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SPECULATIVE LENDING IN MORTGAGE LOAN MARKET: A MACROECONOMIC ANALYSIS

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Abstract: This paper critically examines the link between the loan market and the housing market that works through mortgage loans. Repayment of such mortgage loans depends on the future earning potential of the borrowers, which in turn depends on the overall state of the macro economy. Under buoyant macroeconomic conditions, all borrowers pay back their loans and both the loan market and the housing market function well. However, a temporary income shock in the economy, which undermines the repayment ability of the borrowers, may result in speculative lending by banks thereby leading to a crisis. This calls for strict monitoring of mortgage loans by regulatory authorities.

INTRODUCTION

The linking of the loan markets with housing market through mortgage loans is a common practice in many advanced countries. Recently such practices has picked up in India as well. With rapid economic growth, India has been experiencing a chronic shortage of housing, especially in the urban areas. This has resulted in a real estate boom, fueled by mortgage loans offered, and often actively pushed, by various financial intermediaries, including public sector banks. For example, the outstanding housing loans by the Scheduled Commercial Banks increased from Rs. 15,317 crore on March 31, 2001 to Rs.1,62,562 crore on March 31, 2006 and to Rs.4,64,372 crore on March 31 2013.[1] While a buoyant housing sector is often seen as the sign of a prospering economy, such rapid expansion in mortgage loans may inherently be associated with long term instability and impending crisis.

Banks typically suffer from imperfect information. Baye and Jansen (1996) [3] describe it as bank's inability to know for certain which borrowers will and which will not repay their loans. Thus even when they know with

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certainty that some borrowers will default, the inability to identify the potential defaulter means that banks cannot charge differential rates to borrowers with different credit risks. While this imperfect information may itself be a source of future instability, speculative motives on part of the banks may further contribute to this. And mortgage loans, by their very nature, are particularly prone to such speculative motives.

In this paper we develop a theoretical model to examine the link between the loan market and the housing market, and analyze its implication for the macro economy. In the process we show that such interlinkage between the housing sector and the banking sector may encourage financial intermediaries to engage speculative lending, thereby increasing the potential risk in the banking sector. Such speculative activities are especially attractive under adverse macroeconomic conditions, when the regular repayment channels are not working well and the risk of potential defaults are high. Such speculative activities by the banks further aggravate the already precarious macroeconomic scenario, leading to eventual collapse of the banking system and overall crisis.

The structure of the paper is as follows. In section 2 of the paper we provide the general set up and describe in detail the objectives and activities of the lenders and the borrowers. In section 3, we introduce the financial intermediaries (banks) who mediate between the primary lenders and the borrowers and show how the lending and borrowing activities are inherently linked to the housing market in the economy. We then analyze the short run temporary equilibria that results from the decision takes by various sets of agents. Section 4 traces the economy over a period of time to predict the long run outcome of this process. Finally, section 5 concludes the paper.

1. THE MODEL

We consider a closed economy populated by two sets of agents: rentiers and workers. Rentiers are people who are born with some endowments and live off the income generated from these endowments. Workers are people who are not endowed with any resources at birth and have to work and/or borrow to meet their various needs. Further, there are financial intermediaries who mediate between these two sets of agents.

We are going to abstract away from actual production. So there are no firms (other than the financial intermediaries) and wage incomes of agents are specified exogenously.

This is an overlapping generation's model where each agent lives exactly for two periods, which, for convenience, are called periods of 'youth' and 'maturity'. Each agent is born young, lives through the period to attain maturity and die at the end of the 2nd period. Every mature agent has an offspring - the young agent of the next generation - who carries forward the dynastic link. Total population in each cohort is constant, represented by a continuum of measure 1. Within any cohort, α proportion of the population are rentiers and $(1 - \alpha)$ proportion are workers.

Agents in this economy enjoy two types of consumption goods - a regular consumption good (say, corn), denoted by C and a durable consumption good (say, housing), denoted by Q. The regular consumption good is used as the numeraire such that all prices (wage and interests as well as housing price) are defined in terms of this numeraire consumption good. While services of the durable consumption good (house) are enjoyed in both periods of one's life, consumption of the corn is assumed to take place at the 2nd period of one's life. This creates the possibility of mutually gainful lending and borrowing activities between young agents belonging to rentiers' families (who are born with wealth that they cannot consume right away) and young agents belonging to the workers' families (who need resources to buy houses in the first period of their lives). However we shall assume that all lending and borrowing activities are necessarily mediated through the financial intermediaries, called banks.

In the next sub-sections we describe the activities undertaken by each set of agents over their entire life-cycle spanning 2 periods.

1.1. Rentiers'/Lenders' Side Story

Agents belonging to any cohort of rentiers are identical to one another. Each young agent belonging to this group, upon birth, is endowed with an exogenous family asset (say, land-holding) that generate single unit of the regular consumption good (corn). The young rentier is also endowed with a house of a fixed size (h).[2] The housing endowment is taken up for consumption immediately (and the services are enjoyed over both periods of his life), but the corn endowment is saved and invested in the first period so that it can generate an additional interest income at the time of consumption (in the second period). The agent has two investment opportunities. He can invest his one unit of resource endowment in some safe asset which will generate a fixed gross return $(1+\underline{r})$ in the next period. Alternatively, he can deposit his money with the financial intermediaries/ banks. As long as banks are offering him the same rate of return, $(1+\underline{r})$, he is happy to keep his deposit with the banks. We shall assume that the banks *ex ante* offer to its depositors the same rate of interest $\underline{r}$. Hence a young rentier keeps his first period endowment as deposits with the banks.[3]

The lifetime utility function of a rentier is given by

$$U_l(h, Cl) = log\ h + logh + log\ C^e_{\ l}$$

where the first two terms capture the utility that he derives from the house the he is endowed with, and the last term captures the utility from his (expected) second period consumption. Since $C_l^e = 1+\underline{r}$, his life-time utility can be re-written as

$$U_l\ (h, C_l) = logh + logh + log(1 + \underline{r})$$

The rentier agent, who is now mature, dies in the second period and the family land and house is passed on to his next generation, who again begins his life-cycle with a house (inherited from the parent) and an exogenous family asset that gives him an endowment of one unit of corn.

Apart from lending money to the financial intermediaries, rentiers do not actively engage with the rest of the economy. As long as banks are able to pay back an gross interest rate of $(1+\underline{r})$ on their deposits, successive generations of rentiers keep their deposits with the banks, thereby providing the necessary liquidity. Things may go askew if banks in any period end up paying an interest rate less than $(1+\underline{r})$. We shall re-visit this possibility later.

Let us now turn to the life-cycle of an agent who belongs to the worker group.

1.2. Workers'/Borrowers' Side Story

Agents belonging to the worker group are born with zero endowment: neither do they inherit a house, nor are they endowed with any endowment of consumption good (corn) at birth. As young agents, they come to the economy searching for jobs. But finding a job needs time. In fact, we assume that they are able to find a job only at the beginning of the second period of their lives. Meanwhile they need a place to stay and sustain themselves during the first period; so they borrow from the banks.

There are two types of workers in the pool - high ability and low ability. We assume that out of the total pool of young workers in any cohort, exactly β proportion are high-ability, while $(1 - \beta)$ proportion are low-ability. The high ability/good workers expect and eventually find jobs which are high paying and the low-ability/bad workers expect and eventually find jobs which are low paying. However, ability is not observable from outside; hence banks ex ante cannot identify precisely who is a high-ability agent and who is low-ability. So banks treat all borrowers symmetrically and charge the same interest rate, although they know that some of them will have higher ability to repay the loan (making them prime borrowers) while others will have lower ability to repay the low (making them sub-prime borrowers). Given that total population of workers in any cohort is given by $(1 - \alpha)$, the population of prime borrowers at point of time t is $(1 - \alpha)\beta$ and the population of subprime borrowers is $(1-\alpha)(1-\beta)$.

Now consider the life-cycle of a young worker-cum-borrower at any point of time. He lives for two periods. In the first period of his life, neither does he consume any corn, nor does he have any income, although he knows that he will earn an income of y^g or y^b ($y^g > y^b$) at the beginning of the next period - depending on whether he is high-ability or low-ability. Based on the knowledge, he borrows from the bank and buys a house of size Q_j ($j = g$ (i.e., good or prime borrower) or b (i.e., bad or subprime borrower)) at a per unit price of P_t. In the first period he simply consumes the services of the house which gives him a first-period utility of $\log Q_j$.

At the beginning of the second period of his life, he earns his labor income. He then also decides whether to repay the loan or not. If he decides to repay, then he pays back the loan with interest to the bank from his labor income - but retains the ownership right of the house, which he can enjoy for the rest of his life time (which again gives him an utility of $\log Q_j$). Moreover, at the end of his time life-time he can sell it off to the next generation of workers, and consume the sales proceed. We assume that when he sells off the house he expects to get the same price at which he bought it (P_t); thus his expected gain from the sale of the house is P_tQ_j.

If, on the other hand, if he decides not to repay his loan, then the bank takes away the ownership right of house. Thus he has to forego the second period utility from the services of the house as well as from the sales proceed that he could have obtained by selling the house to the bank at the end of his lifetime. In addition, the agent has to some incur administrative costs related to the default (that may include the cost of finding an alternative accommodation), which we assume to be proportional to the house size. This administrative cost in case of default is denoted by δQ_j.

Thus, depending on his repayment decision, at the end of his life-time, he receives some consumption good (consisting of his labor income minus the loan repayment or the administrative cost of default, and the potential sales proceeds of house - in case he does repay) which constitute his second period consumption (C_j), giving him an utility of $\log C_j$. He dies thereafter.

Notice that the value of the life-time utility of a worker/borrower depends on crucially on whether or not he repays the loan in the second period. Repayment decision however is his own choice and he would decide to pay back the loan if and only if the life-time utility associated with repayment is at least as high as the life-time utility associated with default. Therefore we now calculate life-time utility of the worker-cum-borrower separately for these two alternatives.

1.2.1. Option A: Borrower chooses to repay

Recall that the worker/borrower buys a house of size Q_j in the first period of his life itself, giving him a first period utility of log Q_j. In the second period, if he chooses to repay the loan amount then he gets to retain the house for the rest of his life-time and enjoy its services which again gives him an utility of log Q_j in the second period. In addition, he can sell off the house at the end of his life-time to earn a sales proceed of P_tQ_j. He then consumes his entire post repayment income (labor income - repayment + sales proceed) which gives him a utility of log C_j.

Thus his total life-time utility under option A is:

$$\begin{aligned} U_j^A(Q_j, C_j) &= log\,Q_j + log\,Q_j + log\,C_j \\ &= Q_j = log\,C_j \end{aligned} \tag{1}$$

Note that when the worker/borrower chooses to buy a house of size Q_j in the first period, he knows his ability and therefore he can anticipate his second period income (which is either y^g or y^b). Thus his budget constraints in the two periods are: in the first period: $P_tQ_j = L_j$; in the second period: $C_j = y_j - (1+r_t)L_j + Q_jP_t$. Thus the life-time budget constraint of the worker/borrower under option A is:

$$C_j = y_j + [P_t - (1+r_t)P_t]Q_j$$

Hence we can write his optimization problem in Case A as:

$$2\log Q_j + \log C_j$$

subject to $C_j + (r_tP_t)\,Q_j = y_j$

From the FONC:

$$\frac{2C_j}{Q_j} = r_tP_t$$

Hence, the optimal solutions are:

$$C_j^{*A} = \frac{y_j}{3}$$

$$C_j^{*A} = \frac{2y_j}{3r_t P_t}$$

Thus the maximized value of utility of the worker/borrower under option A (repayment) is:

$$U_j^A\left(Q_j, C_j\right) = Q_j^{*A} + log\, C_j^{*A}$$

$$= \left[\left(\frac{2y_j}{3r_t P_t}\right)^2 \frac{y_j}{3}\right] (Option\, A - Utility)$$

1.2.2. Option B: Borrower chooses to default

Recall once again that the worker/borrower buys a house of size Q_j in the first period of his life itself, giving him a first period utility of log Q_j. In the second period, if he chooses to default, then he has to forgo the ownership right to the house and financial intermediaries take possession of the house. Moreover, he has to incur an administrative cost of δQ_j from his second period income. The agent consumes his entire second period income net of administrative costs which generates an utility from consumption of log C_j. Thus, his total utility over his life-time is:-

$$U_j^B(Q_j, C_j) = log\, Q_j + log\, C_j \tag{2}$$

As before, when the worker/borrower chooses to buy a house of size Q_j in the first period, he knows his ability and therefore he can anticipate his second period income (which is either y^g or y^b). Since he does not repay the loan amount, future repayment obligation does not act as a constraint on his current choice of the house size. However, he knows that the administrative cost of default will be proportional to the house size. Hence the only constraint that determines his choice of the house size is his second period budget constraint, which is given by:

$$C_j = y_j - \delta Q_j$$

Thus we can write his optimization problem in Case B as:

$$\log Q_j + \log C_j$$

subject to $$C_j + \delta Q_j = y_j$$

From the FONC:

$$\frac{C_j}{Q_j} = \delta$$

Hence, the optimal solutions are:

$$C_j^{*B} = \frac{y_j}{2}$$

$$Q_j^{*B} = \frac{y_j}{2\delta}$$

Thus the maximized value of utility of the worker/borrower under option B (default) is:

$$U_j^B\left(Q_j, C_j\right) = log\, Q_j^{*B} + \, log\, C_j^{*B}$$

$$= \left[\left(\frac{y_j}{2}\right)^2 \frac{1}{\delta}\right] (Option\, B - Utility)$$

1.2.3. Choosing between option A (Repayment) vis-a-vis option B (Default)

A worker/borrower with income y_j will decide to pay back the loan if and only if indirect utility from option A is greater than or equal to indirect utility from option B. Comparing (Option A -Utility) with (Option B -Utility), we get:

$$U_j^{*A} \geq U_j^{*B}$$

$$\left(\frac{2y_j}{3r_t P_t}\right)^2 \frac{y_j}{3} \geq = \left[\left(\frac{y_j}{2}\right)^2 \frac{1}{\delta}\right]$$

$$y_j \geq M(rtP_t)^2$$

where $M \equiv \frac{27}{16\delta}$, a constant.

There are two points to be noted here. First, since the high-ability borrowers have a higher income than the low-ability borrowers (($y_g > y_b$), for the same r_t and P_t, they are less likely to default - justifying the terms 'prime' and 'subprime' borrowers respectively. Secondly, the interest rate on loans and the housing prices in any period (i.e., r_t and P_t) are determined by the corresponding demand and supply of loans and houses respectively. However in our model borrowers borrow only because they want to buy a house; thus the demand for loan is derived from the demand for housing - they are not independent of one another. A new generation of young workers appear in the scene in every period looking for houses (and loans), who buy the houses either from the mature workers themselves or from the banks, thereby creating a market for houses (and a concomitant loan market) at the end of every time period. We shall analyze the equilibrium determination of r_t and P_t in the next section.

2 PERIOD-*T* STATIC (TEMPORARY) EQUILIBRIUM

We now characterize the temporary equilibrium in the economy at any point of time *t*. We start the discussion by focusing on the latter half of the time period *t*, when (i) each the currently young rentiers (of measure á in total) are sitting with 1 unit of wealth to be kept as deposits with the banks; (ii) each of the currently young borrowers (of either type) are planning to buy a house by borrowing from the banks; and there exists a given supply of houses in the market, denoted by H_t (which are in possession of either the old generation of workers who managed to repay their loans) or the banks (which have taken possession of the house from the old generation of borrowers who defaulted on their loans).

We start by characterizing the demand side of the housing market and the corresponding demand side of the loan market in period *t*.

2.1. Demand and Supply in the Housing Market

Recall that the demand for housing and the concomitant demand for loans come from the young workers/borrowers who start operating at the latter half of period *t*. We know that there are $(1-\alpha)\beta$ measure of prime borrowers with income level y_g and $(1-\alpha)(1-\beta)$ measure of subprime borrowers with income level y_b. We have also derived the optimal housing demand for any young borrower when he decides to repay as well as when he decides to default, which are given as follows.

For a prime borrower,

$$Q_g^{*A} = \frac{2y}{3r_t P_t} \textit{ when he repays} \tag{3}$$

$$Q_g^{*B} = \frac{y_g}{3\delta} \textit{ when he defaults} \tag{4}$$

Moreover, he pays back whenever

$$y_g > M\left(r_t P_t\right)^2$$

$$i.e., \; r_t P_t \leq \left(\frac{y_g}{M}\right)^{\frac{1}{2}}$$

Likewise, for a sub-prime borrower,

$$Q_b^{*A} = \frac{2y_b}{3r_t P_t} \textit{when he repays} \tag{5}$$

$$Q_b^{*B} = \frac{y_b}{2\delta} \textit{when he defaults} \tag{6}$$

Moreover, he pays back whenever

$$y_b \geq M\left(r_t P_t\right)^2$$

$$i.e., \; r_t P_t \leq \left(\frac{y_b}{M}\right)^{\frac{1}{2}}$$

Aggregating over all the borrowers, we get the aggregate demand for loans in period t as a function of $r_t P_t$, which is specified below:

$$Q_t^D = \{(1-\alpha)\beta Q_g^A + (1-\alpha)(1-\beta)Q_b^A \; for \, r_t \, P_t$$

$$\leq \left(\frac{y_b}{M}\right)^{\frac{1}{2}}; (1-\alpha)\beta Q_g^A + (1-\alpha)(1-\beta)Q_b^B \; for \left(\frac{y_b}{M}\right)^{\frac{1}{2}} < r_t P_t$$

$$\leq \left(\frac{y_g}{M}\right)^{\frac{1}{2}}; (1-\alpha)\beta Q_g^B + (1-\alpha)(1-\beta)Q_b^B \; for \, r_t P_t > \left(\frac{y_g}{M}\right)^{\frac{1}{2}}.$$

Substituting for Q_g^{*A}, Q_b^{*A}, Q_g^{*B}, Q_b^{*B}, we can rewrite the loan function as:

$$Q_t^D(r_tP_t) = \begin{cases} \dfrac{2(1-\alpha)}{3r_tP_t}[\beta y_g + (1-\beta)y_b] \; for \; r_tP_t \le \left(\dfrac{y_b}{M}\right)^{\frac{1}{2}} (Region\, I); \\ \dfrac{(1-\alpha)}{2\delta}[\dfrac{4\delta\beta y_g}{3r_tP_t} + (1-\beta)y_b] \; for \left(\dfrac{y_b}{M}\right)^{\frac{1}{2}} < r_t\, P_t \le \left(\dfrac{y_g}{M}\right)^{\frac{1}{2}} (Region\, II); \\ \dfrac{(1-\alpha)}{2\delta}[\beta y_g + (1-\beta)y_b] \; for \; r_tP_t > \left(\dfrac{y_g}{M}\right)^{\frac{1}{2}} (Region\, III). \end{cases} \tag{7}$$

Figure 1 depicts the housing demand graphically, with r_tP_t on the horizontal axis. The diagram clearly depicts three distinct regions marked by the dotted lines: in Region I, both prime and subprime borrowers repay; in Region II prime borrowers repay and subprime borrowers default; Region II both prime and subprime borrowers default.

The supply of housing at the end of period t is given, denoted by H_t (these are houses held either by the previous generation of borrowers or by the banks). Thus we can determine the equilibrium value of r_tP_t depending on the position of the H_t line in the (Q^D, r_tP_t) plane.

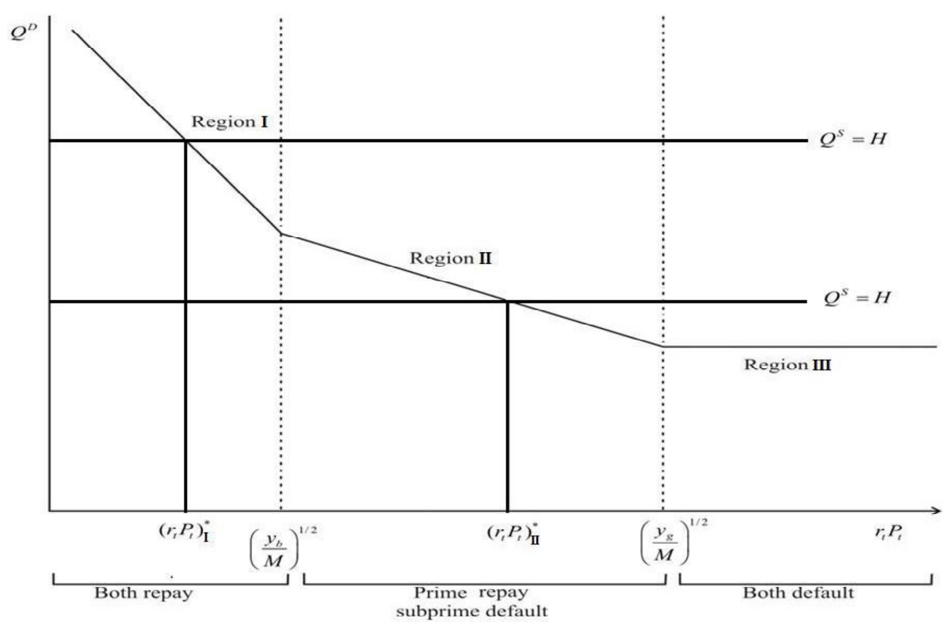

Figure 1: Housing Demand

If housing supply is in Region I in figure 1, then equating $Q^D = H_t$:

$$r_t P_t^* = \frac{2(1-\alpha)}{3H_t}[\beta y_g + (1-\beta)y_b] \tag{8}$$

This will happen when the housing supply is high enough:

$$H_t \geq \bar{H} \equiv \frac{2(1-\alpha)}{3} \frac{[\beta y_g + (1-\beta)y_b]}{\left(\frac{y_b}{M}\right)^{\frac{1}{2}}}$$

If housing supply is in Region II, then

$$r_t P_t^* = \frac{4\delta\beta y_g}{3[\frac{2\delta}{1-\alpha}H_t - (1-\beta)y_b]} \tag{9}$$

This will happen when the housing supply is moderately high:

$$\bar{H} > H_t \geq \underline{H} \equiv \frac{(1-\alpha)}{2\delta}[\frac{4\delta\beta y_g}{3\left[\left(\frac{y_g}{M}\right)^{\frac{1}{2}}\right]} + (1-\beta)y_b]$$

If housing supply is in Region III, then the housing demand and housing supply will never match unless by pure chance (i.e., H_t happens to be exactly equal to $\frac{(1-\alpha)}{2\delta}[\beta y_g + (1-\beta)y_b]$,, which we shall ignore). In fact, housing supply in this region is less than housing demand, which means there has to be some rationing in allocation of houses. We assume that the total number of houses available are divided across the two sets of buyers (low-ability workers and high-ability workers) in proportion to their demand. Let $\hat{Q}_g^B$ and $\hat{Q}_b^B$ denote the size of the rationed houses to the two groups of workers respectively. Then

$$(1-\alpha)\beta\hat{Q}_g^B = \left[\frac{(1-\alpha)\beta Q_g^{*B}}{(1-\alpha)\beta Q_g^{*B} + (1-\alpha)(1-\beta)Q_b^{*B}}\right]H_t$$

$$= \frac{(1-\alpha)\beta \frac{y_g}{2\delta}}{\frac{(1-\alpha)}{2\delta}[\beta y_g + (1-\beta) y_b} H_t$$

$$= \frac{\beta y_g}{[\beta y_g + (1-\beta) y_b]} H_t \tag{10}$$

Likewise,

$$(1-\alpha)(1-\beta)\hat{Q}_b^{*B} = \left[\frac{(1-\alpha)(1-\beta)Q_b^{*B}}{(1-\alpha)\beta Q_g^{*B} + (1-\alpha)(1-\beta)Q_b^{*B}} \right] H_t$$

$$= \frac{(1-\alpha)(1-\beta)\frac{y_b}{2\delta}}{\frac{(1-\alpha)}{2\delta}\left[\beta y_g + (1-\beta) y_b\right]} H_t$$

$$= \frac{(1-\beta) y_b}{[\beta y_g + (1-\beta) y_b]} H_t \tag{11}$$

Notice that the given rationing rule effectively divides the existing houses between the two groups in proportion to their income. Since neither housing supply not housing demand in region III depend on $r_t P_t$, the equilibrium value of $(r_t P_t^*)$ cannot be determined from the housing market in this region; we shall have to look at the concomitant loan market. Moreover, since neither group of workers can avail the size of the houses that they had initially wanted, and have to settle for smaller houses, this will modify their loan requirement as well. Thus to completely characterize the temporary equilibrium in period *t*, we have to simultaneously analyze the loan market, which we discuss next.

2.2. Demand and Supply in the Loan Market

Demand for loans come from the same set of people who are demand to buy houses. Hence aggregate demand for loans can be easily obtained from the aggregate demand for houses (as specified in equation (7)), such that

$$L_t^D = P_t Q_t^D$$

Substituting for the value of Q_t^D for each region, we can write down the corresponding loan demand equation as:

$$L_t^D(r_tP_t) = \begin{cases} \dfrac{2(1-\alpha)}{3r_t}[\beta y_g + (1-\beta)y_b]\ for\ r_tP_t \leq \left(\dfrac{y_b}{M}\right)^{\frac{1}{2}} (Region\ I); (L_t^D)_I \\ P_t\dfrac{(1-\alpha)}{2\delta}[\dfrac{4\delta\beta y_g}{3r_tP_t} + (1-\beta)y_b]\ for \left(\dfrac{y_b}{M}\right)^{\frac{1}{2}} < r_tP_t \leq \left(\dfrac{y_g}{M}\right)^{\frac{1}{2}} (Region\ II);\ (L_t^D)_{II} \\ P_tH_t\ for\ r_tP_t > \left(\dfrac{y_g}{M}\right)^{\frac{1}{2}} (Region\ III). (L_t^D)_{III} \end{cases} \tag{12}$$

Notice that in specifying the demand for loans in Region III, we have already taken into account the fact the in this region houses are rationed; so loan demand is exactly proportional to the number of houses available in the economy.

Supply of loans on the other hand is determined by the banks. To derive the loan supply function, let us first describe the behavior of the firms in some detail.

2.2.1. Banks' Side Story

There are N identical banks that take deposits from the young rentiers in period t and offer loans against these deposits to the current cohort of young workers. There are α measure of young rentiers, each of whom is endowed with one unit of wealth. Hence the total deposit available to the banks is given by α, which is also total potential supply of loans. However, whether the banks actually operate and offer these deposits as loans to the young borrowers or not depends on whether the banks expect to earn some future profits from these lending activities.

It the banks operate then they undertake the following set of activities. At the end of period t, they accept the deposits from the young rentiers, promising them a return of $(1 + \underline{r})$ in the next period. They then put forward these deposits as loans to the young workers at time t, who use the loan to buy houses from the housing market in period t.

At the beginning of period t+1, the workers - now mature - earn their respective incomes and decide to pay back or default on the bank loans. Depending on the workers' decision to pay back, the banks collect some repayments - which they use immediately to pay up their old depositors on a priority basis - before they start collecting deposits from the new set of depositors (young rentiers) in period t+1. It is conceivable that the repayment collected is not enough to pay back all the depositors at the promised deposit rate of $(1+\underline{r})$ immediately. While this does not affect the immediate financial position of the banks, it does affect their reputation and credibility. As a result, the new set of lender (young rentier in period $t+1$) may alter their portfolio choices and move their investment to safe asset rather than keeping them with the banks. We shall come back to this issue later, when we discuss the dynamics.

In case of default, the banks take possession of the house, which they sell at the end of the period to the new set of young workers in period $t+1$. If they make enough profit from selling of these houses, they are still legally obliged to pay back their old depositors the promised return of $(1+\underline{r})$. However this second installment of payments (done by selling their assets/ houses) is not enough to restore the banks' reputation or credibility. The currently young depositors are guided entirely by the signals received during the first installment of payments.

When the banks are providing the loans in period t, they of course know that all borrowers are not alike - some of them are prime and some of them are subprime. They also know that exactly $\beta\,(1-\alpha)$ proportion of the borrower are prime and exactly $(1-\beta)\,(1-\alpha)$ proportion of the borrowers are subprime, although they do not know the exact identity of these borrowers. Hence they are aware that some of them will default in period $t+1$, and they take this possibility into account when they provide the loans in period t.

A bank operates in the loan market in period t if and only if it expects to earn some non-negative profits from such lending activities in period $t+1$. In calculated their expected profit, they internalize the fact that in Region I, both prime and subprime borrowers will pay back; in Region II, the prime borrowers will pay back while the subprime borrowers will not; and in Region III, both set of borrowers will default.

Profitability of Banks & Equilibrium in Loan Market: Region I

In Region I, when both prime and sub-prime borrowers repay, expected profit of the banks in period $t+1$ is given by

$$\pi_I = \left(1+r_t\right)\left(L_t^D\right)_I - (1+\underline{r})\alpha$$

The banks will operate in Region I if and only if $\pi_I = 0$.

Equating potential loan supply (á) with loan demand in this region (from equation (12)),

$$\left(L_t^D\right) \equiv \frac{2(1-\alpha)}{3r_t}[\beta y_g + (1-\beta)y_b] = \alpha$$

$$r_t^* = \frac{2(1-\alpha)}{3\alpha}[\beta y_g + (1-\beta)y_b] \quad (13)$$

We already know the value of $(r_tP_t)^*$ in this region. Hence we can calculate the corresponding equilibrium price level in this region as:

$$P_t^* = \frac{\alpha}{H} \quad (14)$$

Substituting the value of r_t^* in the expression for π_I above and replacing $\left(L_t^D\right)_I$ by α, it is easy to see that banks will operate in Region I if and only if

$$\frac{2(1-\alpha)}{3\alpha}[\beta y_g + (1-\beta)y_b] \geq \underline{r} \qquad (\textit{Profitability Condition I})$$

Profitability Condition I identifies an economy in a boom period when the average income of the workers is high. In such a scenario, banks are happy to offer loans as they anticipate, and actually make, positive profits. Nobody defaults. Banks are able to pay back all its depositors the promised deposit rate from the repaid amount itself and depositors are happy too. Hence all the markets run smoothly.

Profitability of Banks & Equilibrium in Loan Market: Region II

Next consider Region II where only the prime borrowers repay while the sub-prime borrowers default. In this case the banks get back only part of the loans given to the prime borrowers, amounting to $(1-\alpha)\beta P_t Q_g^{*A}$. But they also get possession of the houses bought by the subprime borrowers, given by $(1-\alpha)(1-\beta)Q_b^{*B}$ which they can sell at the housing market at the end of period $t+1$. When the banks are making their loan supply decisions in period t, they do not know what price will prevail in period $t+1$. So they operate on the basis of an expected price, P_{t+1}^e. Thus in Region II, expected profit of the banks in period $t+1$ is given by

$$\pi_{II} = \left(1+r_t\right)(1-\alpha)\beta P_t Q_g^{*A} + P_{t+1}^e (1-\alpha)(1-\beta)Q_b^{*B} - (1+\underline{r})\alpha$$

From equations (3) and (6), substituting for the values of Q_g^{*A} and Q_b^{*B}, we get

$$\pi_{II} = (1+r_t)(1-\alpha)\beta P \frac{2y_g}{t\ 3r_{t\ t}^{P}} + P_{t+1}^{e}(1-\alpha)(1-\beta)\frac{y_b}{2\delta} - (1+\underline{r})\alpha$$

Banks will operate in Region II if and only if $\pi_{\text{II}} > 0$.

Equating potential loan supply (α) with loan demand in this region (from equation (12)), and substituting for $(r_t P_t)^*$ in this region (from equation (9)), after simplifying, we get,

$$\left(L_t^D\right)_{II} \equiv P_t \frac{(1-\alpha)}{2\delta}\left[\frac{4\delta\beta y_g}{3r_t P_t} + (1-\beta)y_b\right] = \alpha$$

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

We already know the value of $(r_t P_t)^*$ in this region. Hence we can calculate the corresponding equilibrium interest rate in this region as:

$$r_t^* = \frac{4\delta H_t \beta y_g}{3\alpha[\frac{2\delta}{1-\alpha}H_t - (1-\beta)y_b]} \tag{16}$$

Substituting for P_t^* and r_t^* in the expression for π_{II} above, it is easy to see that banks will operate in Region II if and only if

$$P_{t+1}^{e} \geq \frac{(1+\underline{r})\alpha - (1-\alpha)\dfrac{3\alpha\left[\dfrac{2\delta}{1-\alpha}H_t - (1-\beta)y_b\right] + 4\delta H_t \beta y_g}{6\delta H_t}}{(1-\alpha)(1-\beta)\dfrac{y_b}{2\delta}}$$

(Profitability Condition II)

Profitability Condition II implies that banks will operate in Region II if and only if their expectations about the future housing price is high enough, which we shall assume to be true at least in the initial period. This condition also highlights the fact that banks are willing to extend loans to subprime borrowers, despite knowing that they will default, only because they want to make some speculative gains from the future housing markets. This indeed is a volatile situation which may lead to a banking crisis and instability in the economy. We shall explore this issue further when we analyze the dynamics.

Profitability of Banks & Equilibrium in Loan Market: Region III

Next consider Region III where both prime and subprime borrowers default. In this case the banks do not get any repayment at all. But they get possession of all the houses bought both by the prime and subprime borrowers, given by $(1-\alpha)\beta\hat{Q}_g^{*B}$ and $(1-\alpha)(1-\beta)\hat{Q}_b^{*B}$ respectively. The banks sell these houses at the housing market at the end of period t +1. Once again, not knowing the price that will prevail in housing market in the next period, banks in period t operate on the basis of an expected price, P_{t+1}^e.

Thus in Region III, expected profit of the banks in period t +1 is given by

$$\pi_{III} = P_{t+1}^e[(1-\alpha)\beta\hat{Q}_g^{*B} + (1-\alpha)(1-\beta)\hat{Q}_b^{*B} - (1+\underline{r})\alpha$$

From equations (4) and (6), substituting for the values of Q_g^{*B} and Q_b^{*B}, we get

$$\pi_{III} = P_{t+1}^e H_t - (1+\underline{r})\alpha$$

Banks will operate in Region III if and only if $p_{III} \geq 0$. From the above expression, it is easy to see that banks will operate in Region III if and only if

$$P_{t+1}^e \geq \frac{(1+\underline{r})\alpha}{H_t} \quad \textit{(Profitability Condition III)}$$

Profitability condition III captures an extreme situation where the banks indulge in pure speculative lending, even when they know that none of the lenders will pay back their loans in the next period. They still offer loans only because they expect to make a big gain from selling of these houses in the next period. Once again this is an extremely volatile situation which can trigger a collapse of the banking system in the near future. We shall come back to this case when we analyze the dynamics in the next section.

Equating potential loan supply (α) with loan demand in this region (from equation (12)) we get,

$$\left(L_t^D\right)_{III} \equiv P_t H_t = \alpha$$
$$\rightarrow P_t^* = \frac{\alpha}{H} \quad (17)$$

Notice that we still cannot pin down the equilibrium interest rate r_t^* in region III. This is because the banks here do not care for the interest rate at all; whatever is the interest rate, banks know that the borrowers will default and they will not be able to recover the interest rate. They are only aiming for the speculative profit that they expect to earn from the housing market in the next period. Hence the interest rate in this region could be arbitrarily high, giving a false sense of buoyancy to the loan market, based purely on speculation.

Having characterized the period t static (temporary) equilibria for different possible values of H_t, and the corresponding equilibrium values of P_t^* and r_t^* in every region, we now turn to the dynamics of the model.

3. DYNAMICS OF THE MODEL

The dynamic analysis examines the link between period t and period $t+1$ and explores how the demand and supply factors change depending on realization of agents' expectations.

Recall that in period t, various sets of agents (rentiers, workers, bankers) had made their choices based on various expectations about period t+1 and the nature of these expectations were different depending on whether the static equilibrium in period t lied in Region I or Region II or Region III. Accordingly we analyze the dynamics separately for each of these regions.

3.1. Dynamics in Region I

Recall that Region I characterized an economy where the supply of housing is high and so is the earning potential of the workers. In period $t+1$, these potential incomes are realized and all the borrowers pay back their loans. Since income of the workers is high enough, banks are able to pay back their old depositors out of the repaid amount; hence their credibility remains intact. Thus at the end of period $t+1$, the new set of young rentiers again put forward their entire wealth (α) in the form of deposits to the banks, which the banks again offer as loans to the new set of workers, with potential earning capacity of y_g and y_b respectively. Thus at the end of period $t+1$, the housing market and the loan market again clear at the same equilibrium price level and equilibrium interest rate:

$$P_t^* = \frac{\alpha}{H},\ r_t^* = \frac{2(1-\alpha)}{3\alpha}[\beta y_g + (1-\beta) y_b]$$

Thus we get a stable economy with constant (steady state) housing prices and constant (steady state) interest rate, which perpetuates forever.

If the equilibrium interest rate is high enough, the banks may even earn some positive profit in Region I. We assume that whenever banks earn positive profit, they invest in real estate which increase the supply of houses in the economy in the next period, i.e., H_{t+1} goes up. If the economy is already in region I (which means H is high enough), an even higher H in the next period goes on to ensure that the economy remains in Region I in the next period as well. Of course any rise in H_t over time brings down the equilibrium house prices over time, but equilibrium interest rate remains unaffected. Thus the economy remains perpetually in Region I, exhibiting all round stability and prosperity.

3.2. Dynamics in Region II

In region II, only the prime borrowers repay. Whether that repayment amount is sufficient to pay back the depositors at the promised rate of not depends on whether

$$(1+r_t^*)(1-\alpha)\beta Q_g^{*A} P_t^* \geq (1+\underline{r})\alpha$$

We know that in region II, $Q_g^{*A} = \dfrac{2y_g}{3r_t^* P_t^*}$; $r_t^* = \dfrac{4\delta H_t \beta y_g}{3\alpha[\frac{2\delta}{1-\alpha} H_t - (1-\beta)y_b]}$, and $P_t^* = \dfrac{\alpha}{H}$.

Using these equilibrium values in the condition above, we get

$$H_t \geq \frac{\alpha(1-\alpha)(1-\beta)y_b}{[4\delta(1-\alpha)\beta y_g - \underline{r}\alpha 2\delta]} \equiv \hat{H}$$

(Viability Condition II)

We already know that in region II, H_t lies between $\overline{H}$ and $\underline{H}$. Now we get a further cut off in terms of $\hat{H}$. If indeed the housing supply in period t is greater than $\hat{H}$, then once again the banks are able to pay back their depositors at the promised rate of $(1+\underline{r})$ and the old depositors are happy. This maintains the credibility of the banks and the new set of depositors are happy to put forward the same amount of deposit as in the previous period. Thus once again at the end of period $t+1$, the housing market and the loan market again clear at the same equilibrium price level and equilibrium interest rate:

$$P^*_{t+1} = \frac{\alpha}{H};\ r^*_{t+1} = \frac{4\delta H_t \beta y_g}{3\alpha[\frac{2\delta}{1-\alpha}H_t - (1-\beta)y_b]}$$

However notice that the realized price in period $t+1$ is the same as that in period t. This necessarily fails to meet the price expectation of the bankers (P^e_{t+1}) who wanted to make some speculative gain in period $t+1$ by selling the houses at a higher price. Thus the bankers in period $t+1$, modify their expectations about the next period (P^e_{t+2}). As long as Profitability Condition II is still satisfied, the bankers will still continue to offer loans and the economy will go on, albeit with a prolonged mismatch between bankers' expectations and reality until it gets corrected in the long run.

However a direr scenario emerges if the period t housing supply falls short of $\hat{H}$. In this case, the old deposits do not get back the deposit rate promised by the banks. This affects the credibility of the banks and the new generation of depositor move their wealth to the safe asset instead of keeping it with the banks. This immediately leads to a banking crisis and a collapse of the loan market (since no supply of loan is possible without a deposit). Thus Region II represents a knife edge situation; a negative supply shock in the housing market (such that supply of houses fall below the cut off level of $\hat{H}$) may take the economy tumbling down towards a collapse of the loan markets and a concomitant collapse of the housing market.

3.3. Dynamics in Region III

Region III is dynamically most volatile. In region III, none of the borrowers repay. Therefore the banks simply fails to meet the promised return to the old depositors. This immediately leads to a banking crisis leading to eventual collapse of the loan market and the housing market in period $t+1$.

The dynamic analysis in this section tells us that if the loan market and housing markets are closed interlinked (through mortgage loans) then that immediately creates potential instability into the system. Things may go fine if the economy is experiencing a boom time with high income levels of all agents (as depicted by Region I in our model). But any negative income shock and/or negative house supply shock brings the economy down to regions II and III, wherein banks indulge in speculative lending, creating potential or real instability and crisis.

Here we have made the assumption that as soon as banks fail to meet the interest obligation to its depositors, next generation of depositors immediately transfer their entire wealth to some other safe asset. This is of course a drastic assumption. However, our conclusions will go through even when the withdrawal of the deposits is gradual. Suppose for example, new generations of depositor withdraw only a proportion of the deposits as long as the banks meet at least part of their earlier obligations (as happens in Region II). In this case, the supply of loan with gradually shrink, pushing up the interest rate so that eventually the economy will move to Region III and everybody defaults. Thus a gradual withdrawal of deposits only postpones the crisis; it cannot bypass it.

4. CONCLUSION

In this paper we have argued that mortgage loans that links the loan market with the housing market are inherently problematic. While they may work in the advanced countries where average income levels are high and potential supply of housing is also high (due to low cost, availability of space), in relatively less developed economies, this linkage could be a recipe for disaster. Even in the advanced economies, a temporary negative income shock may have a cascading effect, leading to a banking sector crisis and collapse of the loan market, as we did witness during the subprime crisis in the US economy in 2008.

We have shown here how adverse macroeconomic conditions (low income, low housing supply) may create channels for speculative lending by financial intermediaries. Even when banks know that borrowers do not have the potential to pay back their loans, they may offer loans based on their expectations about future housing prices. Banks with high house price expectations will serve the loan market to speculate on housing prices, as expected return from lending is higher only for speculative lending. Such speculative lending increases the risk of borrowing, making the system vulnerable to crisis. Eventually all borrowers begin to default, leading to bank runs and melting down of the entire financial structure.

This highlights the importance of regulation in the financial markets, especially in the presence of mortgage loans. Regulatory authorities should monitor the lending practices of banks, especially the proportion of loan given to borrowers whose credit-worthiness is questionable. In the absence of close monitoring by the regulatory authorities, mortgage loans are recipes for disaster.

Notes

1. Singh, Kumar and Prasad (2012).
2. One could think of these endowments as bequests/inheritance from parents. However we do not explicitly model any optimal bequest behavior that generates

utility for the parents. All inheritances are purely incidental, passed on from the old generation to the young as the old generation dies.

3. It is conceivable that the banks, due to certain circumstances in the next period, end up paying their depositors an interest rate less than r. In that case, the current depositors, having already sunk their money with the bank, will have to bear an unanticipated income loss and consequent consumption loss in the second period. They cannot do anything about it ex post. But they can caution their next generation, who can then accordingly alter their portfolio behaviors when they become economically active. We shall come back to this possibility later.

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