Studies in Economics and International Finance
ISSN: 2583-1526
Vol. 1, No. 2, 2021, pp. 137-160

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

HOUSE PRICE EXPECTATIONS AND LENDING BEHAVIOR OF FINANCIAL INTERMEDIARIES

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ARTICLE HISTORY

Received : 23 October 2021
Revised : 10 November 2021
Accepted : 9 December 2021
Published : 30 December 2021

TO CITE THIS ARTICLE

Arora, P. M. (2021). House Price Expectations and Lending Behavior of Financial Intermediaries. *Studies in Economics & International Finance,* Vol. 1, No. 2, pp. 137-159

Abstract: Intermediaries exist because they economize on the transaction and information costs. In the context of the mortgage loan market, expectations about future housing prices influence the lending behavior of intermediaries. This paper develops a model to analyze how changes in housing prices may lead to speculative lending by intermediaries by influencing the expectations of intermediaries about future housing prices (adaptive expectations) as a result of which they shift between prime and subprime loans market. Intermediaries with high house price expectations will serve the sub-prime borrowers as the expected return on lending to subprime borrowers is higher for them. These intermediaries mostly rely on high expected returns from housing, even if borrowers default on their loan repayments. Hence, as housing prices rise, lending in the subprime market increases at the cost of the prime market making the system vulnerable to instability.

Keywords: Financial Intermediaries, adaptive expectations, speculation, housing prices, sub-prime borrowers.

I. INTRODUCTION

It is often observed many times that despite having a good amount of funds to channelize into productive opportunities, the economy does not experience much of the rise in productive investments. Instead, funds get diverted into other channels that do not add productivity gains for an economy but generate speculative gains for investors. Although such investments offer lucrative returns to investors, it adversely affects growth prospects of an economy and may also make the system vulnerable to crisis. Such a type of speculative investment is based on certain expectations about price behavior. This paper analyzes through a theoretical model how expectations about housing prices influence the allocation of loanable funds by financial intermediaries.

The main contribution of the model is to explore the role of expectations in allocating loanable funds by financial intermediaries. There is a recent 'news shock' business cycle literature (such as Beaudry and Portier, 2007) that investigates the role of changes in agents' expectations about future total factor productivity. We extend this idea to the expectations of financial intermediaries about housing prices. The news-shock literature emphasizes the role of changes in expectations in generating economic fluctuations. While the news-shock literature focuses on imperfect signals about total factor productivity as a source of business cycles, we extend this idea to the financial sector particularly to see how housing price expectations influence the allocation of loanable funds.

Although the paper develops a model of mortgage loans as speculative investments, it can be applied to any other form of speculative investment as well. In the context of the mortgage loan market, expectations about future housing prices influence the lending behavior of intermediaries. Two important factors influence such decisions: availability of productive investment opportunities and expectation about price moments of the speculative asset.

House prices may exert influence on lending rates by influencing the loan supply. Hence, a model on housing price and credit may have important monetary policy implications. There has recently been lively literature debating the extent to which monetary policy should respond to asset price movements. On the one hand, Bernanke and Gertler (1999) conclude that "the inflation-targeting approach dictates that central banks should adjust monetary policy actively and pre-emptively to offset incipient inflationary and deflationary pressures...It also implies that policy should not respond to changes in asset prices, except in so far as they signal changes in expected inflation."

Against this Cecchetti *et al.* (2000) conclude that reacting to asset prices in the normal course of policymaking will reduce the likelihood of asset price bubbles forming, thus reducing the risk of boom-bust investment cycles. Both Bernanke and Gertler (1999) and Cecchetti *et al.* (2000) discuss equity prices whereas our discussion will be concerning house prices.

The rational expectations hypothesis is still most commonly used to describe human behavior in financial markets. But empirical evidence fails to verify the forecasts generated by this approach. There exists a range of observed phenomena that need explanation such as emergence and bursting of bubbles, deviation of the price of an asset from its fundamental value, overreaction and underreaction to information, and many more (Guerdjikova (2003)). It has been found that people often use simple rules and heuristics, when asked to make decisions and exhibit common biases, when proceeding with information and reacting to it (Kahneman *et al*, 1973, 1974, 1998).

Most of the approaches to model financial intermediaries simply take into account loans for productive activities. The objective here is to develop a model to analyze how changes in housing prices, for which loans are obtained by consumers from financial intermediaries, influence the system over time by making it more or less fragile. Change in housing prices leads to changes in the expectations of future housing prices based on adaptive expectations. Financial intermediaries, based on their expectations of future prices, shift between the prime and subprime loan market. It is shown that, as housing prices rise, lending in the subprime market increases at the cost of the prime market making the system vulnerable to crisis. Intermediaries with high housing price expectations will serve the subprime borrowers as the expected return on lending to subprime borrowers is higher for them. These intermediaries with high housing price expectations mostly rely on high expected returns from housing, even if borrowers default on their loan repayments.

It is also shown that borrowers may not default at an initial range of negative equity. This may be because of several factors, such as the cost of locating a new unit and moving the family belongings, the psychic costs of foreclosure, the loss of the advantages of homeownership over renting, attachable assets, and brokerage fees. The model also shows that as housing prices start to fall, it is the sub-prime borrower who defaults first.

Banks suffer from imperfect information. Baye and Jansen (1996) describe it as a bank's inability to know for certain which borrowers will and which will not repay their loans that lead banks to provide loans backed by collateral. The expected value of collateral can alter the lending behavior by changing the expected return to the intermediary. The paper develops a model that incorporates such an analysis. The objective of the model is to see how changes in housing price (due to demand or supply-side shocks) influence the fragility of the financial system through its impact on lending decisions and defaults. Such an analysis would have important monetary policy implications, i.e. the impact that the central bank can have on the probability of the bubble growing, by signaling that it will respond. A transparent rule of thumb will make it easier to affect expectations and may also reduce the degree of the house price misalignment.

This paper consists of two parts. The first part (section II) is on the *model formation and static equilibrium* that discusses the general setup of the model, builds the borrower's side story, lender's side story, discusses the role of financial intermediation in the model, solves for housing and loan market equilibrium, and also analyses comparative statics. The second part (section III) consists of *dynamics of the model* that discusses the expectations adjustment mechanism, transition to the steady-state and its properties, housing price shocks, and borrower's default behavior and finally (Section IV) concludes.

II. MODEL FORMATION AND STATIC EQUILIBRIUM

1. Model's General Set up

This is an overlapping generations model consisting of two periods, the first period is the planning period, and the second period, when consumption takes place. There exist two types of consumption goods - houses and perishable consumption goods. There is a countable infinity of agents, each of whom is either a lender or a borrower. Population in each generation is normalized to 1. A fraction of α of these agents are lenders and the remainder $1 - \alpha$ are borrowers.

There is one input production function. Labor (L) is the only input. Hence, there is no income other than labor income.

$$Y = f(L) \tag{1}$$

where Y is units of perishable consumption goods produced using L units of labor input. There also exists a safe asset in the economy that grows by itself at the rate of r.

2. Borrower's Story

There are two types of borrowers in the market. Prime borrowers, who are expected to earn a higher income, and subprime borrowers, who are expected to earn a lower income. β proportion of borrowers are prime borrowers and $1 - \beta$ are subprime borrowers. Hence, the population of prime borrowers is $(1 - \alpha)\beta$ and the population of sub-prime borrowers is $(1 - \alpha)(1 - \beta)$.

Borrowers are not endowed with perishable goods in the first period and purchase Q_j units of the house at the end of the first period by taking a loan from an intermediary. Q_j is a parameter that can take any discrete value such as 0, 1, 2, 3......for $j = g$ (prime borrower) or b (subprime borrower). The price of a single unit of dwelling at period t is P_t units of the consumption good.

Borrowers are endowed with labor at the beginning of the second period and earn instantaneous labor income Y. Hence, borrowers are involved in production for self-consumption at beginning of the second period. Income Y is subject to idiosyncratic shocks. These shocks may occur due to any reason such as technological shock, weather, or any life event shock. Idiosyncratic income shocks are exogenously given leading to a fall in income to ρY where $0 < \rho < 1$.

The probability of facing income shock is higher for sub-prime borrowers $(1-\pi_b)$, whereas it is lower for prime borrowers $(1-\pi_g)$. Intermediaries get to know these probabilities through monitoring and treat the probabilities of income shocks as probabilities of default by each type of borrower.

A borrower borrows at the end of the first period to purchase a house and is required to repay the loan amount at the beginning of the second period. At the beginning of the second period, borrowers are involved in productive activity for self-consumption and also choose to repay the loan or default. In case a borrower chooses to repay the loan amount, he continues to gain utility of living in his own house in the second period and sells the house to young borrowers at the end of the second period, and consumes the balance amount. In case he defaults to repay the loan amount, the house will be taken away by the intermediary to recover the loan amount.

Borrower's preferences allow for the direct utility benefit of owning a house. Borrower's decisions are determined by maximizing expected utility given by

$$U(h,x) = Q_j h + x_r \quad (2)$$

where $h = 0$ or 1. Q_j represents units of houses owned. Hence, utility from owning a house increases with the number of houses owned.

Utility from owning a house could reflect for example an emotional attachment to the house or the benefit that an owner cannot be asked to move out by a landlord as may happen to a tenant. In case the borrower defaults h becomes zero.

x_r is the borrower's second-period consumption that depends on the remaining wealth at the end of the second period and has an element of uncertainty. If he does not repay the loan, x_r would be equal to his labor income as he would have to surrender the house to the intermediary. His utility would be:-

$$U_d = y \quad (3)$$

If the borrower repays the loan, x_r would be equal to his labor income plus sale proceeds from selling the house at the end of the second period minus the repayment amount. His utility would be:

$$U_{nd} = Q_j + Q_j\,[P_{t+1} - P_t(1+r_j)] + y \quad (4)$$

where $Q_j[P_{t+1} - P_t(1+r_j)]$ is capital gain to the borrower

Repayment amount $Q_j P_t(1+r_j)$ can potentially differ across borrower type because intermediary may decide to charge different lending rates (r_j for $j = g$(prime) or b(subprime)). Borrower's demand for housing is constrained by their expected income. The repayment amount has to be less than or equal to the borrower's expected income.

$$Q_j P_t(1 + r_j) \leq \pi_j y + (1-\pi_j)\rho y \quad (5)$$

Since consumption takes place at the end of the second period, borrowers would like to get as huge a house as possible in period one as utility increases with the number of houses owned. It also raises expected capital gains in their utility function. At the time of buying a house, borrowers know the current housing price, but second-period housing price is unknown. Borrower's beliefs are biased in the direction of optimism, i.e. they expect housing investment as gainful. Kahneman and Riepe (1998) explains, "Most people's beliefs are biased in the direction of optimism. The combination of overconfidence and optimism is a potent brew, which causes people to overestimate their knowledge, underestimate risks and exaggerate their ability to control events. It also leaves them vulnerable to statistical surprises."

In addition to that, the model does not have any additional penalty on default except for losing the utility gains of owning a house. Hence, demand function for housing is:

$$Q_j = \pi_j y + (1 - \pi_j)\rho y / P_t(1+r_j) \tag{6}$$

As demand for housing is discrete demand, demand curve of a borrower of type j is a step function.

3. LENDER'S STORY

Each young lender is endowed with a single indivisible unit of consumption good in first period which is deposited in an intermediary. The deposits with intermediaries in period t–1 are held until t, when the old lenders withdraw and consume the returns from deposits. We have lender's utility as:-

$$U(x,c) = x_n = 1+r \tag{7}$$

where x_n is lender's second period consumption that depends on the deposit rate (r) paid by financial intermediaries to the lenders. Deposit rate paid by intermediaries to the lenders is equal to the return on safe asset, i.e. r.

4. FINANCIAL INTERMEDIATION

There exists an arrangement called financial intermediation, dealing with large number of borrowers and lenders. We identify separate intermediary agents (as does Diamond, 1984) adding up to N financial intermediaries. Each intermediary, issuing financial claims to lenders/depositors, acts to maximize expected return (based on the expectation of next period housing price) by lending $Q_j P_t$ units of consumption good to a borrower for financing a house.

Intermediaries get to know the type of the borrower through monitoring. Although financial intermediaries exist to economize on monitoring and transaction costs, we assume monitoring cost to be zero for convenience, as our objective is not to justify the existence of financial intermediaries, a fact, which is already proved and well documented in the literature (e.g. Diamond, 1984). Monitoring includes screening the borrowers, entering into contract and laying down the conditions to prevent the opportunistic behavior of the borrower to avoid moral hazard problems so that borrower of any type do not simply run away with the amount lent or does not destroy or sell the house that is acting as collateral. It ensures that intermediaries get the possession of collateral in good condition in case of default.

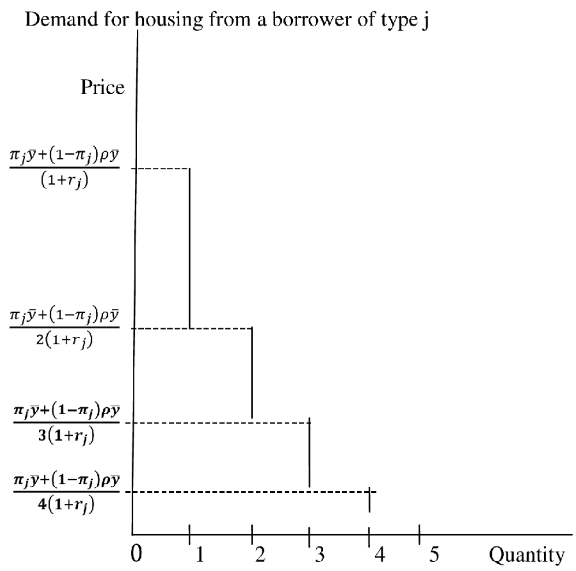

Figure 1: Borrower's demand for loan

As there are large numbers of financial intermediaries offering loans to borrowers, the situation resembles that of perfect competition where each intermediary takes market determined lending rate as given. Intermediaries protect themselves from the threat of repudiation by collateralizing the loan contract. In case of default, intermediary sells the financed house at current market price to recover the loan amount.

For simplicity, we consider only the case, in which there are only two portfolios possible for a single intermediary – either entire deposit amount is lent to prime borrowers or sub-prime borrowers. This actually comes out to be obvious as each intermediary prefers to lend in whatever option giving higher expected return.

Financial intermediaries in our model share several of the important features of intermediaries; they issue securities having pay off characteristics which are different from those of the securities they hold, they write debt contracts with borrowers and they process information. Our framework resembles that considered by Williamson (1986). Here monitoring decisions are made ex ante, monitoring is cost less and occurs with certainty in the context of housing loans whereas in Williamson (1986) monitoring decisions are made ex post in the context of loans for productive purposes, monitoring is expensive and only occurs in the 'default'state. Our model is based on adaptive expectations unlike Williamson (1986), which is based on rational expectations.

Intermediaries in the economy have different expectations about next period housing prices and learn from the experience of their predecessor with the same expectation levels. The mapping from intermediaries to expectation levels is one-to-one and one can identify the continuum of intermediaries with the continuum of expectation levels over the interval $[E_t(\underline{w}_{t+1}),E_t(w'_{t+1})]$, where $E_t(w_{t+1})$ is expectation of next period housing price shock. The expectation level of intermediaries is uniformly distributed on $[E_t(\underline{w}_{t+1}),E_t(w'_{t+1})]$. Hence, intermediaries are also uniformly distributed over the same interval.

4.1. Expected Profits of Intermediaries in period *t*

By lending to and borrowing from many agents, an intermediary exploits the law of large numbers. It can predict the total amount that intermediary is going to get back from borrowers, given the π value. Expected return of an intermediary giving housing loan in period t is given by:

$$E(TR) = [\pi_j(1 + r_j) + (1 - \pi_j)P^e_{(t+1)i}/P_t - (1 + r)]q_{jt} \tag{8}$$

where P^e_{t+1} is expected housing price in period $t+1$ and $1/P_t$ is share of each lender to a single borrower (of either type) and q_{jt} is the housing loan given by an intermediary which is derived from housing demand Q_j. Hence,

$$q_{jt} = P_t Q_j m_j \qquad for\ j = g\ and\ b$$

where mj = Total number of type j borrowers / total number of intermediaries in prime (or sub-prime) market

4.2. Distribution of Intermediaries between Prime and Sub prime Market

Consider a single borrower, at period t, who wishes to fund her housing purchase. This borrower must then enter into contract with a financial intermediary. The contracts must specify the amount of consumption good that will be transferred from the intermediary to the borrower Q_jP_t and will also specify the repayment amount $Q_jP_t(1+r_j)$ for j = g or b and conditions that needs to be fulfilled by the borrower of any type to maintain the underlying asset acting as collateral.

The expected return to i^{th} intermediary on one unit of consumer good lent is the expected value of total payments:

$$[\pi_j(1 + r_j) + (1 - \pi_j)P^e_{(t+1)i}/P_t = (1+R_j) \tag{12}$$

where $P^e_{(t+1)i}$ is housing price in next period as expected by i^{th} intermediary, $1/P_t$ is share of each lender to a single borrower (of either type).

$$P^e_{(t+1)i}/P_t \equiv Pt + [E_t(w_{t+1})^i] / P_t \tag{13}$$

Hence, expected return to i^{th} intermediary is:

$$\pi_j(1 + r_j) + (1 - \pi_j)\, P_t + [E_t(w_t + 1)^i]/\, P_t = (1 + R_j) \tag{14}$$

where $(1+r_j)$, for $j = g$ or b, is the amount that borrower of type j has to repay back per unit of loan amount.

In period t, there exists an intermediary (M) who is indifferent between lending to a prime borrower or a sub-prime borrower. For whom expected return on lending to a prime and sub-prime borrower is the same, i.e

$$\pi_b(1 + r_b) + (1-\pi_b)\, P_t + [E_t(w_t+1)^M]/\mathrm{P_t} = \pi_g(1+r_g)+(1-\pi_g)\, P_t + [E_t(w_t+1)^M]/\mathrm{P_t} \tag{15}$$

On simplifying, we get:

$$E_t(w_t+1)^M = P_t\,(\pi_g r_g - \pi_b r_b)/\ \pi_g - \pi_b \tag{16}$$

Proposition 1: *All Intermediaries, who are expecting housing price change to be more than what the marginal intermediary (M) expects, will serve sub prime market and all intermediaries expecting house price change to be lesser than the expectations of marginal intermediary (M) will serve prime market.*

Proof. $(P_t+[E_t(w_t+1)^i])/\ P_{t\,>}\,(P_t+[Et(w_{t+1})^M])/\ P_t$

$\pi_b(1 + r_b) + (1 - \pi_b)\, P_t + [E_t(w_t + 1)^M]/P_t > \pi_g(1 + r_g) + (1 - \pi_g)\, P_t + [E_t(w_t+1)^M]/P_t$

Hence, all intermediaries with $E_t(w_{t+1})^i > E_t(w_{t+1})^M$ will serve sub prime market as expected return on lending to sub prime borrowers is higher for them. These intermediaries with high housing price expectations mostly rely on high expected returns from housing, even if borrowers default on their loan repayments.

5. LOAN MARKET EQUILIBRIUM

Prime and sub prime lending rates are determined by equating market demand and market supply of loanable funds in respective markets. Demand for loanable funds from prime borrowers is $(1 - \alpha)\beta P_t Q_g$ and from sub prime borrowers is $(1 - \alpha)\,(1 - \beta)P_tQ_b$.

$$\textit{Prime market}: \alpha\frac{\left[E_t\left(w_{t+1}^M\right)-E_t\left(w_{t+1}\right)\right]}{\left[E_t\left(\overline{w}_{t+1}\right)-E_t\left(w_{t+1}\right)\right]}=(1-\alpha)\beta\frac{\pi_g y+(1-\pi_g)\rho y}{(1+r_g)} \tag{17}$$

$$\textit{subprime market}: \alpha\frac{\left[E_t\left(\overline{w}_{t+1}\right)-E_t\left(w_{t+1}\right)^M\right]}{\left[E_t\left(\overline{w}_{t+1}\right)-E_t\left(w_{t+1}\right)\right]}=(1-\alpha)(1-\beta)\frac{\pi by+(1-\pi_b)\rho y}{(1+r_b)} \tag{18}$$

It is assumed that all intermediaries receive equal number of deposits $\left(\frac{\alpha}{N}\right)$.

On substituting equation (16) in (17) and (18) we get:

$$\frac{\alpha}{[E_t(\overline{w}_{t+1})-E_t(\underline{w}_{t+1})]}[P_t\frac{\pi_g r_g-\pi_b r_b}{\pi_g-\pi_b}-E_t(\underline{w}_{t+1})]=(1-\alpha)\beta\frac{\pi_g y+(1-\pi_g)\rho y}{(1+r_g)} \tag{19}$$

$$\frac{\alpha}{[E_t(\overline{w}_{t+1})-E_t(\underline{w}_{t+1})]}[E_t(\overline{w}_{t+1})-P_i\frac{\pi_g r_g-\pi_b r_b}{\pi_g-\pi_b}]=(1-\alpha)(1-\beta)\frac{\pi_b y+(1-\pi_b)\rho y}{(1+r_b)} \tag{20}$$

Supply of loanable funds in prime market is positively related to prime lending rate and negatively related to subprime lending rate. Similarly, supply of loanable funds in subprime market is positively related to subprime lending rate and negatively related to prime lending rate. Demand for loanable funds (Q_j) is negatively related with lending rate (r_j).

Since prime and subprime market are not independent, equation (17) and (18) add up to following equation:

$$\alpha=(1-\alpha)\left[\beta\frac{\pi_g y+(1-\pi_g)\rho y}{(1+r_g)}+(1-\beta)\frac{\pi_b y+(1-\pi_b)\rho y}{(1+r_b)}\right] \tag{21}$$

Proposition 2: *Some intermediaries serve prime market and some subprime market if and only if:*

$$\frac{\pi_g}{\pi_b}r_g-\frac{E_t(\overline{w}_{t+1})}{\frac{\alpha}{H}}\left[\frac{\pi_g-\pi_b}{\pi_b}\right]<r_b<\frac{\pi_g}{\pi_b}r_g-\frac{E_t(\underline{w}_{t+1})}{\frac{\alpha}{H}}\left[\frac{\pi_g-\pi_b}{\pi_b}\right]$$

or

$$E_t\left(\underline{w}_{t+1}\right)<P_t\frac{\pi_g r_g-\pi_b r_b}{\pi_g-\pi_b}<E_t\left(\overline{w}_{t+1}\right)$$

i.e. if there exist a marginal intermediary then, some intermediaries serve subprime market and some prime market.

Proof: There can be three possibilities: First, some intermediaries serve in the prime market and some serve in the subprime market. This happens when intermediary at the upper end ($E_t(w'_{t+1})$) earns more expected profit from subprime market than prime market and intermediary at the lower end ($E_t(\underline{w}_{t+1})$) earns more expected profit from prime market than subprime market. Second possibility is that if all intermediaries serve the subprime market. This happens if intermediary at the lower end ($E_t(\underline{w}_{t+1})$) earns more expected profit from subprime market than prime market.

$$\pi^e p(\underline{w})<\pi^e_{sp}(\underline{w})$$

This is the case where r_b rises above the range specified in condition 1 and can happen when the cut off expectation level is below the distribution interval of intermediaries. Hence, there does not exist any intermediary who is indifferent between lending in prime and subprime market and since, subprime lending rate

r_b is very large, all intermediaries prefer lending only in subprime market. Third possibility is when all intermediaries serve the prime market. This happens if intermediary at the upper end earns more expected profit from prime market than subprime market.

$$\pi^e_p(w) > \pi^e_{sp}(w)$$

This is the case where r_b falls below the range specified in condition 1. This can happen when the cut off expectation level is above the distribution interval of intermediaries. Hence, there does not exist any intermediary who is indifferent between lending in prime and subprime market and since, subprime lending rate r_b is very low, all intermediaries prefer lending only in prime market.

6. HOUSING MARKET EQUILIBRIUM

It is assumed that units of houses in the model remain constant (H) for all periods. Housing is at once both consumption good and an investment good. Housing's role as an investment good requires that individual agents deal with uncertainty and form expectations regarding future housing prices. Uncertainty and expectations therefore play a role in housing models since expectations of future prices influence future consumption.

Total demand for housing is:

$$(1-\alpha)\beta\frac{\pi_g y+(1-\pi_g)\rho y}{P_t(1+r_g)}+(1-\alpha)(1-\beta)\frac{\pi_b y+(1-\pi_b)\rho y}{P_t(1+r_b)}$$

Hence, demand for housing is inversely related to price of housing, market clears if:

$$(1-\alpha)\beta\frac{\pi_g y+(1-\pi_g)\rho y}{P_t(1+r_g)}+(1-\alpha)(1-\beta)\frac{\pi_b y+(1-\pi_b)\rho y}{P_t(1+r_b)}=H$$

Equation (21) and (29) solve for equilibrium housing price P*.

$$P_t^*=\frac{\alpha}{H}$$

7. GENERAL EQUILIBRIUM

Condition for non negative expected profits Intermediaries must earn non negative expected profits in order to continue operating in loan market. Hence, we now derive the non negativity condition for intermediaries in optimistic, pessimistic and normal situation.

Proposition 3 *If intermediary at $E_t(\underline{w}_{t+1})$ earns non negative expected profits then all intermediaries above this intermediary will also earn non negative expected profits.*

Proof. Intermediaries' expected profits are increasing in housing price expectations in each prime and subprime market as there is one lending rate in each market. Also, it is more profitable for intermediaries expecting housing price to be less than $E_t(w_{t+1})^M$ to operate in prime loan market and for intermediaries expecting housing price to be higher than $E_t(w_{t+1})^M$ to operate in sub prime loan market. Hence, we can depict the expected profits of intermediaries as in figure 2 and if intermediary at $E_t(\underline{w}_{t+1})$ earns non negative expected profits then all intermediaries above this intermediary on the expectation interval will also earn non negative expected profits.

7.1. Optimistic Scenario at time t: All intermediaries in period t expect housing price to rise in period t+1

Condition 1 *Condition for non negative profits for all intermediaries is:*

$$\pi_g(1+r_g)+\frac{1-\pi_g}{\pi_g}\geq(1+r)$$

Proof. Given proposition 3, the condition for non negative expected profits for all intermediaries is: $\pi_g(1+r_g)+(1-\pi_g)(P^t+E^t(\underline{w}_{t+1}))/P_t-(1+r)\geq 0$. Lowest value of $E_t(\underline{w}_{t+1})$ in optimistic situation is 0 as it is assumed that next period housing price is not expected to fall. Then the constraint in general becomes: $\pi_g(1+r_g)\geq(1+r)-(1-\pi_g)$.

Optimistic Scenario

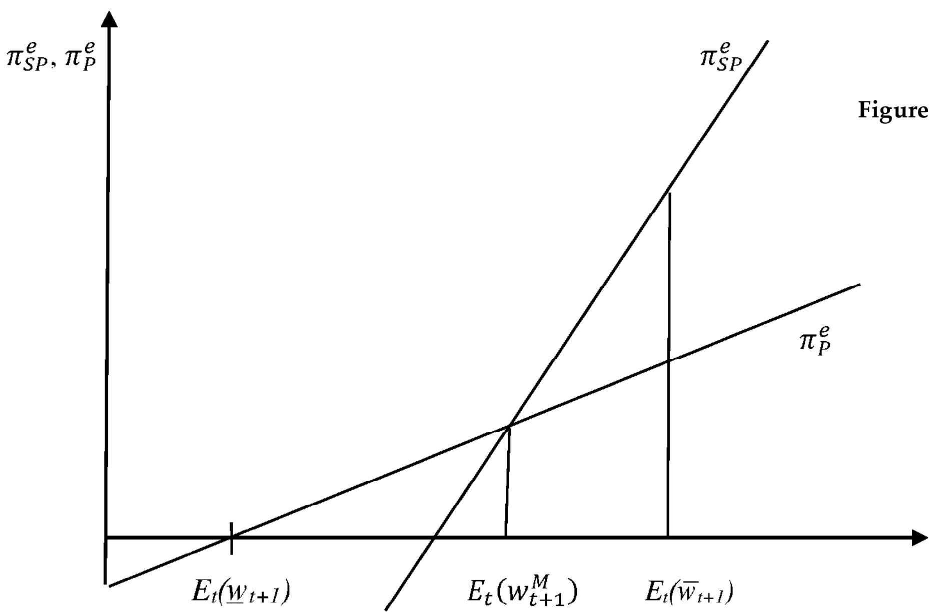

Figure 2A

Pessimistic and Normal Scenario

Figure 2B

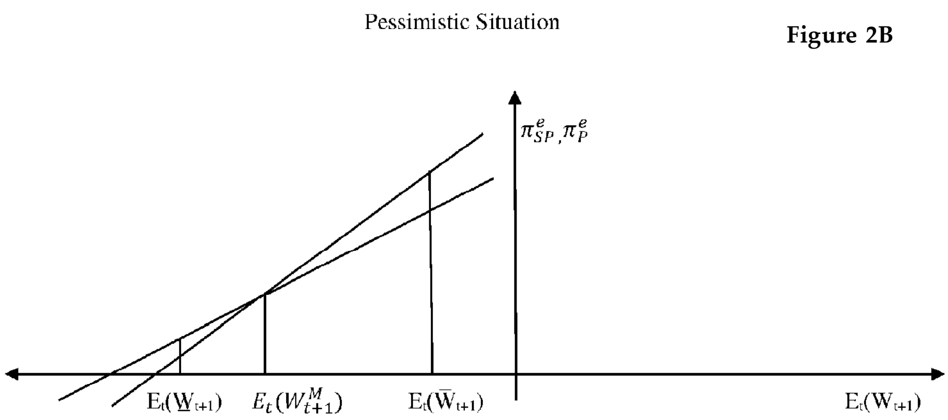

Figure 2C

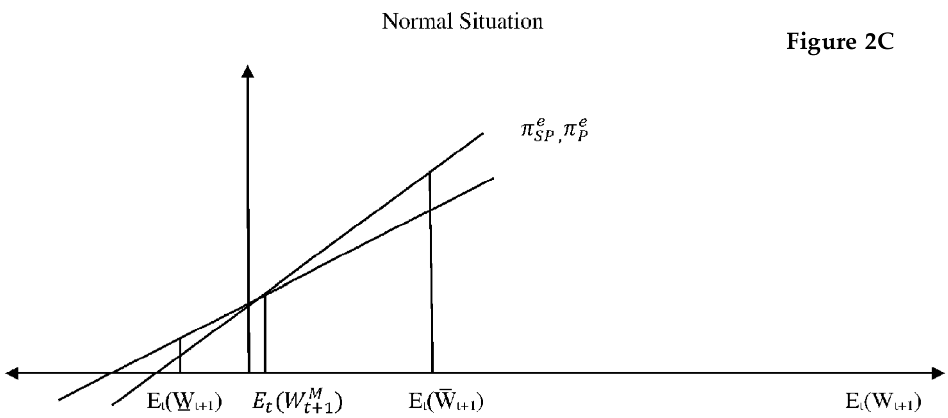

Figure 2: Profit function of intermediaries in optimistic, pessimistic and normal scenario

7.2. Pessimistic or Normal Scenario at time t: All intermediaries in period t expect housing price to fall in period t+1.

Condition 2 *Condition for non negative profits for all intermediaries is:*

$$\pi_g(1+r_g) \geq (1+r)$$

Thus, if expected repayment value of loan from prime borrower is greater than or equal to the cost of loanable funds, then all intermediaries earn non negative expected profits.

Proof. Given proposition 3, the condition for non negative profits for all intermediaries is:

$$\pi_g(1+r_g)+(1-\pi_g)\frac{(P_t+E_t)(\underline{w}_{t+1}))}{P_t}-(1+r)\geq 0$$

$$(1+r_g)\geq\frac{1+r}{\pi_g}-(1-\pi_g)\frac{P_t+E_t(\underline{w}_{t+1})}{\pi_g P_t}$$

Lowest value of $E_t(\underline{w}_{t+1})$ in pessimistic situation is $-P_t$ as it is assumed that next period housing price is not expected to be negative. Then the constraint in general becomes: $\pi_g(1+r_g)\geq(1+r)$. It is assumed that return on safe asset is low enough that condition 2b holds to be true and all intermediaries earn non negative profits in all three scenarios discussed above.

7.3. Equilibrium

Equation (21) is the loan market equilibrium condition and gives us a negative relation between prime and subprime lending rates.

$$r_b=\frac{(1-\alpha)(1-\beta)(\pi_b y+(1-\pi_b)\rho y)(1+r_g)}{\alpha(1+r_g)-\beta(\pi_g y+(1-\pi_g)\rho y)(1-\alpha)}-1$$

$$\frac{dr_b}{dr_g}=\frac{-\beta(1-\alpha)^2(1-\beta)(\pi_b y+(1-\pi_b)\rho y)(\pi_g y+(1-\pi_g)\rho y)}{(\alpha(1+r_g)-\beta(\pi_g y+(1-\pi_g)\rho y)(1-\alpha))^2}$$

Hence, prime and subprime lending rates are negatively related as $dr_g/dr_b<0$ and slope is falling as r_g increases.

Proposition 2 gives us a range of prime and subprime lending rates in which some intermediaries serve the prime market and some serve the subprime market. On substituting (16) in (17), we get indifference condition for marginal intermediary.

$$r_b=\frac{\pi_g}{\pi_b}r_g-\frac{E_t(\underline{w}_{t+1})}{\frac{\alpha}{H}}\left[\frac{\pi_g-\pi_b}{\pi_b}\right]-\frac{\pi_g-\pi_b}{\pi_b\frac{\alpha^2}{H}}(1-\alpha)\beta\frac{(\pi_g y+(1-\pi_g)\rho y)[E_t(\overline{w}_{t+1})-E_t(\underline{w}_{t+1})]}{1+r_g} \qquad (22)$$

$$\frac{dr_b}{dr_g}=\frac{\pi_g}{\pi_b}+\frac{\pi_g-\pi_b}{\pi_b\frac{\alpha^2}{H}}(1-\alpha)\beta\frac{(\pi_g y+(1-\pi_g)\rho y)[E_t(\overline{w}_{t+1})-E_t(\underline{w}_{t+1})]}{(1+r_g)^2}$$

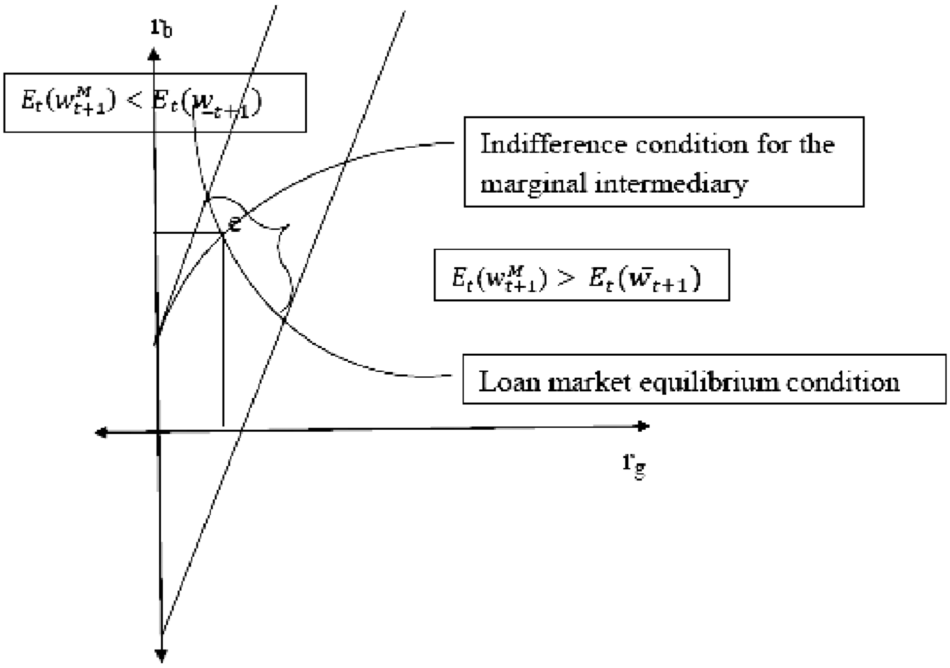

Figure 3: Equilibrium lending rates in normal scenario

Thus there exists a positive relation between prime and subprime lending rate and as r_g increases slope falls. Hence, we get an upward sloping concave curve as indifference condition for marginal intermediary. Equation (22) and (21) solve for equilibrium prime and subprime lending rates as depicted in figure 3.

III. DYNAMICS OF THE MODEL

1. Expectations adjustment mechanism

Intermediaries learn from the experience of their predecessors with same expectation levels, in each period they adjust their expectation by some fraction of the error in expectations of the previous period.

Given the error, intermediaries adjust their expectations according based on adaptive expectation rule.

$$E_t(w^i_{t+1}) = E_{t-1}(w^i_t) + \delta_i \varepsilon^i_t \qquad 0 < \delta_i \leq 1$$

where δ_i be a constant of proportionality called the coefficient of expectations. Thus, intermediaries revise their previous expectations of housing price change in each period in proportion to the difference between actual shock and what was previously expected. There exists good amount of literature in psychology and behavioral economics that justify our choice of taking adaptive expectation regime. Kahneman and Riepe (1998) argue that "there is a tendency to attribute causal significance to chance fluctuations that leads investors to overreact to any information to which their attention is drawn. In the context of finance, the same psychological quirk causes investors to perceive trends where none exist, and to take action on these erroneous impressions." Hence, people perceive patterns where none exist and it is also explained by the authors that they have too much confidence in their judgments of uncertain events. Kahneman and Tversky (1973) explain that, in making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead, they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors.

The reliance on heuristics and the prevalence of biases are not restricted to laymen. Experienced researchers are also prone to the same biases when they think intuitively. For example, the tendency to predict the outcome that best represents the data, with insufficient regard for prior probability, has been observed in the intuitive judgments of individuals who have had extensive training in statistics (Tversky and Kahneman, 1974). The representatives bias (i.e. the fact that people interpret short sequences of observations as representative for the population) is used by Barberis, Shleifer and Vishny (1998) to explain under and over reaction in financial markets. In our model, the decision-maker, here financial intermediaries rely on information about past cases a situation more akin to adaptive expectations than to rational expectations.

The error adjustment mechanism can be applied to all previous periods so that current housing price expectations equal:

$$E_t\left(w^i_{t+1}\right) = \delta\left[\sum_{k=0}^{t}(1-\delta_i)^k w_{t-k}\right]$$

Thus, current expected housing price change reflects a weighted average of all past housing price shocks, where the weights get smaller and smaller as we move further in the past. Hence, intermediaries having different expectations of housing prices reflect that intermediaries are having different coefficient of expectations (δ_i). This implies that, those intermediaries with higher value of $ä_i$ are reacting more to recent movements in housing prices in comparison to those intermediaries with lesser value δ_i.

2. Dynamics After Period t

As discussed earlier, there could be three possibilities at time t:

1. All intermediaries expected housing price to rise ($E_t(w_{t+1}) > 0 \;\forall i$). This happens when market is very optimistic about housing prices.

2. All intermediaries expected housing price to fall ($E_t(w_{t+1}) < 0 \ \forall i$). This happens when market is very pessimistic about housing prices.
3. Some intermediaries expected housing price to fall and some expected housing price to rise. This situation is in between the two extremes discussed above and occurs under normal circumstances. This situation is depicted in figure 3.

We will discuss the dynamics associated with each possibility one by one. No matter what the situation was in period t, overtime expectation interval converges to zero as intermediaries learn from their past errors. Given that expectation interval converges to zero as intermediaries learn from their past errors, the range specified in proposition 2 shrinks overtime and both slope and intercept of the curve depicting 'indifference condition for marginal intermediary' changes as shown in figure 4. In optimistic scenario, as intermediaries learn that they were too optimistic and adjust their expectations, the new equilibrium prime lending rate falls and subprime lending rate rises. In pessimistic scenario, as intermediaries learn that they were too pessimistic and adjust their expectations, the new equilibrium prime lending rate rises and subprime lending rate falls.

During normal times those intermediaries who expected housing price to fall realize that they underestimated prices for the next period and hence revise their

Optimistic situation at time t

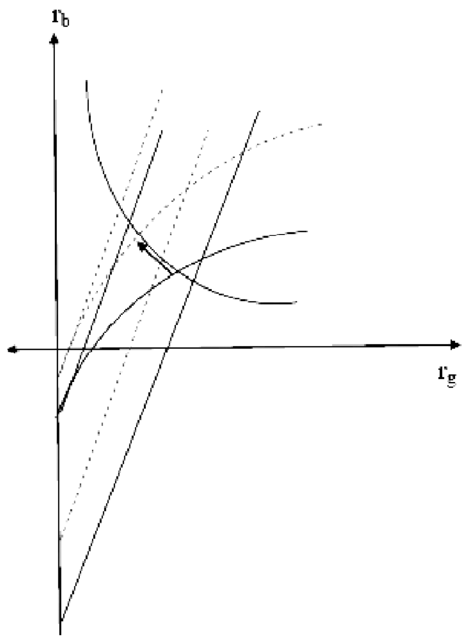

Figure 4A

Pessimistic situation at time t

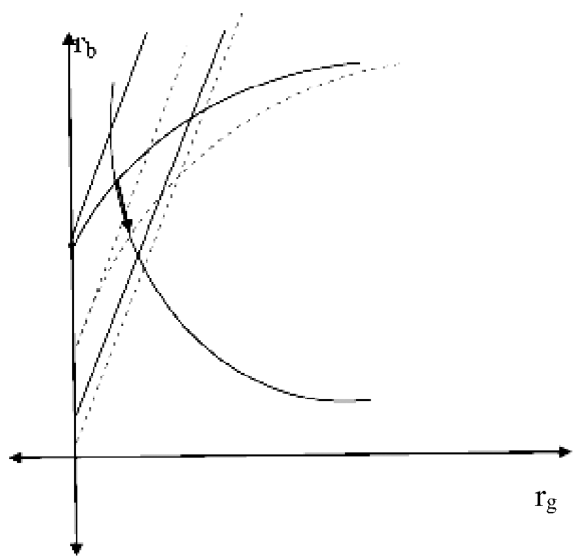

Figure 4B

Normal situation at time t

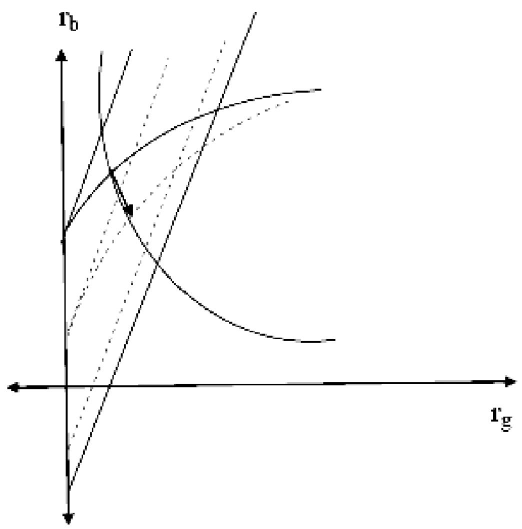

Figure 4C

Figure 4: Transition from optimistic situation

expectation upwards. As a result intercept of the indifference curve for marginal intermediary shifts down and new equilibrium subprime lending rate is smaller than previous period's rate.

Hence, under normal circumstances, there is a tendency in the system to make sub prime borrowing cheaper because of the expectation adjustment of intermediaries who underestimated housing price. Hence, *Until there exist intermediaries who underestimate the housing price, under normal circumstances, the system have tendency to reduce the cost of borrowing in riskier markets, making the system more and more fragile.*

3. Steady State

Intermediaries continue to adjust their expectations until they make zero error in making housing price expectations. Hence steady state will be reached when $E_t(\underline{w}_{t+1}) = E_t(w_{t+1}) = E_t(w_{t+1}^M) = 0$ and $r_b = (\pi_g/\pi_b)r_g$. Steady state equilibrium prime and subprime lending rates are depicted in figure 5. Given these equilibrium lending rates, all intermediaries are indifferent between lending in prime or subprime market and may also choose to lend partially in prime and subprime market. Thus, any type of borrower can obtain loan from any intermediary at specified lending rates.

In or near steady state, subprime lending rate is greater than the prime lending rate ($r_g^* < r_b^*$) as $r_b = r_b = (\pi_g/\pi_b)r_g$ at steady state. From housing demand functions of prime and sub prime borrowers, we find that prime borrowers are able to get bigger houses than sub prime borrowers in steady state, i.e., $Q^*_g > Q^*_b$.

$$Q_g^* = \frac{\pi_g y + (1-\pi_g)\rho y}{\frac{\alpha}{H}(1+r_g^*)} \quad and \quad Q_b^* = \frac{\pi_b y + (1-\pi_b)\rho y}{\frac{\alpha}{H}(1+r_b^*)}$$

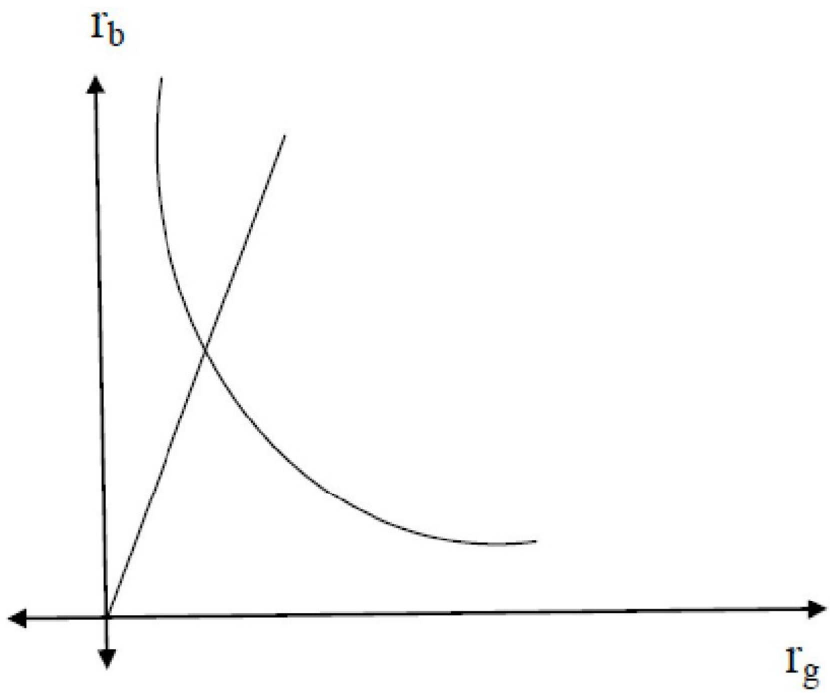

Figure 5: Steady State

4. SHOCK IN HOUSING MARKET

In this section, we discuss the impact of shocks in housing market on equilibrium price and lending rates. These shocks may be from the supply side due to construction or destruction of houses or may be from the demand side due to aggregate demand effects such as aggregate income shocks, technological or productivity shocks. In order to study the impact of such shocks, we add a shock term in the housing market equilibrium condition.

$$(1-\alpha)\beta\frac{\pi_g y + (1-\pi_g)\rho y}{P_t(1+r_g)} + (1-\alpha)(1-\beta)\frac{\pi_b y + (1-\pi_b)\rho y}{P_t(1+r_b)} = \theta H$$

where θ is shock term. θ > 1 implies positive supply side shock and θ < 1 is negative supply side shock. Negative demand shock has the same implications as positive supply shocks and positive demand shock has the same implications as negative supply side shock. Hence, we restrict our attention to positive and negative supply side shocks but analysis is applicable to the demand shocks too.

Positive Supply Side Shock Suppose there is construction of new houses and there is positive supply shock due to which equilibrium housing price falls. Economy was initially at its steady state: $P^*_t = \alpha/\theta H$, where θ > 0. Due to fall in the housing price, some borrowers may choose to default in loan repayment as shown in proposition 9.

Proposition 4 *As the housing price start to fall, it is the subprime borrower who are more likely to default.*

Proof. Given the utility function, a borrower will default if $U_d > U_{nd}$. That will happen when

$$\theta > \frac{\alpha}{(1+r_j)\alpha - H}$$

Since steady state equilibrium subprime lending rate is greater than the prime lending rate, we get a range for the size of the shock where there will be no defaults, where subprime borrower defaults and where all borrowers will not have incentive to repay back the loan, as shown in figure 6.

Proposition 5: *It may happen that borrower does not default even with negative equity (i.e. when the value of the property dropped below the outstanding balance of the mortgage). This happens when*

$$1 < \theta < \frac{\alpha}{(1+r_b)\alpha - H}$$

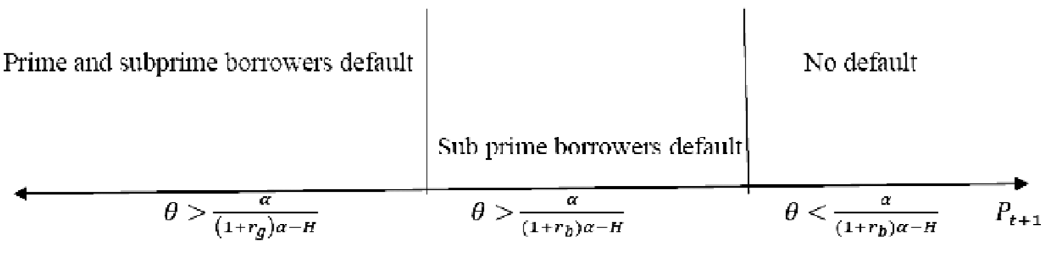

Figure 6: Borrower's default mechanism

Hence, our argument is different from the 'ruthless default model' which says that borrowers default as housing prices falls to the level of mortgage value. Borrowers do not default due to transaction cost associated with default. This may be because of number of factors, such as, cost of locating a new unit and moving the family belongings, the psychic costs of foreclosure, the loss of the advantages of home ownership over renting, attachable assets, and brokerage fees. This also explain the empirical observation that house price decline is not very steep due to the reluctance of house owners to sell the house as its value starts falling.

As housing price falls, intermediaries adjust their expectations for the next period. Some intermediaries react more and some less to this change in house price, but all intermediaries expect that price will fall and the situation resembles that of pessimistic situation discussed above.

Proposition 6: *In pessimistic scenario, those intermediaries who take more risk and lend to subprime borrowers earn more per unit realized profits.*

Proof. As $E_t\left(w_{t+1}^M\right) < 0$ in pessimistic situation, this implies:

$$\frac{\pi_g(1+r_g)-\pi_b(1+r_b)}{\pi_g-\pi_b}P_t - P_t < 0 \Rightarrow \pi_g(1+r_g)+(1-\pi_g) < \pi_b(1+r_b)+(1-\pi_b)$$

[Given $\frac{P_{t+1}}{P_t}=1,$ as it is only one time shock.]

Mechanics behind the adjustment Suppose the positive supply side shock takes place in period t, we will now look at the adjustment mechanism of intermediaries in each period starting from period t+1. **Period t+1** Due to positive supply side shock, house price has changed by w units where $w < 0$. Error in expectation for all intermediaries is same in period t+1. Intermediary with highest value of δ will be the one at the bottom of the new band i.e. $E(\underline{w})$. Similarly, intermediary with lowest value of δ will be the one at the top of the new band i.e. $E(w')$. In General, expectations of intermediaries adjust overtime according to following mechanism:

$$E_t\left(w_{t+1}^i\right) = \delta_i w(1-\delta_i)^{t-i}$$

Since $0 < \delta_i < 1$, overtime all expectations converge to zero.

Negative Supply Side Shock Suppose there is destruction of some houses and there is negative supply shock due to which equilibrium housing price rises. Economy was initially at its steady state: $P^*_t = \alpha/\theta H$ where $\theta < 0$. As housing price rises from its steady state equilibrium, old borrowers receive capital gains on their housing sales. Intermediaries adjust their expectations for the next period. Some intermediaries react more and some less to this change in house price, but all intermediaries expect that price will rise and the situation resembles that of optimistic situation discussed above.

Proposition 7: *In optimistic scenario, when many intermediaries tend to speculate and provide loans to subprime borrowers, intermediaries who play safe and lend to prime borrowers earn more per unit realized profits, i.e. intermediaries who are reacting less to the changes in prices earn more per unit profits.*

Proof. As $E_t\left(w_{t+1}^{M}\right) < 0$ in optimistic situation, this implies:

$$\frac{\pi_g(1+r_g)-\pi_b(1+r_b)}{\pi_g-\pi_b}P_t - P_t < 0 \Rightarrow \pi_g(1+r_g)+(1-\pi_g) < \pi_b(1+r_b)+(1-\pi_b)$$

[Given $\frac{P_{t+1}}{P_t}=1$, as it is only one time shock.]

Hence, given propositions 6 and 7, those intermediaries who are less reactive to the changes in housing prices are better off in both pessimistic and optimistic situation than those intermediaries who are reacting more. Overtime system has tendency to move back to its steady state as intermediaries continue to adjust their expectations unless they make zero errors in framing their expectations about housing price.

IV. CONCLUSIONS

In housing market price rises and is followed by a more a similar decline after reaching its peak. One reason why we may often fail to see a hard crash in real estate, particularly in single family homes, if not in other types, is that individuals become reluctant to sell when their homes fall in value. This may be because of number of factors, such as, cost of locating a new unit and moving the family belongings, the psychic costs of foreclosure, the loss of the advantages of homeownership over renting, attachable assets, and brokerage fees. This fact is also established in our model, as we have shown that borrowers may not default even with negative equity, particularly for the initial range of negative equity. Intermediaries with high house price expectations will serve sub prime market as expected return on lending to sub prime borrowers is higher for them. These intermediaries mostly rely on high expected returns from housing, even if borrowers default on their loan repayments.

As realised price is higher than expected for some intermediaries, those intermediaries who expected housing price to fall realize that they underestimated prices for the next period and hence revise their expectation upwards. Intermediaries learn that they were too pessimistic and adjust their expectations, the new equilibrium prime lending rate rises and subprime lending rate falls implying that some intermediaries are shifting from prime market to subprime market. Hence, intermediaries start to operate in riskier market.

Hence, under normal circumstances, there is a tendency in the system to move towards subprime market because of the expectation adjustment of intermediaries who underestimated housing price. Until and unless there exist intermediaries who underestimate the housing price, the system will continue to move towards riskier market, making the system more and more fragile.

As the housing price start to fall due to positive supply shock or negative demand shock in housing market, it is the subprime borrower who are more likely to default. Since steady state equilibrium subprime lending rate is greater than the prime lending rate, we get a range for the size of the shock where there will be no defaults, where subprime borrower defaults and where all borrowers will not have incentive to repay back the loan.

It may happen that borrower does not default even with negative equity (i.e. when the value of the property dropped below the outstanding balance of the mortgage). Hence, our argument is different from the 'ruthless default model' which says that borrowers default as housing prices falls to the level of mortgage value. Borrowers may not default due to transaction cost associated with default. This may be because of number of factors, such as, cost of locating a new unit and moving the family belongings, the psychic costs of foreclosure, the loss of the advantages of home ownership over renting, attachable assets, and brokerage fees.

In pessimistic scenario, when most intermediaries do not expect much of the increase in house price, those intermediaries who take more risk and lend to subprime borrowers earn more per unit realized profits. On the other hand, in optimistic scenario, when many intermediaries tend to speculate and provide loans to subprime borrowers, intermediaries who play safe and lend to prime borrowers earn more per unit realized profits. Hence, those intermediaries who are less reactive to the changes in housing prices are better off in both pessimistic and optimistic situation than those intermediaries who are reacting more.

Overtime system has tendency to move back to its steady state as intermediaries continue to adjust their expectations unless they make zero errors in framing their expectations about housing price (as discussed above). We can see that the risk faced by the investors in the market consists of two parts exogenous and endogenous risk. The exogenous risk is created by the random fluctuation of the housing prices. The endogenous risk is caused by the ignorance of intermediaries and their reliance on the past cases when predicting returns. It depends positively on the mass of intermediaries with high expectations of housing prices and are not satisfied with the returns in prime market and thus would hold the risky asset, as long as prices are rising, but sell it, the moment they fall. Hence, the risk faced by the economy, as well as the volume of trades increases, as the number of overconfident intermediaries rises.

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