ECONOMICS OF MORTGAGE TERMINATION IN INDIA

***Piyush Tiwari*[1]**
Institute of Policy and Planning Sciences
University of Tsukuba
Tsukuba 305 8573, Japan

Abstract

Mortgage termination due to prepayment is an important issue in pricing of mortgage and mortgage-backed securities (MBS) due to its stochastic nature. In developing countries where MBS is not yet fully developed, mortgage termination affects the flow of funds to the lenders. Recent literature has used option price models (OPM) to analyze prepayments. Prepayment is a 'call option' whose price is dependent on fluctuation in market interest rates. However, the termination of mortgage in housing is not as `ruthless' as OPM theory would suggest, primarily because households are not financiers in `stricter sense'. Recent literature has used Cox proportional hazard model to model mortgage termination. The idea is that other household related variables besides option price of the instrument jointly determine the mortgage termination. We use Cox proportional hazard model to analyze prepayment of mortgage behaviour in India. The results indicate that financial concerns (like option price, loan to value ratio and monthly principal and interest to income ratio) are important determinants besides household characteristics. Self employed or low educated or single borrowers have less probability of prepaying the loan. An important variable inducing prepayment is irregular repayment behaviour of borrower. If loan repayment is in arrears for some months, borrowers' often terminate their liability by prepaying.

[1] This paper was completed when I was visiting Department of Urban Studies, University of Glasgow as Journal of Urban Studies Research Fellow during the summer of 1998. I would like to thank Professor Lever, Managing Editor for extending me an opportunity to work at University of Glasgow. My special thanks to Professor Edwin Deutsch, University of Technology, Vienna for suggestions and comments on empirical model.

MORTGAGE TERMINATION DUE TO PREPAYMENTS IN INDIA

Abstract

Mortgage termination due to prepayment is an important issue in pricing of mortgage and mortgage-backed securities (MBS) due to its stochastic nature. In developing countries where MBS is not yet fully developed, mortgage termination affects the flow of funds to the lenders. Recent literature has used option price models (OPM) to analyze prepayments. Prepayment is a 'call option' whose price is dependent on fluctuation in market interest rates. However, the termination of mortgage in housing is not as `ruthless' as OPM theory would suggest, primarily because households are not financiers in `stricter sense'. Recent literature has used Cox proportional hazard model to model mortgage termination. The idea is that other household related variables besides option price of the instrument jointly determine the mortgage termination. We use Cox proportional hazard model to analyze prepayment of mortgage behaviour in India. The results indicate that financial concerns (like option price, loan to value ratio and monthly principal and interest to income ratio) are important determinants besides household characteristics. Self employed or low educated or single borrowers have less probability of prepaying the loan. An important variable inducing prepayment is irregular repayment behaviour of borrower. If loan repayment is in arrears for some months, borrowers' often terminate their liability by prepaying.

1. INTRODUCTION

The mortgage market is quite large and is increasing in importance. The outstanding volume of residential mortgage is currently over Rs. 14,000 crores in India, and the volume has more than doubled compared to last decade. Recent guidelines of National Housing Bank, permitting mortgage based securities as collateral for "derivatives" has generated a great deal of interest in the economics of mortgage and mortgage based securities.

Most of available literature on analysis of mortgage termination is for developed countries particularly US housing markets. Empirical estimation of mortgage termination have utilized logit or probit models to estimate the probability of termination or, more recently, have 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.

Pricing of mortgage and mortgage backed securities is complicated due to stochastic and interdependent nature of prepayments and default risks. The option to prepay or default is available to borrower. It is widely accepted that mortgage can be viewed as ordinary debt instruments and 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 or further obligation.

Several explanations, however, can be offered to explain why the contingent claim option pricing models (Black and Scholes, 1972; Cox, Ingersoll and Ross, 1985) do not apply exactly to individual households housing mortgages. First, owner-occupants may not be financially sophisticated as the pure option pricing models (OPM) implies. Alternatively stated, these households may face substantially high transaction costs in their refinancing decisions because it requires much time and effort to make correct decision given their lack of financial sophistication. Second, prepayments 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 location of job changes or there is a change in composition of household structure, say, for example, divorce. Third, prepayment may occur as a part of overall desire of household to readjust their composition of portfolio. 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 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.

Several recent empirical studies have applied the Cox Proportional Hazard Model (Cox and Oakes, 1984) to evaluate mortgage prepayment 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 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 option value itself. They may include other important determinants of behaviour. The proportional hazard model can thus incorporate reasonable mortgage prepayment behaviour that would be considered sub-optimal under the contingent claim framework.

Results for US market indicates that the hazard rate of prepayment is proportional to “lock-in”: 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 hazard rate besides cash value of mortgage are household income and characteristics of the household head (Quigley 1987). Giliberto and Thibodeau (1989) found that regional location of property besides other mentioned earlier, is also an important variable determining prepayments.

In this paper, we analyze home mortgage termination due to prepayment in India. The only other study analyzing mortgage termination for India is Struyk, Kenney and Friedman (1988) based on a logit model. The data employed in their study is individual home loan data from 1978 to 1985 and the loan is monitored until July 1987. The study indicates that the probability of prepayment increases by 0.04, if the loan term increases from 10 years to 15 years. Higher the cost of the home, the lower the probability of prepayment. Older borrowers are distinctly less likely to prepay from the sale of property and more likely to prepay from provident funds. Women borrowers are about 0.08 less likely to prepay. Location of loan origination is also an important determinant of prepayment pattern. This model was used in predicting prepayments and Struyk et al. (1988) concluded that the prediction success rate has not been very encouraging.

This paper makes three contributions. First we use the most recent proportional hazard framework to analyze prepayment risk empirically for Mumbai (India), using a large sample of individual loans and second we monitor a larger segment of loans originated between 1989 and 1998. Finally, the period that we analyze has seen the one of the fastest upswing and first time ever downswing in real estate prices. Rest of the paper is structured as follows. Section 2 briefly describes the data. Section 3 presents theoretical framework. Section 4 presents and discusses results and section 5 concludes the discussion.

2. DATA

The data used for analysis of mortgage termination due to prepayments is based on the individual mortgage history data from the borrower's files for Mumbai (the largest metropolitan city in India) of a private sector housing finance company (HFC)[2].

Our paper analyzes mortgage termination due to prepayments for Mumbai. Mumbai has the highest prepayment rate and the data is available since 1989. The computerization in all other branches is quite recent and it would be premature to look prepayment behaviour of other branches. The period of our study is from January 1989 to March 1998 (111 months). HFC lends to its borrowers at fixed rate of interest for a fixed term. However, the term is decided between borrower and HFC at the beginning of loan and the maximum term is 20 years.

The total sample size is 12,173 borrowers, which includes all loans made since January 1989 up to March 1998. Sample inclusion requires that, on the date of sample collection (31st March 1998), the loan was active or prepaid. Active loans are considered as censored in the estimation in that they were still active on the date of collection of sample. The data is quite extensive in details.

3. MODEL

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

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

Prob = h(a) * ? $(Z_1,\ldots,Z_n)$,

[2] Author has been advised to protect the identity of the housing finance company to avoid speculation about its balance sheet.

Where h(a) is the baseline hazard, which is proportion of the population that would prepay under completely stationary or homogeneous conditions. The baseline hazard gives the normal time profile of the conditional default rates (the probability of default in year 1, year 2, etc., of a loan in a particular loan group. And ? (Z1,…,Zn), are the exogenous factors that make prepayments more or less likely. The effect of these factors on prepayment 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

$$H(t_i, Z) = h_0(t_i) \exp [Z(t_i) ?]$$

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. The most popular estimation approach for proportional hazard model is the Cox partial likelihood approach (CPL, see Cox and Oates, 1984).

The function specifying prepayment risk estimates the probability that a mortgage loan will be prepaid during any period, conditional on survival to that period. The model assumes that borrowers prepay 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 about how far the options needs to be into the money for it to be optimal to exercise. The ratio of present discounted value of the unpaid balance to the par value of the mortgage measures the extent to which call option is in the money.

A typical way to value the call option in empirical real estate finance research is to compute the ratio of present discounted value of 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

$$POPTION_l = \frac{\overset{TERM_{l-?i}}{\underset{t=1}{?}} \frac{MOPIPMT_l}{\left(\frac{1+ MKTRATE_{?l,K_l+?i}}{100}\right)^l} - \overset{TERM_{1-?i}}{\underset{t+1}{?}} \frac{MOPIPMT_l}{\left(\frac{1+ NOTERATE_l}{100}\right)^l}}{\overset{TERM_{l-?i}}{\underset{t=1}{?}} \frac{MOPIPMT_l}{\left(1+\frac{MKTRATE_{?l,K_l+?i}}{100}\right)^l}}$$

Or, further simplification would yield,

$$POPTION_l = 1 - \frac{MKTRATE_{?_l,K_l+?_i}[1-(\frac{1}{1+\frac{NOTERATE_l}{100}})^{TERM_l-?_i}]}{NOTERATE_l[1-(\frac{1}{1+\frac{MKTRATE_{?_l,K_l+?_i}}{100}})^{TERM_l-?_i}]}$$

Where $?_i$ is loan age measured in months, $?_l$ 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, $MKTRATE\ ?_{l},K_l+?_i$ is the current local mortgage rate, and $TERM_l$ is the mortgage loan term.

To estimate the model with CPL, we, first, calculate the call option covariates (POPTION) for each individual loan and construct the covariate matrix, which consists of call-option covariate POPTION, the initial loan to value ratio, the monthly instalment to income ratio agreed at the time of loan origination, and other household related variables explained in next section. Another factor that we consider is that the prepayment bahaviour for home purchase loans and other loans related to housing (like home improvement etc.) is different. The incidences of prepayment of other loans are much higher. To take this differential in behaviour in account, we stratify the loan group in home purchase loan and other loans. The baseline hazards for both these groups are estimated separately and then along with other variables we estimate hazard function with CPL.

4. EMPIRICAL ANALYSIS

This administrative database of HFC for Mumbai 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 are also quite common. The mortgage history period ends in March 1998. For each mortgage loan, the available information include; the year and month or origination and termination (if it has been closed), indicators of prepayment, the purchase price of property, the original loan amount, the initial loan-to-value ratio, the mortgage contract interest rate, purpose of loan (whether it is for home ownership or home improvement) the monthly interest and principal payment. The database also reflects information about the borrowers like number of co-borrowers, if any, monthly income of borrower at the time of origination, sex of borrower, employment status (self employed, unemployed or in service), education level, marital status (single, divorced, married) and age of the borrower. Another information that we have captured in our analysis is the status of loan whether it was in arrears prior to prepayment. Table 1 describes the variables from the HFC database used in this analysis.

The mean values of these variables are summarized in table 2.

The market rate used in this analysis is the quarterly average interest rate charged by HFC on new mortgages. Loans are observed in each month from the month of origination through the month of termination, maturation, or through March 1998 for active loans.

Figure 1 summarizes the raw data used in the empirical analysis. Figure 1 (a and b) displays the conditional prepayment rate as a function of duration for home loans and other loans respectively. Table 3 presents a Cox-proportional hazard model estimated by non-parametric technique.

The results show that financial motivation is important in governing the prepayment behaviour. For example, when the call option is in money the prepayment hazard increases. Similarly, high equity (low loan to value ratio) reduces the prepayment hazard. 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. This 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. Higher the installment to income ratio, higher is the probability of prepayment hazard.

Household specific variables besides financial variables also play an important role in determining prepayments. HFC allows spouse, parents or brothers income 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. Age of the borrower plays an important role. If the borrower is in late stage of life at the time of borrowing, (s)he is less likely to prepay. Single (unmarried or divorced) borrowers are also less likely to prepay as indicated by negative coefficient for this dummy. The coefficient for SEMPL dummy is negative indicating that self employed persons have less probability of prepaying their loans. Borrowers who are less educationally qualified (LQUALIF, 1-if borrower has studied only up to class 12, 0-otherwise) are less likely to prepay.

If loan was in arrears households exercise their call option and terminate the loan. The variable, which captures this behaviour (DELIN), has positive coefficient and is very highly significant. This variable captures some of the information, which can not 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, induce borrower to prepay and terminate his liability.

Figure 2 (a and b) shows the predicted cumulative prepayment rates for home loans and other loans at mean value of variables. We plot the cumulative prepayment rates for three values of LTV. Figure indicates that prepayment hazard is more critical for other loans than the home loans.

5. CONCLUSION

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

While estimating the hazard function, the sample is stratified in two groups; home loans and other loans and baseline hazard estimated for these groups separately. This baseline hazard is then modeled as a function of price of call option, other financial and household variables.

The results of the analysis indicate that financial value of call option plays an important role in the exercise of prepayment option. The results indicate that introducing volatility and uncertainty about future interest rate movement has effect on mortgage prepayment behaviour.

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

Ceteris paribus, those who have chosen high initial LTV ratios are more likely to exercise prepayment option in 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.

Finally, borrowers’ household variables play important role in determining prepayment rate. All other variables remaining constant, a self-employed person is less likely to prepay. So, is the case with a single person or a less educated borrower or a person in later stage of life at the time of borrowing. However, joint borrowers have more likelihood of prepaying their loan.

REFERENCES

Black, F. and Scholes, M.S. (1972). “*The Pricing of Options and Corporate Liabilities*,” **Journal of Political Economy** 81, 637-654.

Boyer, L.G., Follain, J.R., Ondrich, J. and Piccirillo, R.A. (1997) *A Hazard Model of Prepayment and Claim Rates for FHA Insured Multifamily Mortgages*, Center for Policy Research, Syracuse University, NY

Cox, J. C., Ingersoll, J.E., and Ross, S.A. (1985). “*A Theory of Term Structure of Interest Rates*,” **Econometrica** 53, 385-467.

Cox, D.R. and Oakes, D.(1984), *Analysis of Survival Data*, Monographs on Statistics and Applied Probability, London: Chapman and Hall.

Deng, Y., Quigley, J.M. and Van Order, R. (1998), *Mortgage Termination, Heterogeneity and the Exercise of Mortgage Options*, Unpublished, May.

Follain, J.R., Ondrich, J. and Sinha, G.P. (1996*) Ruthless Prepaymnt? Evidence From Multifamily Mortgages*, Center for Policy Research, Syracuse University, NY.

Green, J. and Shoven, J.B., (1986), "*The Effect of Interest Rates on Mortgage Prepayments*," **Journal of Money, Credit and Banking** 18, 41-50.

Quigley, J.M. and Van Order, R., (1990) "*Efficiency in the Mortgage Market: The Borrower's Perspective*," **Journal of the American real Estate and Urban Economics Association** 18(3), 237-252.

Quigley, J.M. and Van Order, R., (1995) "*Explicit Tests of Contingent Claim Models of Mortgage Defaults*," **Journal of Real Estate Finance and Economics** 11(2), 99-117.

Schwartz, E.S. and Torous, W.N. (1989), "*Prepayment and the Valuation of Mortgage-Based Securities*," **Journal of Finance** 44(2), 375-392.

Struyk, R.J., Kenney, G., Friedman, M. (1988), *Mortgage Prepayment in India*, Paper No. 3641-07-3A, USAID/India.

Table 1: HFC single-family mortgage data description

Variable name	Definition	Description
COBORR	Number of coborrowers	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 amount. This variable indicates the number of coborrowers, if any.
IIR	Instalment 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	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.
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.
DELIN	Loan in arrears before prepayment	Dummy equal to 1, if loans were in arrears before prepayment, otherwise 0.

Table 2: Mean Values of Variables

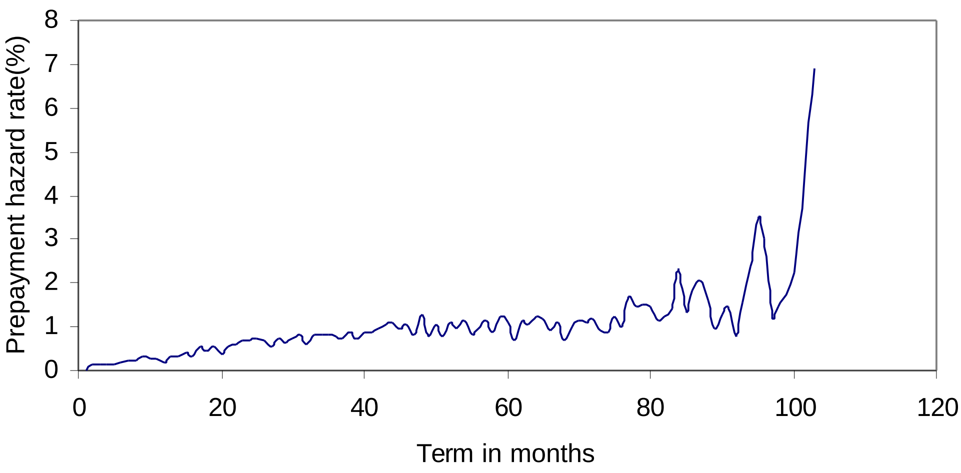
Variable (Units)	Mean
COBORR (Numbers)	0.3988
IIR (%)	33.6432
LCR (%)	55.5668
AGE (Years)	40.9245
POPTION	0.0010
SINGLE (Proportion)	0.1763
LQUALIF (Proportion)	0.4004
SEMPL (Proportion)	0.0726
DELIN (Proportion)	0.1895

Table 3: Cox Proportional Hazard Model of Prepayment

Variable	Estimate
COBORR	0.056 (3.01)*
IIR	0.0034 (10.9)
LCR	-0.007 (69.7)
AGE	-0.009(14.81)
POPTION	0.47 (2.30)**
SINGLE	-0.125(7.68)
LQUALIF	-0.332(93.9)
SEMPL	-0.181(7.56)
DELIN	2.104 (3905.2)

Figures in bracket indicate wald statistics
* significant at 8% ** significant at 12%. All other variables are significant at 5% levels.

Figure 1a: Conditional Prepayment Rate for Home Loans



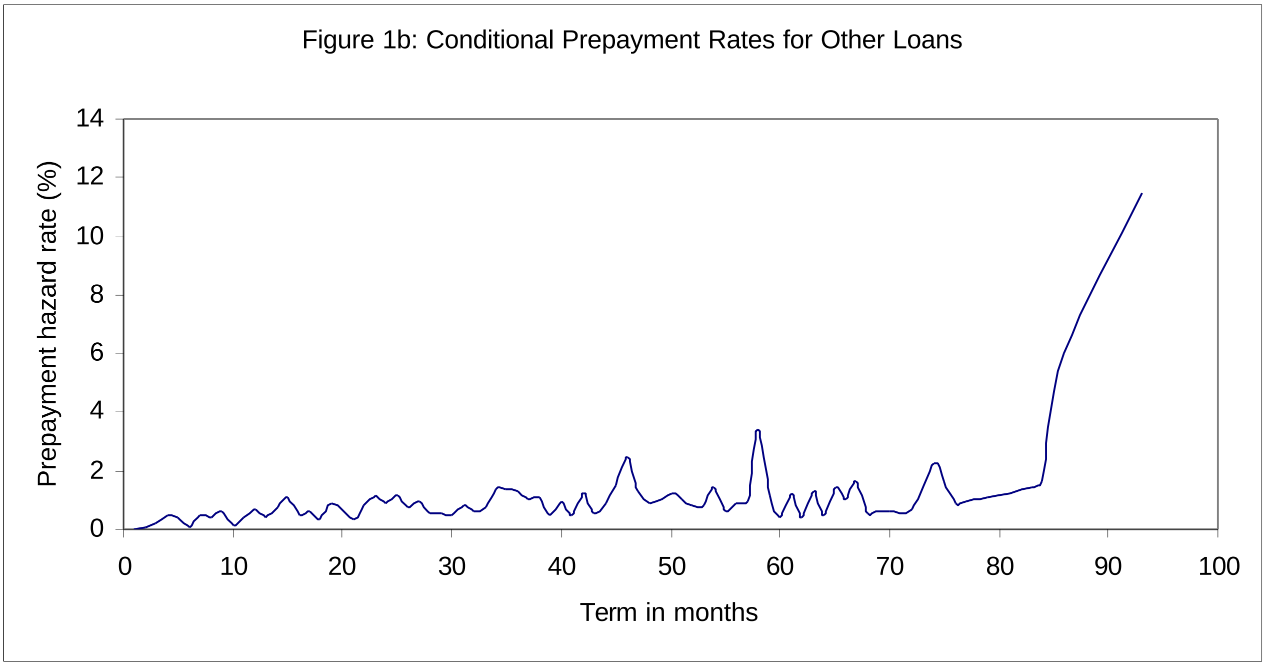


Figure 1b: Conditional Prepayment Rates for Other Loans
Prepayment hazard rate (%)
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
80
90
100
Term in months

Figure 2a: Cumulative Hazard Function for Home Loans

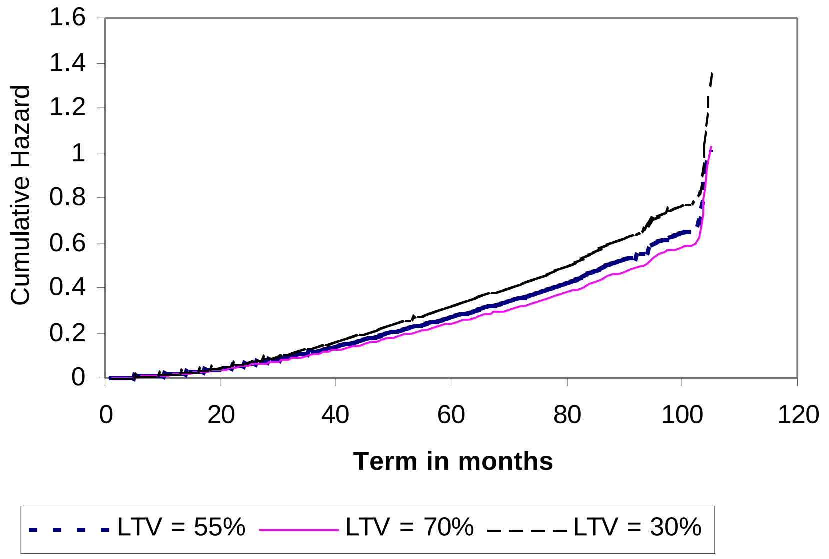


Figure 2b: Cumulative Hazard Function for Other Loan