5 Simulations

In this section we simulate the general model to show that the main ideas discussed in section 2 still hold in a multi-period setting. In the simulations, high-income and low-income households are interpreted, respectively, as Prime and Subprime borrowers. We follow Sufi and Mian (2009) to calibrate both the median income and the unemployment probability. They document that Prime borrowers have an annual median income of 76 thousand dollars and an unemployment rate of 3% while Subprime borrowers have an annual income of 39 thousand dollars and an unemployment rate of 8%. Furthermore, we assume that households spend on average one third of their income on housing according to the 2009 Consumer Spending Survey.

We make some simplifying assumptions regarding the stochastic variables in general model. We assume that the household's income is a binary process such that $y_t = \bar{y}$ with probability π and zero with probability $1-\pi$. We simulate a mortgage contract of length $T^* = 6$ due to computational limitations, so we interpret each period in the simulated model as 3.3 years of a 20 year mortgage. In this context, Prime family receives three annual incomes and spend one third of it with mortgage in each simulation's period, so we set $\bar{y} = 0.8$ for them (interpreted as 80 thousand dollars per simulation period). The unemployment probability in each simulation period is calibrated to be one minus the probability of being employed for three years, so we set $\pi = 0.08$ for Prime families ($\pi \approx 1 - (0.97)^3$). Following equivalent assumptions, we set $\bar{y} = 0.4$ and $\pi = 0.2$ for Subprime borrowers.

We also assume that rent is a binary process. It can either increase, $u \cdot r_{t-1}$, with probability p or decrease, $d \cdot r_{t-1}$, with probability $1 - p$. Lastly, the bubble bursts with probability $1 - q$ or grows with probability q in which case $B_t = \xi \cdot B_{t-1}$. For illustrative analysis, consider a risk free interest rate of 5%. As in Campbell et al. (2009), we set the recovery rate at $\gamma = 0.7$ which means that both the representative bank and only get 70% of the house value if they decide to sell it in any period.

5.1 Who has access to the mortgage market?

To analyze the behavior of families facing a bubble burst in the price of houses, we need to characterize which families have access to the mortgage market in the first place. In the model, households default on their mortgages either because of liquidity problems or because they cannot commit to pay the mortgage whenever possible. The default behavior of households is anticipated by the representative bank when evaluating the mortgage's value, so the risk of the costly foreclosure state is incorporated into the equilibrium competitive mortgage rate. In turn, households observe which mortgage contracts are available and decide whether to buy or rent a home.

For both household types, we compute the mortgage payment such that the representative bank break even as defined in equation (3-7) and then determine the household's decision to purchase a home as in equation (4-10). Households' default behavior and the mortgage payment depend on the mortgage down payment. In Table B, we simulate the mortgage contract on a 220 thousand dollars house using several initial wealth values.

We can see from Table B that households must have a minimum wealth level to access the mortgage market at time $t = 0$. The representative bank requires a minimum down payment to compensate for the default risk of the contract. As the down payment increases, the mortgage payment decreases and more households choose to finance their home purchase. Because Subprime families have a higher delinquency probability, they are required to have a higher initial wealth.

The down payment also has an effect on the strategic default probability like discussed in the first main insight of the simple model of Section 2. In Table B, families that make a large down payment are less likely to default strategically because their debt balance is low in the event of a large price drop. After the bubble burst, a new mortgage even on a lower price house entails a high payment when compared to the current contract of households that made a large down payment.

To illustrate that the General Model is consistent with the second main insight of the simple model of Section 2, we analyze in Figure B.2 the impact of the expectation of a bubble burst on mortgage contracts of Subprime families. When the probability of a bubble burst increases, the expected collateral value decreases which leads to a increase of both the minimum down payment and the interest rate of a mortgage.

The General Model also allow us to replicate the US mortgage market. With the mortgage characteristics of the homeowners, it is possible to estimate the strategic default incidence controlling for the effect of the income compo-

sition of borrowers. The interaction between income level and negative equity position is suggested by a simple analysis on the delinquency rate across states in the US. On the one hand, high income states like New Jersey and Maryland have a proportion of negative equity lower than the national average, but their delinquency rate rank among the highest in the country. On the other hand, low income states like Michigan and Ohio have a high share of households underwater, but mortgage delinquency rates in these states are small. In fact, the correlation between median income and delinquency rate is -0.25 in states with more than 15% of mortgages underwater.

Finally, we present a more formal test the main implication of our model in the next section. Using a panel data set of US states, we estimate a state fixed effects model to evaluate the impact of the interaction between income and negative equity on mortgage delinquency.