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Home Mortgage Risk: A Case for Insurance in India

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Housing mortgage finance in India is constrained by the maximum loan-to-cost ratio and installment income ratio conditions imposed by housing finance companies. The typical reason for this behaviour is that the market for the sharing of risk in mortgage lending is not yet fully developed. Mortgage insurance plays an important role in developing this market. The objective of this paper is to present a case for mortgage insurance market in India. This paper develops a mortgage premium structure framework in which mortgage insurers charge an insurance premium that equates losses to revenue.

This paper also models mortgage termination due to prepayment and defaults. We contend that the termination of mortgage in housing is not as `ruthless' as OPM theory would suggest, primarily because households are not financiers in the `stricter sense'. We have used the Cox proportional hazard model to analyze prepayment and default of mortgage behaviour in India. The results indicate that financial concerns (like the option price, loan to value ratio, and monthly principal and interest to income ratio) are important determinants besides household characteristics. The cumulative prepayment or default probabilities from these models are used in the estimation of the insurance premium structure.

Keywords

Default, Home mortgages, India, insurance, mortgage prepayment, proportional hazard

Introduction

The home mortgage market is growing rapidly in volume and importance. The outstanding volume of residential mortgage in India is currently over 200 billion rupees and the volume has more than tripled during the last 15 years. The last decade has seen the emergence of many new housing finance companies, and an increasing participation of banks in lending for housing finance. Traditionally, the housing finance business in India has been limited to primary markets. The nature of housing companies has been like a typical savings and loan corporation. The linkage with the secondary market has been very weak. Housing finance companies have to raise resources from the primary markets through various deposit schemes and lend to individual borrowers. These companies bear the risk associated with the housing mortgage. Unlike housing finance markets in the USA or the UK, the role of secondary markets has been meager in India. Only recently, National Housing Bank (NHB) permitted mortgage-backed securities with the role of NHB as the ‘special purpose vehicle’. The first pool of mortgages securitized by NHB was fully subscribed by financial institutions. One of the consequences of weak linkage with secondary market has been that the risk related to housing finance is solely borne by the housing finance institutions. This has restricted the availability of finance. The other implication of this is seen in the low loan-to-cost ratios of residential properties. The average loan-to-cost ratio in India is around 55%. In the USA, the loan-to-cost ratio is around 95%, and in Japan it is around 80%. A low loan-to-cost ratio implies that households have to amass a substantial amount of their own equity before deciding to buy their own houses. High equity requirement for housing has been a major constraint in home ownership.

In the absence of a secondary market, institutions and banks making housing loans bear various lending risks. These lending risks are (I) macro-economic risk – due to changes in interest rates, which in turn are due to changes in macroeconomic conditions, and (ii) liquidity risk – due to prepayment and default of loans. Housing finance institutions design instruments with an intention to offset these risks. The typical way is a penalty imposed for prepayments and high interest rates for lending to take into account macro-economic risk. The high interest payments by households restrict their ability to borrow any further because the monthly payments towards their housing loans are restricted by their income. Housing finance institutions set the limit of monthly payments to about 30% of the monthly income of the borrower.

Wealth and income constraints restrict households from achieving the desired standard of housing. In more developed housing finance markets like the USA or Hong Kong, mortgage insurance plays an active role where income and wealth are binding for households’ access to housing finance. Housing mortgage insurance does not exist in India. In fact, the insurance market is in its infant stage in India, and has assumed great importance recently after the Government allowed private insurers to operate in the Indian insurance market. This paper is written with two purposes: (I) to empirically estimate risks associated with housing mortgages, and (ii) to design a framework for mortgage insurance in India.

The rest of the paper is organized as follows: Section 2 provides an overview of the role of residential mortgage insurance in housing finance and home ownership. Section 3 reviews the literature in measuring the risk associated with the residential mortgages. Section 4 presents the results of the estimation of risk for residential mortgage market in India. In Section 5, a framework for residential mortgage insurance is presented. Section 6 concludes the discussion.

The Role of Residential Mortgage Insurance

In developed economies, mortgage insurance has become an important instrument to cover some of the risks incurred by housing finance institutions or investors in mortgage-based securities, and also to assist borrowers in mobilizing higher amounts of housing loans than would have been possible otherwise, due to their wealth and income constraints.

For wealthier households, choice of loan-to-cost ratio depends on a household's portfolio diversification desires and its aversion to risk, as well as the after-tax cost of mortgage financing relative to both the cost of other debt financing and after-tax returns on financial assets (Jones, 1993). For less wealthy households facing binding mortgage qualification constraints, the choice is more straightforward: what loan-to-cost ratio maximizes their wealth is the value of the house they can purchase.

Figure 1[1] illustrates the maximum attainable housing value when wealth and income constraints are binding separately, simultaneously, or not at all binding. The right vertical axis is the house value and the left axis is wealth. The horizontal axis is the loan to cost ratio, ranging from 0 to 0.95. The two upward sloping lines indicate the maximum house value possible given the initial wealth of W_L (low) or W_H (high). These curves can be derived by

[1] This example was taken from Hendershott and LaFayette (1995).

solving $\frac{W_i}{(1-LTV)}$ for different values of LTV[2]. The downwards-sloping line indicates the maximum house value possible given the household's income (Y), market interest rates, and the underwriting criteria. This curve[3] is obtained by solving $\frac{0.30*Y}{\phi LTV}$ for different LTV values. Increasing the LTV makes a given wealth amount go down, but it also reduces the buying power at a given income level because income constraint becomes binding.

Consider a household with wealth W_L and income Y. Its possibility set is the slashed area. If the optimal unconstrained house value is V_L^* (indicated on the right vertical axis), the household can achieve this value anywhere on the line segment AB. That is, with an LTV between 0.8 (this LTV is possible even without buying mortgage insurance) and 0.95 (if this LTV is possible by buying mortgage insurance). On the other hand, an optimal unconstrained house value of V_H^* is unattainable. The best a low wealth household can do is to select a 95% LTV and buy mortgage insurance and reach the point C. Now let us consider a household with wealth $W_H > W_L$. With a higher wealth curve, the possibility set expands to include the dotted area. An LTV of 0.4 to 0.95 allows the household to reach V_L^*. At the point of intersection of the wealth curve and income curve, the two constraints are equally non-binding.

To achieve a higher level of LTV, households buy mortgage insurance, which protects lenders against claims. By its nature, mortgage insurance is different from typical insurance in the following ways:

First, the casualty insurance covers a single period, so the performance of a particular policy can be used in determining the premium to be charged in the subsequent periods. Mortgage insurance, on the other hand, covers multiple periods with premiums defined at the origination date.

Second, in contrast to life insurance, mortgage insurance has a definite termination date, and the claim decreases rather than increases over time.

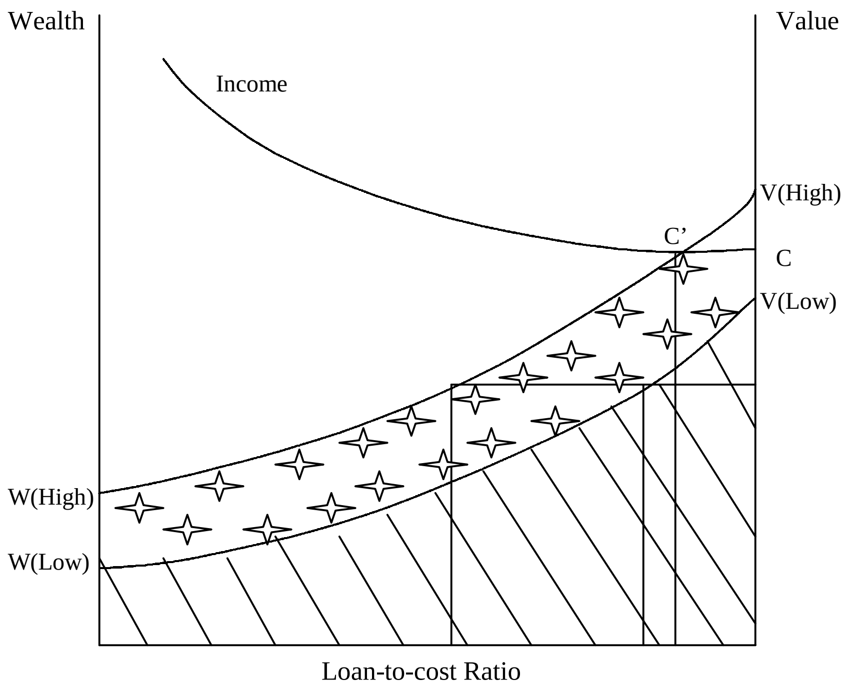
[2] A house is financed with debt and equity (E). Thus, V=LTV*V+E. The maximum house purchase is one in which all available wealth is invested in the house, i.e. E=W.

[3] The housing cost underwriting constraint is $\phi LTV * V = 0.3 * Y$, where ϕ includes the principal and interest payment per annum and Y is the annual initial income of the household at the time of borrowing.

Third, both prepayment and default of housing loans are highly correlated to macro-economic variables like interest rates, property price movements, and household income. Therefore, the risk involved is a systematic risk.

Given these unique features, premium structure and the calculation of mortgage premiums would be very different from a typical insurance policy. The literature on the pricing of mortgage insurance is scanty.

Figure 1: Mortgage Qualification Constraints and the Optimal Loan to Cost Ratio



This paper uses the framework for calculation of feasible insurance premium structure proposed by Kuo and Yang (1997). A feasible premium structure is defined as one such that the present value of expected loss for the insurer is equal to that of the expected premium revenues. For each period, a borrower determines whether to default, prepay, or continue the loan by making payments. The conditional probability of default and prepayment rates at time *t* are given by d_t and p_t. The conditional probability of continuation of payment of loan bill is $C_t = 1 - d_t - p_t$.

For the insurer, the present value of accumulated loss from present to time t, denoted by EAL_t is given by:

$$EAL_t = EL_1 + EL_2 + \ldots + EL_t \tag{1}$$

Alternatively, we can write Equation (1) as:

$$EAL_t = d_1 L_R B_1 r^{-1} + \sum_{s=2}^{t} (\prod_{t=1}^{s-1} C_t) d_s L_R B_s r^{-s} \tag{2}$$

where B_t is the unpaid balance at time *t*, L_R is the ratio of the loss-to-unpaid balance at time *t*, and r is the present value factor dependent on the discount rate used for calculating the present value of loss and revenue.

The present value of the expected revenue from present period to time *t*, EAR_t , is given by:

$$EAR_t = ER_0 + ER_1 + \ldots + ER_t \tag{3}$$

Alternatively, we may write:

$$EAR_t = a_0 B_0 + C_1 a_1 B_1 + \sum_{s=2}^{t} (\prod_{t=1}^{s-1} C_t) C_s a_s B_s r^{-s} \tag{4}$$

where a_t refers to the ratio of time *t* insurance premium payment to B_t. The insurers would charge premium so that:

$$EAL_t = EAR_t \tag{5}$$

The Residential Mortgage Risk Model

In the mortgage insurance premium framework, conditional probabilities of default and prepayment have to be specified exogenously. In this section, we present a model for the estimation of these mortgage risks.

Mortgage insurers would like the loans they insure to continue until their maturity. However, at any point in time, borrowers have four options: (i) to continue paying their loans, (ii) to prepay their obligation before the maturity term, (iii) to default, and (iv) to delay payment. The option to prepay or default is available to borrowers. It is widely accepted that mortgages can be viewed as ordinary debt instruments with various options attached to them.

Default is a put option: the borrower sells the house back to the lender in exchange for eliminating the mortgage obligation. Prepayment is a call option: the borrower exchanges the unpaid balance on the debt instrument for a release of further obligation. By insuring the loan, the insurer bears the risk of terminating the loan due to prepayment and default. Prepayment stops the future stream of insurance premiums. Default stops future premiums and, in addition, the insurers have to pay the insured amount to the housing finance company. Probabilities of prepayment and default of mortgage loan enter into the insurance premium calculations of the insurer, as discussed earlier. We therefore need to estimate prepayment and default probabilities at each point in time.

Empirical estimation of mortgage termination has utilized logit or probit models to estimate the probability of termination or, more recently, utilized hazard models to estimate the age of mortgages. Analyses of the probability of termination have utilized either data from mortgage pools (Cooperstein, Redburn, and Meyers, 1991; Foster and Van Order, 1985) or data from individual loans (Vandell and Thibodeau, 1985; Zorn and Lea, 1986; and Capone and Cunningham, 1992). Similarly, analyses of loan age have also used either data from mortgage pools (Follain, Scott, and Yang 1992; and Schwartz and Torous, 1993) or data from individual loans.

Earlier researchers (see for example Cox, Ingersoll, and Ross, 1985) have used the option-pricing model proposed by Black and Scholes (1972) to estimate prepayment and default probabilities. Whenever the option is in money, the borrower terminates its obligation. Several explanations, however, can be offered to explain why the contingent claim option pricing models do not apply exactly to individual households' housing mortgages. First, owner-occupants may not be as financially sophisticated as the pure option pricing models (OPM) imply. Alternatively stated, these households may face substantially high transaction costs in their refinancing decisions because they require much time and effort to make correct decisions, given their lack of financial sophistication. Second, prepayments or defaults by homeowners are influenced by many other decisions that make it difficult to identify clearly the effects of OPM. For example, households often prepay because their job locations change, or there is a change in the composition of household, like divorce. Third, prepayment or default may occur as a part of the overall desire of households to readjust the composition of their portfolios. For example, a person may choose to refinance in order to increase his or her loan-to-value ratio and use the proceeds to make other investments. Fourth, the data available to estimate prepayment or default studies may constitute part of the problem. In particular, the interest rate pattern of the past fifteen years may not contain enough volatility to measure with this precision their effects on prepayments. Similarly, housing prices may not have enough volatility to measure their effects on defaults.

Several recent empirical studies have applied the Cox Proportional Hazard Model (Cox and Oakes, 1984) to estimate mortgage risk (e.g. Green and Shoven, 1986; Schwartz and Torous, 1989; Quigley and Van Order, 1990, 1995; Follain, Ondrich, and Sinha, 1996; Boyer, Follain, Ondrich, and Piccirillo, 1997). Instead of solving for the unique critical vales of the state variables in the contingent claim model, the proportional hazard model assumes that at each point of time during the mortgage contract period, the mortgage has a certain probability of termination, conditional on survival of the mortgage. The hazard function in this model is defined as the product of a baseline hazard and a set of time-varying covariates. These covariates need not be limited to the option value itself. They may include other important determinants of behaviour. The proportional hazard model can thus incorporate reasonable mortgage termination behaviour due to prepayment or default that would be considered sub-optimal under the contingent claim framework.

Results for the US market indicates that the hazard rate of prepayment is proportional to “lock-in,” which is the difference between the face value and the market value of the mortgage as a proportion of the value of the property (Green and Shoven 1986). Other variables that affect the hazard rate besides the cash value of a mortgage are household income and characteristics of the household head (Quigley 1987).

The proportional hazard model is used in the loan termination literature to analyze mortgage termination behaviour.

In technical terms, on the basis of proportional hazard methodology, the probability of mortgage termination due to prepayment or default (a), given the exogenous factors $Z_1,\ldots,Z_n$ at time *t*, can be divided into two multiplicative factors:

$$\text{Prob} = h(a) * \Pi\ (Z_1,\ldots,Z_n), \tag{6}$$

where h(a) is the baseline hazard, which is the proportion of the population that would prepay or default under completely stationary or homogeneous conditions. The baseline hazard gives the normal time profile of the conditional prepayment or default rates (the probability of prepayment or default in year 1, year 2, etc., of a loan in a particular loan group). In addition, Π(Z1,…,Zn), are the exogenous factors that make prepayments or default more or less likely. The effect of these factors on prepayment or default is also assumed to be time separable. That is, past and future attributes of the environment are assumed to have no effect on turnover in the present (Green and Shoven 1986; Quigley 1987; Van Order 1990)

The Cox Proportional Hazard model (Cox and Oates, 1984) is defined as:

$$H(t_i, Z) = h_0(t_i) \exp [Z(t_i)\ \beta] \qquad (7)$$

where i is the month in observation, $Z(t_i)$ is a set of time-varying covariates, and h_0 (.) is the baseline hazard reflecting the age-related amortization feature of mortgage. β s are the coefficients of covariates in Equation (7). The most popular estimation approach for proportional hazard model is the Cox partial likelihood approach (CPL, see Cox and Oates, 1984).

The function specifying mortgage risk estimates the probability that a mortgage loan will be prepaid or be defaulted during any period, conditional on survival to that period. The model assumes that borrowers prepay or default to maximize their wealth. Following the contingent claim model, the empirical model specifies the probability of exercising these options as a function to the extent to which options are `in the money,' and the `trigger events' that effect the decision on how far the options need to be in the money for it to be optimal to exercise. The ratio of the present discounted value of the unpaid balance to the par value of the mortgage measures the extent to which the call option is in the money. The put option is defined as the probability that the difference between the current value of the house and present value of the outstanding balance would be negative.

A typical way to value the call option in empirical real estate finance research is to compute the ratio of the present discounted value of the unpaid mortgage balance at the contract interest rate relative to the value discounted at the current market mortgage rate, assuming a deterministic structure (Deng, Quigley, and Van Order 1998).

Prepayment option (POPTION) for l^{th} loan:

$$POPTION_l = \frac{\sum_{t=1}^{TERM_{l}-\tau_i} \frac{MOPIPMT_l}{\left(\frac{1+MKTRATE_{\omega_l,K_l+\tau_i}}{100}\right)^l} - \sum_{t=1}^{TERM_{l}-\tau_i} \frac{MOPIPMT_l}{\left(\frac{1+NOTERATE_l}{100}\right)^l}}{\sum_{t=1}^{TERM_{l}-\tau_i} \frac{MOPIPMT_l}{\left(1+\frac{MKTRATE_{\omega_l,K_l+\tau_i}}{100}\right)^l}} \qquad (8)$$

Or, further simplification would yield:

$$POPTION_l = 1 - \frac{MKTRATE_{\omega_l, K_l + \tau_i}[1 - (\frac{1}{1 + \frac{NOTERATE_l}{100}})^{TERM_l - \tau_i}]}{NOTERATE_l[1 - (\frac{1}{1 + \frac{MKTRATE_{\omega_l, K_l + \tau_i}}{100}})^{TERM_l - \tau_i}]} \quad (9)$$

where τ_i is loan age measured in months, ω_l is a vector of indices for geographical location, K_l is the loan origination time, $MOPIPMT_l$ is the monthly principal and interest payment, $NOTERATE_l$ is the mortgage contract rate, MKTRATE $\omega_l, K_l+\tau_i$ is the current local mortgage rate, and $TERM_l$ is the mortgage loan term.

Similarly, to estimate the put option, we need to measure the market value of each house quarterly and to compute homeowner equity quarterly. We use the house price index for Mumbai from Tiwari and Hasegawa (2000). We estimate the variance of price for each house at the time of default. The price index and estimated variance permits us to estimate the distribution of homeowner equity monthly for each observation. The equity for loan l (EQY_l) is given by:

$$EQY_l = mktvalue_l - pdvunpblc_l \quad (10)$$

where, $mktvalue_l$ is the present market value of the house and $pdvunpblc_l$ is the present value of the unpaid loan balance. Furthermore:

$$mktvalue_l = purprice_l \frac{Pindex_{k_l,\tau_i}}{Pindex_{k_l}} \quad (11)$$

$Pindex_{k_l,\tau_i}$ is the price index at the time of claim or censorship of loan. $Pindex_{k_l}$ is the price index at the time of loan origination.

The present discounted value of an unpaid mortgage is the same as in the calculation of the call option.

The probability of negative equity (put option) is given by:

$$pneq_l = cdf\,(\frac{\log(pdvunpblc_l) - \log(mktvalue_l)}{\sqrt{e^2{}_{k_l+\tau_i}}}) \quad (12)$$

where cdf(.) is the cumulative standard normal distribution function, and $e^2{}_{k_l,\tau_i}$ is the variance of price. *pneq* is the probability that equity is negative. That is, the probability that the put option is in money.

To estimate the model with CPL, we first calculate the call or put option covariates for each individual loan and construct the covariate matrix, which consists of the call option covariate (POPTION), put option covariate (PNEQ), the initial loan to value ratio, the monthly installment-to-income ratio agreed to at the time of loan origination, and other household-related variables explained in next section. Another factor that we consider is that the mortgage termination behaviour for home purchase loans and other loans related to housing (like home improvement etc.) is different. The incidences of prepayment and default of other loans are much higher. We include a dummy variable for other loans in our model to account for this difference.

Estimates of Mortgage Risks

Data

There are two databases that we have used for our analysis. The database for the prepayment analysis is the administrative database of a housing finance company for Mumbai, which contains 12,173 observations on single-family mortgage loans issued between January 1989 and March 1998. All are fixed-rate, level payment, and fully amortized. The term of loan in most cases is 15 years, but other terms (5 and 10 years) also exist. The mortgage history period ends in March 1998. The database for the default analysis contains 3,497 loan observations for Mumbai. We define a loan delinquent for three consecutive months as defaulted[4]. The term of loan in most of the cases is 15 years and the loans were issued during January 1990 to March 1996. These two databases are completely different but contain all segments of households and properties in all locations of Mumbai. The typical way of buying properties in Mumbai is through real estate agents or developers. Most of the houses are of the apartment type. The share of independent houses in total houses in Mumbai is negligible.

Developers require construction finance for their projects, and they borrow from housing finance companies. Housing finance companies lend to developers based on their credit worthiness and project viability. Past experience with developers plays an important role. In the process, housing finance companies rate the developers and their projects. These ratings are

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[4] This is the typical way in which housing finance companies define defaults in India on their balance sheets.

an important feature of developers' marketing of their projects. Housing finance companies also simplify the process for approving loans to borrowers who buy properties in approved projects. The criterion to evaluate borrowers' credit worthiness is based on their repayment abilities. Salaried borrowers have easy access to housing finance compared to self-employed or other types of borrowers. Income plays an important role in determining the maximum amount of a loan. The borrowers and the properties, which they have bought, are distributed all over Mumbai.

The data used in this paper is an administrative database, which accounts for the flow of loan repayment for each of the loans during their term. Whenever the loan is prepaid or defaulted, the amount and date are also entered into the database. In both databases, for each mortgage loan, the available information includes the year and month of origination and termination (if it has been closed), indicators of prepayment or default, the purchase price of the property, the original loan amount, the initial loan-to-value ratio, the mortgage contract interest rate, the purpose of the loan (whether it is for home ownership or home improvement), the monthly interest, and principal payment.

Though we have referred to these databases as prepayment or default databases mainly due to the purpose for which they have been used, the prepayment databases include loan information for those which are either prepaid or still active. Similarly, the defaults database includes loans, which are either delinquent or still active. These active loans may close normally at the end of their terms or become prepaid or defaulted in the future. The databases also reflect information about the borrowers, like the number of co-borrowers, if any, the monthly income of borrowers at the time of origination, the sex of the borrower, his or her employment status (self employed, unemployed, or in the service), education level, marital status (single, divorced, married), and the age of the borrower.

Databases used for prepayment analysis have information about whether a loan was in arrears before being prepaid. This information we have captured in our analysis on prepayment. Housing finance companies in India lend for purchase of houses and also for the extension, redevelopment, etc., of existing houses. We have referred to the loans for home extension, etc., as other loans (OTHLOAN), although they are part of the same database to help us in identifying the role that different financial products play in the prepayment or default motives of households. Table 1 describes the variables from the database used in this analysis.

Table 1: Single-family Mortgage Data Description

Variable name	Definition	Description
COBORR	Number of co-borrowers	HFC allows more than one person jointly borrowing, subject to some conditions, for the same house because it enhances their income based eligibility to borrow for higher amounts. This variable indicates the number of co-borrowers, if any.
IIR	Installment income ratio	Monthly principal and interest payment to income ratio. This payment is decided at the time of origination of loan.
LCR	Loan-to-cost ratio	Loan value to cost of property at the time of origination
AGE	Age of the first borrower	Age at the time of origination of loan
POPTION	Call option price	As discussed above
PNEQ	Put option price	As discussed above
SINGLE	Borrower's marital status is single	Dummy equal to 1, if borrower is unmarried, divorced, widower, or widow at the time of borrowing; otherwise 0.
HQUALIF	High qualification	Dummy equal to 1, if the first borrower has a professional qualification.
LQUALIF	Low education qualification of borrower	Dummy equal to 1, if the first borrower's qualification is less than or equal to class 12; otherwise 0.
SEMPL	Borrower is self-employed	Dummy equal to 1, if the borrower is self-employed; otherwise 0.
SEX	Male	Dummy equal to 1, if the borrower is male, and 0 otherwise.
NRI	Non-resident Indian	Dummy equal to 1, if the borrower is a non-resident Indian, and 0 otherwise.
OTHLOAN	Loan for home improvement, extension etc.	Dummy equal to 1 if the loan is for home improvement, extension, etc., and 0 if the loan is for home purchase.
SERVPLACE	Place where loans are serviced	Dummy equal to 1, if the servicing of loan is at the office of the housing finance company, and 0 if the servicing is at the collection centers.
DELIN	Loan in arrears before prepayment	Dummy equal to 1, if loans were in arrears before prepayment, and 0 otherwise.

The mean values of these variables are summarized in Table 2. There are some differences in the mean values of variables for the two databases. Most striking is the loan-to-cost (LCR) ratio. The average LCR in the prepayment database is 55.56%, and in the default database 68.39%. In India, the second mortgage is not common. The rest of the finance is raised through households' own equity.

As indicated by the database, the own equity is very high and ranges from 31 to 45%. Another difference is in educational levels. The number of low educationally qualified households in the first database (used for prepayment analysis) is 40%, while in the second database (used for default study) it is 52%. The typical installment to income ratio is around 34%. The average age of borrowers is around 41, and the average number of borrowers per loan is 1.40. The proportion of self-employed is higher (7.3%) in the prepayment database than in the default database (5.6%).

Table 2: Mean Values of Variables

Variable (Units)	Mean (Prepayment database)	Mean (Default database)
Data Period	January 1989 - March 1998	January 1990-March 1996
COBORR (Numbers)	0.3988	0.37
IIR (%)	33.6432	34.9666
LCR (%)	55.5668	68.39
TERM (Years)	13.2	13.0
AGE (Years)	40.9245	41.627
POPTION	0.0010	-0.0018
PNEQ		0.0039
SINGLE (Proportion)	0.1763	0.1553
LQUALIF (Proportion)	0.4004	0.5258
SEMPL (Proportion)	0.0726	0.0557
NRI (Proportion)	0.03	0.0098
OTHLOAN	0.1124	0.0545
SEX (Male)	0.92	0.9527
DELIN (Proportion)	0.1895	

The market rate used in this analysis is the quarterly average interest rate charged by housing finance companies on new mortgages. This was taken by collecting historical announcements and creating a time series of the housing finance company's mortgage rate changes.

To calculate the option price for prepayments (POPTION), we used the market rate as the applicable rate of interest on new mortgages at the time when prepayment occurs. To calculate the option price for defaults (PNEQ), we used the time series market price from Tiwari, et al. (2000). The value of POPTION in the prepayment database is 0.0010. This means that the value of the mortgage in money is POTION times the present value of the mortgage at market interest rates. The value of POTION in default database is –0.0018, indicating that there is no incentive to prepay the loan. The value of the mortgage in money for the default database (PNEQ) is 0.0039, indicating that the value of the mortgage in money is 0.0039 times the initial value of the property. Loans are observed in each month from the month of origination through the month of termination, maturation, or through March 1998 for active loans.

Estimation Results

Figure 2a and 2b displays the conditional prepayment rate as a function of duration for home loans and other loans, respectively. Figure 3 shows the conditional default rate as a function of duration.

Figure 2a: Conditional Prepayment Rate for Home Loans

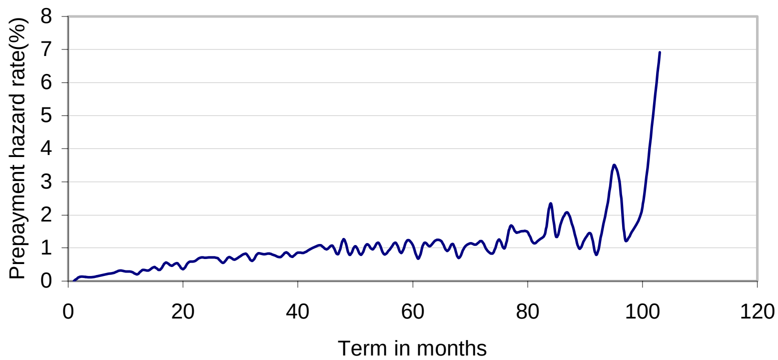


Figure 2b: Conditional Prepayment Rates for Other Loans

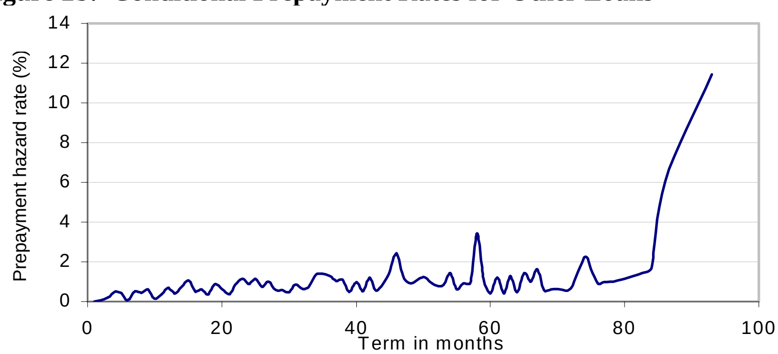


Figure 3: Conditional Default Rate

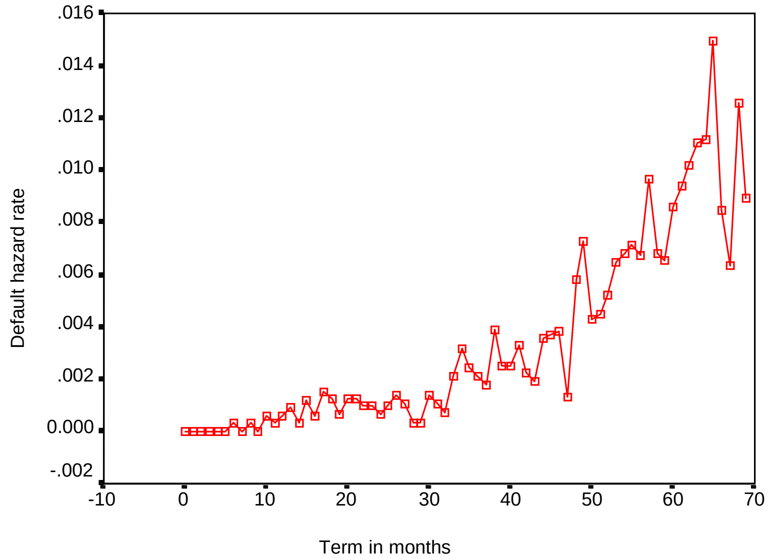


Table 3 presents estimates from a Cox-proportional hazard model estimated by the non-parametric technique for the prepayment and default models separately. The results show that financial motivation is important in governing the prepayment or default behaviour. For example, when the call option or put option is in money, the mortgage termination hazard increases. High equity (low loan to value ratio) reduces the prepayment hazard, While low equity increases the possibility of defaults. Borrowers with loan-to-cost ratios higher than 80 are more likely to default on their loans. The loan-to-value ratio is known when the mortgages are initiated and may well reveal borrowers' risk preferences.

The model includes a variable measuring the monthly payment to income ratio. The coefficient of this variable is positive for both the prepayment and default models. The positive coefficient in the prepayment model indicates that if the value of this variable is higher, then the monthly income outflow becomes significant and any financial wealth gain is utilized to reduce this outflow. The higher the installment to income ratio, the higher the probability of prepayment hazard. However, the positive sign in the default model indicates that higher monthly outflows of households may cause defaults because households find it difficult to repay higher amounts.

Table 3: Cox Proportional Hazard Model of Prepayment and Default

Variable	Prepayment Estimate	Default Estimate
COBORR	0.056 (3.01)*	
IIR	0.0034 (10.9)	.0068(3.6)
LCR	-0.007 (69.7)	
LCR > 80		0.21(2.87)
AGE	-0.009(14.81)	.0070(1.01)
POPTION	0.47 (2.30)**	
PNEQ		27.1(63.3)
SINGLE	-0.125(7.68)	
HQUALIF		-0.281(2.41)
LQUALIF	-0.332(93.9)	0.119(1.1)
SEMPL	-0.181(7.56)	0.616(13.9)
OTHLOAN	0.519(2.56)	0.543(5.43)
SERVPLACE		-0.359(5.01)
SEX		-0.81(7.73)
NRI		1.45(12.2)
DELIN	2.104 (3905.2)	

Notes: (1) Figures in brackets indicate wald statistics
(2) * significant at 8% and ** significant at 12%. All other variables are significant at the 5% level.

Household-specific variables besides financial variables also play an important role in determining prepayments. Housing finance companies allow the incomes of spouses, parents, or siblings to be pooled together to determine the loan amount for a house. If there are joint borrowers for the same house, the prepayment hazard increases. This is because the change in income of any of the borrowers could result in incidences of prepayment. This variable was insignificant in the default model. The age of a borrower plays an important role. If the borrower is in the late stage of his or her life at the time of the loan, s/he is less likely to prepay.

The default model shows positive signs for age the variable, which means that default probability increases with age. Single (unmarried or divorced) borrowers are also less likely to prepay, as indicated by the negative coefficient for this dummy. This variable dropped out as insignificant in the default model. The coefficient for the SEMPL dummy is negative, indicating that self-employed persons have less probability of prepaying their loans.

The SEMPL dummy has a positive sign for the default model, indicating that the probability of default by self-employed borrowers is higher.

Borrowers who are less educationally-qualified (LQUALIF, 1-if borrower has studied only up to class 12, 0-otherwise) are less likely to prepay but more likely to default. Highly-qualified borrowers are less likely to default. In the default model, the omitted borrowers are those who have attended university but have not acquired professional qualifications. A non-resident Indian borrower is more likely to default. This is primarily because her (his) intention of investing in residential properties in India is governed more by the returns on the investment. Another likely reason can be that s/he finds it difficult to pay because s/he lives abroad. Male borrowers are less likely to default.

If a loan was in arrears, households can exercise their call option and terminate the loan. The variable, which captures this behaviour (DELIN), has a positive coefficient and is very highly significant. This variable captures some of the information, which cannot be captured otherwise. For example, if the borrower has infrequent income or difficulty in paying every month because of inaccessibility to payment location or lender's recovery mechanism or arrears, the lender can induce the borrower to prepay and terminate his liability.

Figure 4a and 4b shows the predicted cumulative prepayment rates for home loans and other loans at the mean value of variables. We plot the cumulative prepayment rates for three values of LTV. The cumulative hazard function due to default is shown in Figure 5a and 5b. These Figures show that the prepayment hazard is more critical for other loans than for home loans.

Figure 4a: Cumulative Prepayment Function for Home Loans

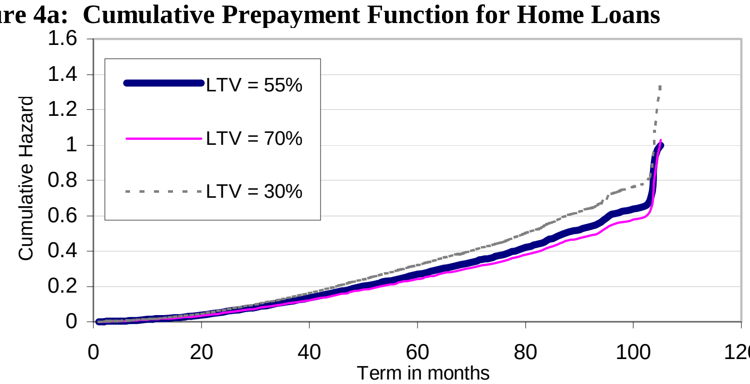


Figure 4b: Cumulative Prepayment Function for Other Loans

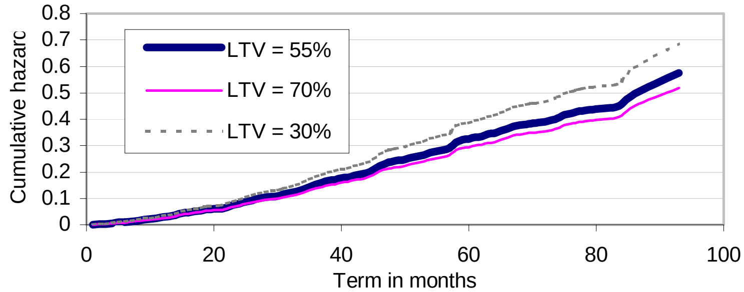


Figure 5a: Cumulative default function for home loans

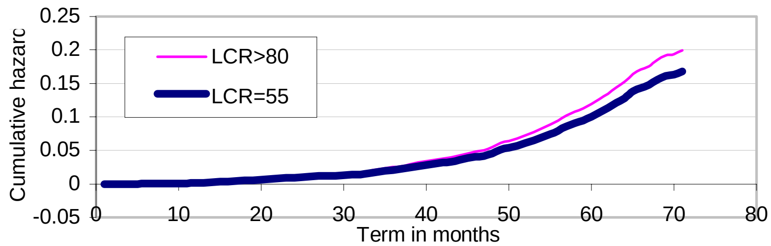
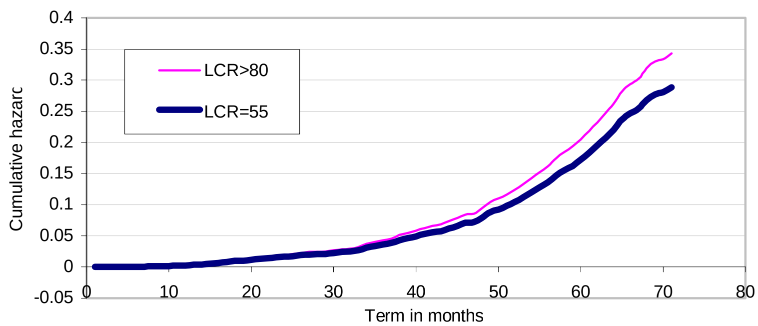


Figure 5b: Cumulative default function for other loans



Mortgage Insurance Simulation: An Example

After knowing the prepayment and default probabilities, the structure of an insurance premium can be calculated. Mortgage insurance in India does not exist. This paper computes the premium structure for a hypothetical case. The default and prepayment probabilities are estimated for the following borrower category.

- Age: 40 years
- Sex: male
- Qualification: High
- Employment: Employed
- Monthly income: Rs.47500
- Cost of property: Rs.1428571
- Initial loan amount: Rs.1000000 (with LCR of 70)
- Loan amount with insurance: Rs.1357143 (with LCR of 95)
- Term of loan: 15 years
- Applicable interest rate: 15%
- Loan to cost ratio: Initial – 70, but after buying insurance – 95
- Installment to income ratio – 30 but with changed loan to value ratio - 41

We assumed the discount rate as 15% for the calculation of loss and revenue for the mortgage insurance equation. We assumed an insurance structure that requires a uniform premium rate depending on outstanding unpaid balances. A calculation for the above borrower category indicates that a premium of 0.05% of the outstanding balance would be able to cover the cost of insurance.

Conclusion

The objective of this paper is to evaluate the possibility of mortgage insurance in India. The Indian housing market is constrained by the availability of finance. The risk associated with the residential loan is borne by the lender. This makes the criteria of lending very stringent. The average loan-to-cost ratio in India is around 0.55, and the installment-to-income ratio is 0.34. These constraints require a large initial equity from the home buyer. In developed markets like the US, borrowers buy mortgage insurance, which enables them to borrow higher amounts. Mortgage insurers insure the loans against defaults for an insurance premium. We presented a framework to estimate the premium structure. To formulate the premium structure, a knowledge of the probability of prepayment and default was necessary. The second objective of this paper was to estimate the probability of mortgage termination due to either default or prepayment.

This paper has presented a model of mortgage termination through prepayments or defaults for home mortgages in India using the Cox proportional hazard technique. This is the first analysis of housing mortgage termination in India.

As a first step, we estimated the baseline hazard for mortgage termination. This baseline hazard was then modeled as a function of the price of call options and other financial and household variables.

The results of the analysis indicate that the financial value of a call option or put option plays an important role in the exercise of a prepayment or default option. The results indicated that introducing volatility and uncertainty to future interest rates has an effect on mortgage prepayment behaviour. The uncertainty and volatility of housing prices leads to default.

In addition, the results indicated that liquidity constraints also play an important role in the exercise of options in the mortgage market. Those are more likely to have low-levels of equity, and are less likely to exercise prepayment options when it is in their financial interest to not do so. These results are explicable, not by option theory, but rather by liquidity constraints that arise from qualification rules typically enforced by lenders.

Ceteris paribus, those who have chosen high initial LTV ratios are more likely to exercise prepayment options in the mortgage market. This factor, known at the time mortgages are issued, also reflect investor preferences for risk and investor sophistication in the market for mortgages on owner-occupied housing. A low level of equity has an impact on defaults. Though the results did not find a very strong relation between the loan-to-cost ratio with defaults.

Finally, borrowers' household variables play an important role in determining prepayment or default rates. All other variables remaining constant, a self-employed person is less likely to prepay, but more likely to default. The same goes for a single person, a less educated borrower, or a person in the later stages of life at the time of the loan. However, joint borrowers have a greater likelihood of prepaying their loans. We used the conditional probabilities of default and prepayment in the insurance model, and a hypothetical simulation for the insurance premium structure has been carried out. The overall results of the model are quite promising, and present a case for developing a mortgage insurance market in India.

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