foreclosure is to have housing being a risky asset. We assume that the house purchase ph and the consumption of housing services d are not subject to any source of risk. As in Jeske and Krueger (2005), the decision to sell property, $p\xi h$, is subject to an i.i.d. capital gains shock, $\xi \in \Xi \equiv \{\xi_1, \dots, \xi_z\}$ with an expected value $E(\xi) = 1$ and variance σ_ξ . The timing of uncertainty has to be consistent with no capital gains, that requires the shock to not be observed until the house is put in the market and sold. Purchasing or changing the existing housing investment is subject to non-convex transaction costs. The homeowner pays a proportional cost to the purchase $\phi_b ph$ and/or selling price $\phi_s p\xi h$. Since housing is indivisible, if a homeowners desires to consume more housing $d > h$ it has to sell the existing investment and purchase a larger unit. However, the decision to consumer a different amount of housing services is not subject to transaction costs. Individuals that supply tenant-occupied property (i.e. floor space) receive a rental

income $R(h - d)$ where R represents the rental price per unit of housing services. However, these activity has two pecuniary costs. First, requires landlords to pay a monetary fixed cost $\varpi > 0$ anytime property is rented.² Second, maintenance expense associated to the housing investment $\varphi(h', d) = \delta_o p d + \delta_r p(h' - d)$ depends on whether housing is owner-occupied or rental-occupied. Rental-occupied housing depreciates at a higher rate than owner-occupied housing $\Delta\delta = \delta_r - \delta_o > 0$. The different depreciation rates are a result of a moral hazard problem that occurs in rental markets as renters decide how intensively to utilize the dwelling. In equilibrium the cost of one unit of housing services is R for renters and $R - p\Delta\delta$ for homeowners.

Long-term housing finance: House are purchased using long-term mortgage contracts provided by a competitive lending sector. We assume that lenders offer a finite number of exogenous type loans $z \in \mathcal{Z} = \{1, \dots, Z\}$. These contracts can potentially differ along a number of dimensions such as downpayment, length of contract, and repayment structure. All these different characteristics can be easily be accommodated in a general formulation that specifies the long-term contract for a given loan amount. In general, the purchase of a house of value ph requires a downpayment requirement $\chi(z) \in [0, 1]$ that can vary by loan type z . The size of the mortgage loan is given by $D(N(z)) = (1 - \chi(z))ph'$ where $N(z)$ is the length of the mortgage contract z . The choice of a particular loan product commits the borrower to certain obligations. The first one is to make mortgage payments every period to repay the loan. The magnitude of the mortgage payment $m(x, n, z)$ in a given period n in the contract depends on the loan amount $D(N(z))$, the mortgage interest rate $r^m(z)$, and the repayment structure associated to the loan type z . The term $x \in (p, h', \chi(z), N(z), r^m(z))$ summarizes the set of relevant information necessary to keep track of the loan for any given period n . Second, borrowers are committed to repay the loan as long as they stay in the property. Selling the house immediately terminates the contract. Early prepayments without transacting the property are not allowed.

The mortgage payment $m(x, n, z)$ can be decomposed into an amortization term, $A(x, n, z)$, and an interest rate payment term $I(x, n, z) = r^m(z)D(x, n, z)$. The law of motion for the level of housing debt $D(x, z)$ is given by

$$D(x, n - 1, z) = D(x, n, z) - A(x, n, z),$$

The law of motion for home equity increases with every payments. That is

$$e(x, n - 1, z) = e(x, n, z) + [m(x, n, z) - r^m(z)D(x, n, z)],$$

where $e(x, N, z) = \chi(z)ph'$ denotes the home equity in the initial period. This general specification covers a large number of loans offered by the mortgage industry. For example,

²The introduction of the fixed cost prevents homeowners from freely using the rental market to buffer negative income shocks. This cost should be viewed as either a time opportunity cost, or as a management fee. These costs are paid every period and are independent of the size of the property.

the standard fixed rate mortgage has a constant payment schedule that satisfies $m(x, n, z) = r^m(z)[1 - (1 + r^m(z))^{-N(z)}]^{-1}D(N(z))$. A cash purchase implies $\chi(z) = 1$ that immediately implies $D(N(z)) = m(x, n, z) = 0$. In this context, a 30 year fixed rate mortgage with a 20 percent downpayment is view as a different loan product than a 30 year fixed rate mortgage with a 10 percent downpayment. Since these two loans have different downpayment levels, the implied mortgage payments will be different even though the repayment structure is constant over time for these two loans contracts. In our model homeowners choose among exogenously given contracts that differ in some of the aforementioned characteristics, they do not choose the characteristics of the contract individually.

Default option: The long-term mortgage loan has incorporated a default option that can only be executed upon selling the property and serves to limit the homeowner's losses. The default option is characterized by $V^D = \max(\Pi_\xi, k)$ where $k > 0$ represents the exercise cost and $\Pi_\xi = (1 - \phi_s)p\xi h - D(x, n, z)$ the revenue from selling the property after the capital gain shock is realized. The homeowner forecloses when the option value of defaulting is higher than the one associated with selling the house and clearing any outstanding balance with the financial intermediary.³ There are two essential elements that trigger the default decision. The first one is the size of the capital gain shock, ξ . If the capital gain shock has a low variance σ_ξ homeowners are not likely to foreclose the property. Changes in the riskiness of housing could certainly be a relevant factor for understanding the increase in foreclosures. The second element is leverage. Mortgage loan that allow high levels of leverage imply $D(x, n, z) \approx ph$ (i.e. with contracts that allow zero downpayment $\chi(z) = 0$ depending on the repayment structure could have negative amortization, $D(x, n, z) > ph$). In this situation the size of the capital income shock can be smaller to induce a homeowner to foreclose the property. At this point we assume that the cost of exercising the option k is zero. We defer the discussion about the cost/punishment associated to foreclose to the next section.

Household's Income: In this economy households have four different sources of income: working or retirement income, savings, rental income, and accidental bequests. During working life $j < j^*$, each household is endowed with one unit of time that is inelastically supplied to the labor market. The market value of time across households differs due to two exogenous factors: an age component and a period specific productivity shocks. The age component is defined by v_j and evolves over time in a deterministic pattern $\{\nu_j\}_{j=1}^{j^*}$. The stochastic component, $\epsilon \in \mathcal{E}$, is drawn from a probability space where the realization of the current period productivity component evolves according to the transition law $\Pi_{\epsilon, \epsilon'}$. Each period labor earnings are determined by $w\epsilon v_j$ where w is the market wage rate. Formally,

³The advantage of this approach is computational, since it does not require to introduce an additional state variable. There are alternative timing conventions that could have been used. One could consider a one time capital gain shock. After purchasing the house, the individual observes a one time idiosyncratic shock, ξ . The cost of this approach is to include the shock as an additional state variable. An extension of this timing could allow for an idiosyncratic capital gain with early revelation of uncertainty. The approach is similar to the previous one, but we allow the shocks to change every period according to an *iid* shock with a probability distribution, π_s . The individuals observe the house price shock, ξ , and then they decide to sell or not.

we define the household's disposable income as

$$y = \begin{cases} w\epsilon v_j + (1+r)a + tr + y_r & \text{if } j < j^*, \\ w_{ss} + (1+r)a + tr + y_r & \text{if } j \geq j^*. \end{cases} \quad (3.1)$$

where w_{ss} is retirement benefit, tr represents a lump-sum transfer from accidental bequests, and y_r represents net rental income. Households earn income in the labor market if they are under the age j^* , or from retirement benefits if they are of age j^* or older. Net rental income earned from the housing investment y_r is defined as depends on the decision to become a landlord and pay the fixed and maintenance cost.

The individual state of a household is indexed by their asset holding, a , investment position in housing, h , mortgage choice, z , remaining periods on the mortgage, n , the idiosyncratic income shock, ϵ , and age, j . To keep the notation compact, we summarize the household state by $s = (a, h, n, z, \epsilon, j)$. It is important to notice that this formulation does not consolidate the household balance sheet into a single account and breaks the link between household wealth and home equity. We start with problem of an individual that starts as a renter, and then we consider the decision problem of the individual that starts as a homeowner.

3.1.1. Current Renters

A household that begins the period renting in an individual state $s = (a, h, z, n, \epsilon, j) = (a, 0, 0, 0, \epsilon, j)$ has the option of continue renting ($h' = 0$) or purchase a house ($h' > 0$). The discrete non concave problem is given by

$$v(s) = \max\{v^r, v^o\}.$$

The value associated to continue renting is determined by the choice of consumption, c , housing services, d , and asset holdings, a , that solve

$$v^r(s) = \max_{(d, a') \in \mathbb{R}_+} \{u(y - a' - Rd, d) + \beta_{j+1} E_{\epsilon'}[v(s')]\}$$

where $s' = (a', 0, 0, 0, \epsilon', j+1)$ represents the future state variable, Rd is the expenditure in tenant-occupied housing, and denotes an age specific discount rate that incorporates the survival probability, $\beta_j = \beta\pi_j$. Note that there is no restriction on the size of house rented other than the non-negativity constraint in consumption.⁴ In addition, the restriction in the choice set indicates that asset markets are incomplete since individuals only have access to an uncollateralized asset and borrowing via this asset is precluded.

When an individual that rents purchases a house solves a different problem with a larger

⁴Other housing papers impose some limits in the size of rental-occupied housing. In this paper, renters can consumer any size of housing services. In equilibrium, renters consume smaller housing units that home buyers. This comes as an endogenous outcome in the model as opposed to be assumed.

number of choices than the previous problem. In addition to the previous choice, it has to decide the size of the housing investment, h' , the type of mortgage financing used to purchase the house, z' , and the discrete choice of selling housing services in the rental market, $I_r = 1$, or fully consume the dwelling $d = h'$. This decision problem solves

$$v^o(s) = \max_{\substack{(c,d,a',h') \in \mathbb{R}_+ \\ z' \in \mathcal{Z}, I_r \in \{0,1\}}} \{u(c, d) + \beta_{j+1} E_{\epsilon'}[v(s')]\},$$

$$s.t. \quad c + a' + [\phi_b + \chi(z')]ph' + m(x, n, z') = y.$$

The purchase of a house has two up front expenditures: a transaction costs (i.e. realtors fees, closing costs, etc.) that are proportional to the value of the house $\phi_b ph'$, and a downpayment to the mortgage bank for a fraction $\chi(z')$ of the value of the house (i.e. 20 percent down of the purchase price excluding transaction costs). The downpayment represents the amount of equity in the house at the time of purchase and varies with the choice of mortgage contract, z' . In addition to the expenditures associated to the home purchase, we assume that the homeowner starts to repay the mortgage loan immediately. The mortgage payments are a function of the variable $x = (p, h', \chi(z), N(z), r^m(z))$, the number of period remaining in the loan $n = N$, and the loan choice z' . The optimal decision with respect to housing satisfies

$$\frac{U_d}{U_c} - R + p(\delta_r - \delta_o) \geq 0, \quad (= 0 \text{ when } d < h', I_r = 1, \text{ and } y_r > 0)$$

This equation equates the marginal rate of substitution between housing services and consumption to the opportunity cost of consuming owner-occupied housing. For those individuals that choose to supply rental property in the market $I_r = 1$, the first-order condition is satisfied with equality, the optimal amount of housing services consumed satisfies $d^* < h'$, and receive a net rental income equal to $R(h' - d^*) - \varpi - \varphi(h', d^*)$. The homeowners that do not supply housing services in the rental market avoid the fixed cost ($I_r = 0$) and consume $d = h'$. The optimal choices this period imply next period states according, $s' = (a', h', z', N - 1, \epsilon', j + 1)$.

The choice of whether to continue renting or purchase a home is determined by the highest value between $v^r(s)$ and $v^o(s)$. When $v^r(s) > v^o(s)$ the individual continues to rent, and otherwise becomes a home owner.

3.1.2. Current Homeowners

The decision problem for an individual that starts the period owning a house ($h > 0$) has more choices. The homeowner can choose to stay in the house ($h' = h$), purchase a different house ($h' \neq h$), or become a renter ($h' = 0$). In addition, anytime that the homeowner chooses to sell the property, the transacted price is subject to the capital gains shock, $\xi \in \Xi$, and can choose to foreclose the property. Given the homeowner state variable at the start

of the period, $s = (a, h, z, n, \epsilon, j)$, the individual solves

$$v(s) = \max\{v^m, v^e, v^b\}$$

The different value function are calculated by solving three subproblems. The value function associated to stay in the same house is given by

$$v^m(s) = \max_{\substack{(c,d,a') \in \mathbb{R}_+ \\ I_r \in \{0,1\}}} \{u(c, d) + \beta_{j+1} E_{\epsilon'}[v(s')]\},$$

$$s.t. \quad c = y - (a' + m(x, n, z)).$$

In this case the individual makes mortgage payments when $n > 0$, otherwise $m(x, 0, z) = 0$ and he simple decides the amount of consumption and savings that result from disposable income, and whether to lease tenant-occupied housing (I_r). Given that the individual stays maintain the housing investment, $h' = h$, he is not subject to transaction costs. The future vector of state variables is then determined by $s' = (a', h', z', n', \epsilon', j+1)$ where $n' = \max\{n-1, 0\}$. This counter determines whether the mortgage loan is paid off or not.

For the individuals that choose the sell the current property, h , the default option becomes available, $\max(\Pi_s, k)$. Among those that sell, some individuals prefer to exit the housing market and rent property where v^e represents their value function, and others prefer to buy a different size house $h' \neq h$ (larger or smaller than the previous one) where the term v^b represents their value function. It is important to note that the capital gain shock is realized after the selling decisions has been made. For the individuals that sell and rent we solve

$$v^e(s) = \max_{(c,d,a') \in \mathbb{R}_+} \{E_{s,\epsilon'}[u(c, d) + \beta_{j+1} v(s')]\}$$

$$s.t. \quad c = y + \max(\Pi_s, k) - (a' + Rd)$$

where $\Pi_s = (1 - \phi_s)p\xi h - D(x, n, z)$ represent the net revenue of selling the property. The foreclosure option is straight forward, individuals with negative equity walk away from their mortgage obligations but loose the property. The key element is the household leverage at the time of sell, $D(x, n, z)$, relative to the proceedings associated to sell the house. This difference determines the level of equity in the house. When the house is pay-off, $D(x, n, z) = 0$, the homeowner does never default even when the realization of the idiosyncratic capital gains is the worse one, ξ . The individual problem is equivalent to the one of a renter with the exception that the level of wealth is affected by the option on capital gains. The future state variable is given by $s' = (a', 0, 0, 0, \epsilon', j+1)$.

The individual that purchases a different house size, $h' \neq h$, solves

$$v^b(s) = \max_{\substack{(c,s,a',h') \in \mathbb{R}_+ \\ z' \in \mathcal{Z}, I_r \in \{0,1\}}} \{E_{s,\epsilon'}[u(c, d) + \beta_{j+1} v(s')]\},$$

$$s.t. \quad c + [\phi_b + \chi(z')]ph' + m(x, n, z') + a' = y + \max(\Pi_s, k),$$

This individual sells the property and either receives Π_s or zero. Then, chooses to purchase a new house, h' , pays transaction costs, $\phi_b ph'$, and chooses a mortgage loan, z' , that determines the size of the downpayment, $\chi(z')ph'$. The state variable for tomorrow is $s' = (a', h', N - 1, z', \epsilon', j + 1)$.

3.2. Production of Housing Units and Goods

We follow the approach of Jeske and Krueger (2007) to model the real estate construction sector. We assume a competitive sector that manufactures housing units using a linear and reversible technology, $I_H = C_H/\theta$, where I_H represents the output of new homes, C_H is the input of the consumption good, and θ is a technology constant used to transform consumption goods into new housing units. The first-order condition of the housing sector determines the equilibrium house price that satisfies $p = \theta$. The homes produced are added to the existing housing stock as either new units or as repairs of the existing stock. The aggregate law of motion for housing investment is

$$I_H = (1 + \rho)H' - H + \varkappa(H, \delta_o, \delta_r).$$

The depreciation of the housing stock $\varkappa(H, \delta_o, \delta_r)$ depends on utilization (i.e. owner vs. tenant-occupied housing). The larger the size of the rental market, the larger the investment in housing repairs. When $\delta_o = \delta_r$, the investment function is the standard linear expression, $\varkappa(H, \delta_o, \delta_r) = \delta H$, independent of the distribution of housing consumption. To study the implications of declines in house prices, we assume an exogenous technological change that reduces the marginal cost of manufacturing new housing units, $\Delta\theta = \theta' - \theta < 0$.

The production of goods uses the standard representative firm with a neoclassical constant returns to scale production function, $F(K, L)$, where K and L denote the amount of capital and labor utilized. In the economy with global capital markets the interest rate is fixed, r^* . Given the competitive nature of financial and labor markets, the optimal firm chooses $\{K^*, L^*\}$ to equate the respective marginal products $r^* = F_1(K, L) - \delta$, and $w = F_2(K, L)$. The aggregate output is allocated between consumption, capital investment, housing investment, and transaction costs

$$C + I_K + pI_H + \Upsilon = F(K, L)$$

3.3. Mortgage Brokers or Investment Banks

Mortgage brokers use global capital markets to finance mortgage lending. We assume a competitive lending sector that maximizes expected profits per mortgage contract. The type of contracts transacted is finite, z , and exogenously determined. The objective is to understand the observed mortgage default in the existing contracts and not to provide a positive theory of the type of mortgage contracts offered that is consistent with the evidence.

We assume that the lender collects foreclose property with a haircut, γ . Therefore, the individual loss is smaller than the bank loss, $\Pi_s < \Pi_b = (1 - \phi_s)\gamma p \xi h - D(x, n, z)$. To recoup the loss, the lender has to charge a premium in each credit line. The base interest rate per mortgage contract is given by $r^* + \varrho(z)$, where $\varrho(z)$ is the required mortgage premium in contract z that guarantees zero profits. The profit condition for the line of credit of mortgage z is

$$M(z) - r^* RP'(z) + FL(z) + T(z) = 0, \quad \forall z$$

where $M(z)$ represent mortgage interest payments, $RP'(z)$ represents the beginning of next period outstanding principal, and $FL(z)$ defines the bank proceedings from selling foreclosed property. The mortgage broker borrows in the international capital markets and the premium is used to cover the default rate probability. With the law of large numbers the expected level of profits per line of credit is zero. For every contract, we need to determine $\varrho^*(z)$ such that the mortgage broker makes zero profits per contract. With the equilibrium conditions we need to compute $\{\varrho^*(z)\}_{z=1}^Z$ that guarantee zero profits.

3.4. Market Equilibrium

This economy has three markets: the labor market, the housing market, the rental of housing services market, and the goods market. To compute the market equilibrium conditions we need to aggregate using the measure of individuals over the state space. The aggregate is used to compute the market demand and supply of each respective good. For the sake of concreteness, we abstract from writing down the equilibrium conditions and defining the notion of recursive equilibrium.

4. A Quantitative Version of the Model

To illustrate and evaluate the potential of our proposed model we have to specify functional forms and parameter values. We assume non-homothetic preferences between consumption of goods and housing services. This assumption implies an housing income elasticity larger than one. The aggregate production function is assumed to be Cobb-Douglas. Some of the parameters of the model can be set independently. The equilibrium objects (allocations and prices) are functions of the underlying parameter values and our objective is to set these parameter values so the model matches the desired counterparts in the data. We use a minimum distance approach to ensure that the match is carefully done. However, we cannot guarantee that there exists a unique constellation of parameters consistent with the data. The model performs quite well matching all the targeted moments. The implied targets generated by the model solution are within 1% percent error for all the moments. The estimated parameters expressed in annual terms are presented in Table 1.

Table 1: Model Parameters (Annualized Values)

Statistic	Target	Model
1) Ratio of capital to GDP (K/Y)	2.54	2.54
2) Ratio of housing to capital stock (H/K)	0.48	0.43
3) Housing investment to housing stock (x_H/H)	0.04	0.04
4) Ratio housing services to consumption (Rd/c)	0.24	0.23
5) Ratio capital investment to GDP ($\delta K/Y$)	0.14	0.14
6) Capital share income	0.29	0.29
7) Homeownership rate	66.3	66.5
8) Default rate on Non FRM	0.02	0.02

In addition to the main targets, the model can be evaluated along a number of dimensions. Table 2 shows some selected housing statistics for homeownership and housing consumption by age groups. We view that the model fit is close enough given the limited amount of heterogeneity we impose on individual preferences. The model captures the hump-shaped profile of homeownership by age and also captures the housing downsize observed in the data. The fit is specially good considering that the model does not consider additional shocks that can affect the pattern of homeownership (i.e. shocks to family structure, or health shocks).

Table 2: Housing Distributions: Model and Data (1998 AHS)

Variable		Homeownership Rate					
by Age Cohorts	Total	20-34	35-49	50-64	65-74	75-89	
Data 1998	66.3	39.3	75.8	80.1	79.1	77.4	
Baseline	66.5	46.2	79.6	81.9	84.1	76.9	

Variable		Sqft. Owners ¹					
by Age Cohorts	Total	20-34	35-49	50-64	65-74	75-89	
Data 1998	2,137	1,854	2,220	2,301	2,088	2,045	
Baseline	2,228	1,957	2,185	2,392	2,463	2,377	

¹ Owner occupied house size is measured in terms of square feet.

An important test for the model is to check whether individuals purchase a distribution of home sizes consistent with the empirical evidence. Some papers measure housing consumption using expenditure to measure housing services whereas others report the ratio with respect to goods consumption (defined in a broad sense). We choose to report the consumption in housing services using square feet - the measure most frequently used to measure house size. This is done by renormalizing the average house size in the model to the average value reported in the *American Housing Survey* that is roughly 1,700 square feet (or 156 square meters). This measure is not conditioned by the type of ownership. If we condition, the data suggests that the average owners-occupied house (2,100 sqft) is roughly

twice the size of tenant-occupied housing (1,100 sqft). The model captures two important features observed in the data. First, the level of the average owner-occupied house, and second the hump-shaped distribution of houses over the life-cycle. The pattern suggest that young households purchase a small house, and the house is upgraded to a larger one as income grows over the life-cycle. Upon retirement, individuals move to again to smaller units. The model replicates the hump-shaped profile of house sizes over the life-cycle. However, the peak house size seems to be later in the cycle when compared to the data, and the average house. Although it is not reported, the model also captures the increasing pattern of housing consumption by income levels.

The model also makes predictions about total foreclosures and the distribution of foreclosures. The evolution of total foreclosures and foreclosures by contract is summarized in Table 3.

Table 3: Foreclosures by Loan Type (k=0)

	Data (1998)		Data (2005)		Model	
	Default	Share	Default	Share	Default	Share
Total	1.0-1.5 ¹	1.00	1.6	1.00	1.8	1.00
FRM	0.8	0.85	0.9	0.74	1.7	0.61
GPM	2.0	0.15	3.6	0.26	2.0	0.39

¹ Aggregate number includes additional agencies (FHA, VA)

The model predicts an aggregate foreclosure rate of 1.8 percent which is higher than the observed in the data ranges between 1.0 and 1.5 percent. The difference depends on the weights assigned to each type of mortgage contract and to the exclusion of some type of lending. The model overprediction is mainly driven by foreclosures in the FRM loans where 1.7 percent of the loans are non-performing instead of 0.8 percent observed in the data. However, the model replicates the 2.0 percent of the ARM do not perform. The market share of GPM is slightly higher than the observed in the data for 1999 and more consistent with the levels observed in 2004. The model also predicts a smaller aggregate number of mortgages that are owe free and clear, around 10 percent that contrast with the 25 percent observed in the data. However, it is important to remark the fact that mortgage loans get fully repaid in the model, and there could other motives that explain why a quarter of the properties are clear of debt.

The distributional implications of the model are summarized in Table 4 where we consider the distribution of foreclosures by age and income.

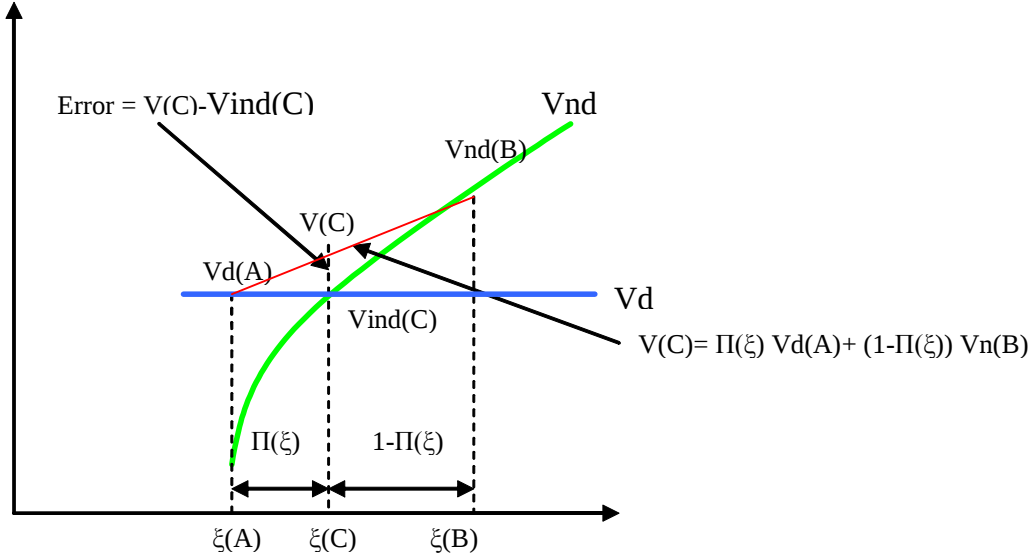
Table 4: Foreclosure Rates

by Age Cohorts	20-34	35-49	50-64	65-74	75-89
	1.6	1.5	1.9	2.5	2.1
by Income Quintiles	1st	2nd	3rd	4th	5th
	4.1	2.2	1.7	1.3	1.7

In this table, the model distributions are not compared with the data since foreclosures rates by age or income levels do not exist at the national level yet. These age and income specific default rates are computed as the fraction of foreclosures by individuals in group x (i.e. age group or income quintiles) over the total number of outstanding loans in the groups. The default rate by age is consistent with the pattern of housing mobility over the life-cycle. A fraction of the first-time buyers cannot afford the mortgage payments and choose to exit the market. That explains why the foreclosure rates falls for borrowers between age 35 and 49. Around the peak of earnings individuals either choose to upsize or downsize before retirement, with the housing trade some households realize negative capital gains and that increases the default rate 25 percent when compared to the previous age group. Finally, at retirement age households run-down the asset and sell property some of which has low levels of equity. The result is a relatively high level of defaults for this age group. The distribution of foreclosure rates by income levels exhibit some interesting features. The default rates across all income levels are relatively small with the exception of the lowest income group. Given that the fraction of homeowners within this income group is around 30 percent, a 4.1 percent of non-performing loans is relatively high. Most of this group is comprised of first-time buyers with a high default rate and retired individuals. High income individuals move more often, hence, they are more exposed to negative capital gains shocks than individuals that never move.

5. The Design of Foreclosure Punishments

In this section we modify the baseline model to understand the importance of default punishments in the determination of foreclosure. For the case $k = 0$ with no exclusion, the value function associated to default is flat. As we change the value $k < 0$, we can tilt down or up the value function to reduce the equilibrium number of foreclosures. Since this is a model with incomplete markets having zero foreclosures could be quite suboptimal



The model provide the nice framework to determine what values of k^* are good for the economy and the individuals. We consider two key dimensions of foreclosure law.

1. **Optimal acceleration or allocation of the deficit:** Since the value of k determines the allocation of the deficit or losses Π , the only constraint on the term is that $\Pi < k$ otherwise you have to repay. In general the value $k(x)$ could be a function of individual characteristics x .

1. **Uniform across individuals:** $k \equiv \gamma\Pi < \Pi$ where $\gamma < 1$.
2. **Income dependent:** $k(j, a) \equiv \gamma(j, a)(w\epsilon v_j + ra) < \Pi$ with $\gamma(j, a) < 1$.
3. **Wealth dependent:** $k(a) \equiv \gamma(a)(1 + r)a < \Pi$ where $\gamma(a) < 1$.

2. **Future punishments:** In addition, it is important to consider not only current punishment (k), but also future consequences for those who foreclose. Future punishments can be used as an effective mechanism to discourage existing homeowners to default. Incorporating future punishment requires to modify the seller problem and include an additional state variable called default flag $\lambda' > 0$. The optimal choice of a seller requires solving:

$$v(x) = \max\{v^r, v^d\}$$

where $x = (a, h, n, z, \epsilon, j, \lambda)$. The state variable incorporate an additional term λ the determine whether the individual has defaulted in the past. A positive flag $\lambda > 0$ can have various implications such as forbid individuals to borrow on good term, or prevent

them from buying property. The value function associated to repay ($\Pi_\xi > k$, $I_f = 0$, and $\lambda' = 0$) is determined by solving

$$v^r(x) = \max_{(c,d,a',h',z')} E_{\xi,\epsilon}[u(c,d,\varphi I_f) + \beta_{j+1}v(x')]$$

when the individual chooses to rent tomorrow

$$s.t. \quad c + a' + Rd = y(x) + \max(\Pi_\xi, k) \quad \text{when } h' > 0$$

or chooses to buy

$$c + a' + [\phi_b + \chi(z')]ph' + m(z') = y(x) + \max(\Pi_\xi, k) \quad \text{when } h' > 0$$

since the homeowner repays, the default flag $\lambda' = 0$ is inactive. The problem where the foreclosure option ($\Pi_\xi < k$, $I_f = 1$, and $\lambda' > 0$) is more interesting since the function v^d depends on the type and size of the default punishment. The individual solves

$$v^f(x) = \max_{(c,d,a',h',z')} E_{\xi,\epsilon}[u(c,d,\varphi I_f) + \beta_{j+1}v(x')].$$

Different punishments can be easily introduced into the budget constraint:

- **Exclusion from future ownership:** The budget constraint under the cost of exclusion from ownership, ($h' = 0$), would be:

$$s.t. \quad c + a' + Rd = w\epsilon v_j + (1+r)a + \max(\Pi_\xi, k)$$

- **Exclusion from housing and financial market:** The budget constraint under these exclusions ($h' = a' = 0$), would be:

$$s.t. \quad c + Rd = w\epsilon v_j + (1+r)a + \max(\Pi_\xi, k)$$

- **Restriction of future home expenditures:** Alternatively, if the cost is a restriction on the size of the home that can be financed such as $\underline{h}$ the budget constraint would become

$$s.t. \quad c + a' + [\phi_b + \chi(z')]p\bar{h}' + m(z') = w\epsilon v_j + (1+r)a + \max(\Pi_\xi, k)$$

Foreclosures has important tax implications. If a lender chooses not to pursue a *deficiency judgement* because the borrower has insufficient assets or the mortgage is legally treated as a non-recourse debt, the debt write-off of the borrower may have an income tax implications on the remaining unpaid principal if it can be considered as “forgiven debt.” Recently, the tax law has been temporarily modified on forgiven debt as it pertains to foreclosed property. This additional margin we plan to examine.

6. Conclusions

To be completed...

7. References

Chambers, M. , C. Garriga, and D. Schlagenhauf, "Accounting for Changes in the Home-ownership Rate," forthcoming *International Economic Review*.

Chambers, M. , C. Garriga, and D. Schlagenhauf, "The Loan Structure and Housing Tenure Decisions in an Equilibrium Model of Mortgage Choice," forthcoming *Review of Economic Dynamics*.

Davis, M., and J. Heathcote, "Housing and the Business Cycle," *International Economic Review*, 46 (August, 2005), 751-784.

Díaz, A. and M.J. Luengo Prado, "Durable Goods and the Wealth Distribution". Unpublished Manuscript, (December, 2006).

Fernández-Villaverde, J. and D. Krueger, "Consumption and Saving over the Life-Cycle: How Important are Consumer Durables?" Working paper, University of Pennsylvania, (December, 2005).

Fisher, J. D. M., and S. Quayyum, "The Great Turn-of the Century Housing Boom," *Economic Perspectives*, Federal Reserve Bank of Chicago, (3rd Quarter, 2006), 29-44.

Jeske, K. "Macroeconomic Models with Heterogenous Agents and Housing," *Federal Reserve Bank of Atlanta Economic Review*, (Fourth Quarter 2005), 39-56.

Jeske, K. and D. Krueger, "Housing and the Macroeconomy: The Role of Implicit Guarantees for Government-Sponsored Enterprises," Federal Reserve Bank of Atlanta working paper, (August, 2005).

Kiyoyaki, N., Michaelides, A., and K. Nikolov, "Winners and Losers in the Housing Market," Working Paper, Princeton University, (June 2007).

Li, W. "Moving Up: Trends in Homeownership and Mortgage Indebtedness," *Federal Reserve Bank of Philadelphia Business Review*, (First Quarter 2005), 26-34.

Nakajima. M., "Rising Prices of Housing and Non-Housing Capital and Rising Earnings Instability: The Role of Illiquidity of Housing," Working Paper, University of Pennsylvania, (2003).

Ortalo-Magne, F., and S Rady, "Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints," *Review of Economic Studies*, 78 (April, 2006), 459-485.

Ríos-Rull, J.V., and V. Sanchez-Marcos, "An Aggregate Economy with Different House Sizes," Working paper, University of Pennsylvania, (September 2006).

Storesletten, K., C. I. Telmer, and A. Yaron, Consumption and Risk Sharing over the Life Cycle, *Journal of Monetary Economics* 51 (April, 2004), 609-633.