

Prepayment risk, impact on credit products

Dan Costin NIȚESCU

Bucharest Academy of Economic Studies
dancostinn@gmail.com

Abstract. *Credit pricing is always an important aspect of operations of banks, as loans are generally two thirds of bank assets. Therefore, the study of factors influencing a bank customer behavior and their impact on early repayment of loans may have a significant influence in reducing the risk assumed by such unexpected operations.*

Objective analysis of prepayment risk is to estimate the probability of repayment to better manage its manifestation. The existence of potential customers that use this option exposes the bank to a number of risks, such as interest rate risk, the maturity mismatch risk and liquidity risk.

Proper evaluation and forecasting the evolution of this risk can bring great benefits for a credit institution in the management of loan products and customer relationship: lower risk of over-ensure against fixed rate mortgage, a better management of short-term and long term liquidity needs (thus reducing the risk of over-financing) can offer customers more competitive pricing (achieved by reducing funding costs due to better assessment and management of risks involved early repayment).

Keywords: prepayment risk; credit products; consumer behavior; indebtedness; refinancing; loans portfolio.

JEL Code: E51.

REL Codes: 11B, 11C.

1. Introduction

Earlier studies used different prepayment risk models to describe the behavior of borrowers, which can be divided into two categories. The first category includes models based on data aggregated using law of large numbers to predict prepayments for the entire mortgage portfolio. Examples of this type of studies we have in the works of Brennan and Schwarz (1985), Kang and Zenia (1992) or Golub and Pohlman (1994). The main disadvantage of this class of models is that behavior prepayment forecasts can be inaccurate if the main features of population change, compared to the population used for the design model. Therefore, the second category, which includes studies on early repayment option based on individual data sets of credit, offers improved accuracy. These types of analyzes were conducted by Archer, Ling and McGill (1996) and Green and Shoven (1986).

The main factors determining the early repayment of a loan can be separated into four categories (Consalvi, Scotto di Freca, 2010): incentives to refinance the existing loan on the market; value of collateral; default state of the client; refund the customer credit as a result of contracting a new loan with the same institution, other conditions to the original.

2. Analysis of early repayment

Tackling prepayment rate quantization can be viewed from two perspectives (Jacobs et al., 2005): financial perspective, which is based on the absence of arbitrage opportunities (analyzed using theoretical models), and behavioral perspective (analyzed via econometric models). Financial models are suitable for the analysis of securitized assets or corporate loans. Behavioral models are used to explain the early repayment of credit retail market, a risk that the bank is continuously exposed.

Difficulties in applying financial models retail market consists of various reasons, the most important being that the level of financial knowledge of participants makes them move away from efficient market theory. In terms of behavioral patterns, there are used in particular those developed using survival analysis.

Survival analysis aims to analyze relations between survival and function of explanatory variables. To achieve this purpose, often using a vector of explanatory variables z to divide the model into two parts: a model for the distribution of time to onset of event, where the vector z is null, and another model used to determine the distribution time of occurrence when variables are nonzero. In the survival analysis the relationship between survival and

explanatory variables function is usually expressed through two models: *the accelerated life and proportional hazard model*.

Option to repay the loan early would be exercised by the client in order to minimize the amount paid. As a result, the mortgage would be paid when the actual value exceeds the option exercise price. Given these issues, the value of a mortgage can be calculated according to the theory of evaluation of options, it can be likened to a call option.

However, studies reveal that decisions are often early repayment of loans even when the refinancing rate is higher than the current contract or, in opposition, there are times when a mortgage is not paid while the market rate is small and the repayment decision would be ideal.

Therefore, we have developed numerous econometric models, aimed to explain the relationship between reimbursement rates and explanatory variables that influence this decision. Most models used in the literature estimate the probability of repayment and are part of survival analysis, whose goal is to model the distribution of "time of occurrence" of the event by defining the relationship with the explanatory variables.

3. Methodology of analysis

In order to achieve an empirical study on the analysis for determining relations between the variables influencing survival function⁽¹⁾ and risk of early repayment manifestation it can be used proportional hazard model developed by Cox (1972, pp. 187-220). This direction will be developed in future work. For now, we will summarize to present and analyze the explanatory variables considered to be relevant in such a study.

The data that can be used in such an empirical analysis represents the mortgage portfolio of a small bank from Romania. In this regard, I appeal to consider a data set comprising 1,178 mortgage, fixed rate or linked to the reference EURIBOR 6M. Lack of individual information on the type of interest can be a source of errors for the model mentioned above. Also, relatively small size of this portfolio and the small number of recorded events can have the same result. After eliminating incomplete records, missing data for some variables, the data set was reduced to 1,053 credits.

The following figure shows the evolution of repayments over the entire range studied.

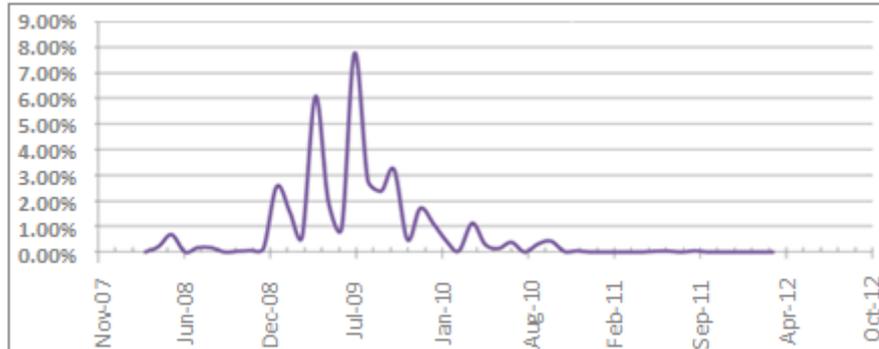


Figure 1. *Evolution of early repayment in the period studied*

Following the chart, we see a period with low rates of reimbursement by December 2008, at which point the values of this ratio increases to a peak in July 2009. It continues a downward trend, and since October 2010 reimbursement rate dynamics becomes similar to the beginning of the period, with little credit repaid early.

The significant repayments beginning in December 2008 may be also a consequence of the international financial and banking crisis, which has led customers to look into a more prudent mortgage problem.

However, the crisis hit our country and caused the reduction of lending to new businesses and the development of numerous refinancing offers to attract customers of other banks, generating mainly the repayment of existing loans.

Using the estimation model developed by Cox, we will select five explanatory variables as follows: age, initial value of the loan, the repayment period of loan, indebtedness of the client signing the contract, the incentive to refinance, calculated as the difference between the interest of the loan contract and the current interest.

3.1. Age

The first variable listed is the age of the mortgage contractor. From the distribution of values, we see an average age of the entire loan portfolio of about 34 years, showing the distribution of positive asymmetry, implying a greater frequency of extreme values above average in terms of this type of loan customers.

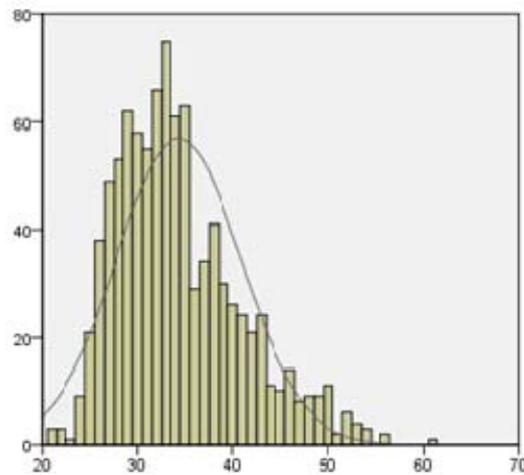


Figure 2. *Distribution of values, normal distribution overlay*

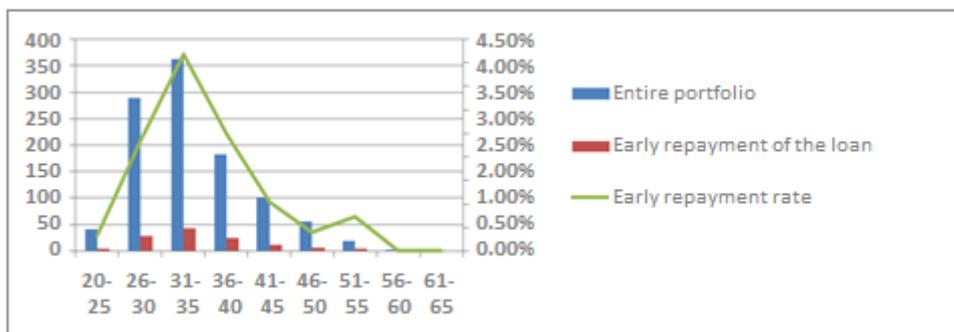


Figure 3. *Influence of age on the rate of prepayment*

Figure 3 shows the percentage of loans repaid early recorded in portfolio analysis. Thus, an increase in repayment rate with age until age group 31-35 years, after which it is reduced. This behavior was observed in previous studies in the specialized literature, the explanation being that young families at the beginning foundation of a home, originally purchased a smaller home, sufficient for the needs of a couple. But with the advent of a child in family life, there is a need for space to hold a larger home, for which the loan is repaid following the sale of existing homes.

3.2. The initial contract

For the initial value of the credit agreement, we have the following values that define the distribution:

Table 1

Main statistical indicators of the initial value of the contract

Number of observations	1,053	Number of observations	117
Mean	44,799.53	Mean	37,964.10
Skewness	2,936	Skewness	1,491
Kurtosis	18,284	Kurtosis	2,155
Minimum	6200	Minimum	7,800
Maximum	400,000	Maximum	119,700

Average of the whole portfolio is 44,800 euros, and loans repaid is 38,000. Both distributions are asymmetric positive, specific to loan portfolios, as contracts with large values are reduced in number and are very far from average.

Given the asymmetry coefficient twice as small loans repaid early, we see that once the loan is higher repayment is higher. This is not surprising, a bigger credit is much more difficult to repay because the less likely a customer to be eligible for a loan of such value considering the economic crisis and financial market turmoil of recent years.

3.3. The period of loan repayment

Most loans are closed for periods greater than average for the entire portfolio of 353 months (29.4 years), as confirmed by negative asymmetry coefficient of -0.945; so the duration loans are rare and represent less extreme the average portfolio, a situation that has resulted in a distribution skewed to the left. To trace the influence of the period in which the loan is repaid on early repayment behavior, we grouped portfolio in several ranges:

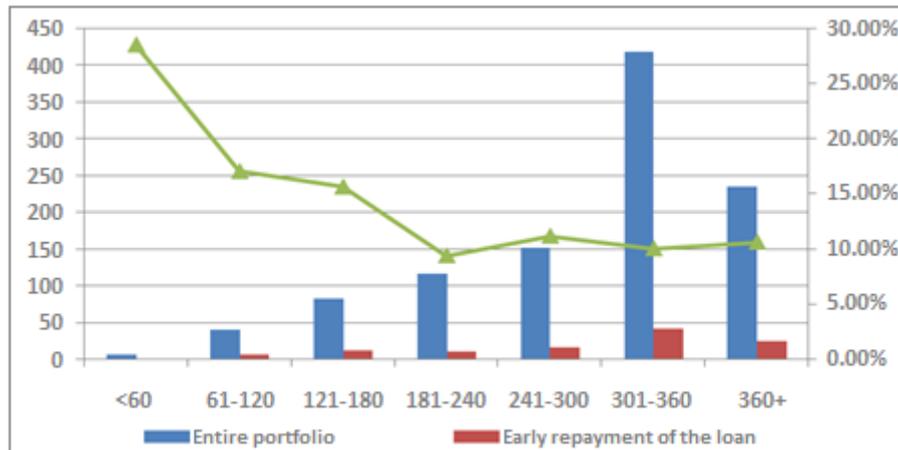


Figure 4. Influence of the contract period of the loan repayment rate

Table 2

Main statistical indicators of the loan repayment period

Number of observations	1,053	Number of observations	117
Mean	302.88	Mean	288.52
Skewness	-.945	Skewness	-.980
Kurtosis	.168	Kurtosis	-.330
Minimum	36	Minimum	60
Maximum	481	Maximum	384

Following the chart, it appears that most of the loans are contracted for more than 300 months. In contrast, for loans which have lower contract period rates of reimbursement are higher.

One explanation for this would be to obtain welfare or safety of future extraordinary income for customers who have made these loans: those who contracted the short-term loans received faith in the ability to make higher monthly payments, therefore such may be able to repay early, others may have been credited with great certainty of future income to pay the mortgage before they ordered a full refund.

3.4. Indebtedness

Indebtedness of the customer is calculated by referring all monthly financial obligations to income received monthly; in this simplistic definition, we can be induced to believe that a high level of debt implies a lower possibility of early repayment of the loan, as the customer remains provide less

financial resources that could be saved and used later to pay the obligation. Illustrative of this can be the following figure:

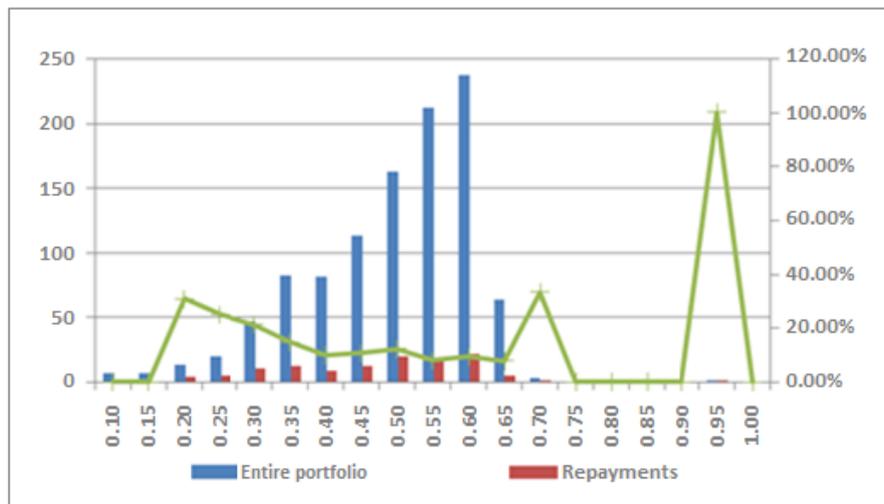


Figure 5. The influence of indebtedness on the rate of prepayment

Starting with contractors whose credit group had a gearing of between 15% and 20%, which represents 30% of total repayments, this rate drops to 65% values of indebtedness, in the range 60-65% reimbursement rate being 7.81%. In other intervals, the degree of leverage applications containing over 65% or below 15%, the link does not keep the same direction, but the results are inconclusive with regard to the proportion of only 1.8% of the total loan portfolio.

Media across the portfolio is 47.05% and the coefficient of asymmetry of -0.886 series is skewed to the left, most of the values of the variable ranging between 50% and 65%. Values over 70% are rare in the used portfolio, as it is higher customer acceptance threshold for such credit type, within the analysed commercial bank.

The main values that describe the distribution per the table below.

Table 3

Main statistical indicators of variable gearing

Number of observations	1,053	Number of observations	117
Mean	.470565	Mean	.446664
Skewness	-.886	Skewness	-.062
Kurtosis	.829	Kurtosis	.541
Minimum	.0586	Minimum	.1596
Maximum	.9210	Maximum	.9210

3.5. The incentive to refinance

Refinancing incentive may be considered to quantify the gain obtained by the client chooses to repay the loan early. Therefore, assuming that most customers seek to minimize interest payments made by the credit institution, this variable should have an important impact on the level of credit worthiness of the portfolio.

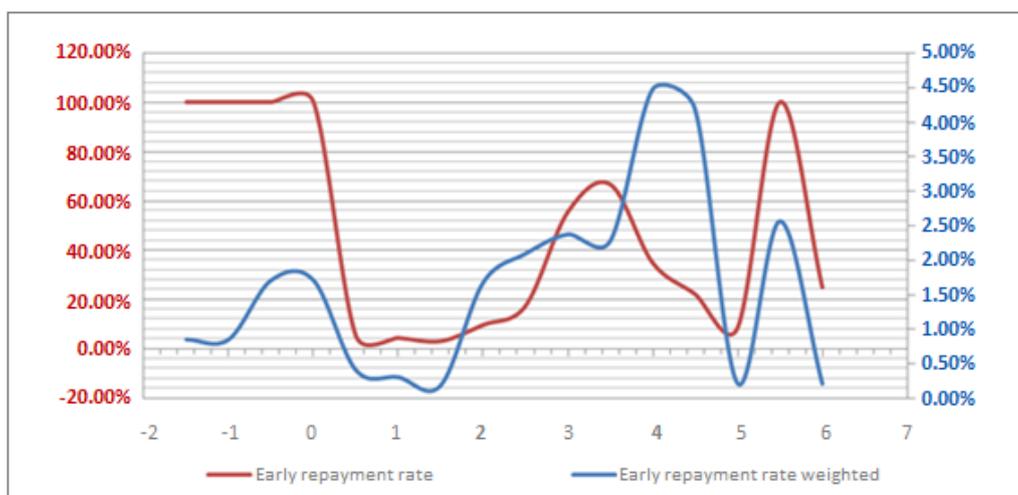


Figure 6. Influence of incentive to refinance the prepayment rates

This behavior of customers can be seen in the figure above, suggestive being early repayment rate weighted, where is also taken into consideration the proportion of reimbursement for that respective value of the index compared with the total.

It is evident within 2-4 pp increase reimbursements to values lower than 2, their rate fluctuating around small values. We can deduce from this graph that a client consider early repayment of its loan when refinancing incentive amount is more than 2 percentage points perhaps to a lower value of this indicator refinancing costs exceed the favorable interest rate difference, reimbursement being not optimal. However, reimbursements are not always optimal from the point of view, so we see positive values also for a negative incentive to refinance.

4. Conclusions

Risk analysis is useful for early repayment of any credit institution, as better management of this risk may result in an increased efficiency of available funds, the development of competitive and flexible products within the banking market, sound budgeting targets for credit sales and a proper allocation of resources accordingly.

By using an econometric model, we can help improvement loan portfolios held, so to minimize the risk of early repayment of credit record. As a result, better risk management can be achieved by managing variables with significant impact on loan portfolio and on early repayment.

Note

- ⁽¹⁾ The survival function describes the probability as an aleator variable to get bigger values than a given x rate (Evans et al , 2000, pp. 6).

References

- Consalvi, M., Scotto di Freca, G. (2010). "Measuring prepayment risk: an application to UniCredit Family Financing", *Working Paper Series, UniCredit&Universities*, no. 5
- Cox, D.R. (1972). "Regression Models and Life-Tables", *Journal of the Royal Statistical Society, Series B (Methodological)*, 34(2)
- Dedu, V. (2011). "Politica monetară și piața imobiliară", *Economie teoretică și aplicată*, XVIII (12), pp. 3-12
- Evans, M., Hastings, N., Peacock, B. (2000). *Statistical Distributions*, 3rd ed. New York: Wiley, p. 13
- Green, J., Shoven, J.B. (1986). „The Effects of Interest Rates on Mortgage Prepayments”, *Journal of Money, Credit and Banking*, 18 (1), pp. 41-59
- Jacobs, J.P.A.M., Koning, R.H., Sterken, E. (2005). *Modelling prepayment risk*, University of Groningen
- Schwartz, E.S., Torous, W.N. (1989). "Prepayment and the Valuation of Mortgage Backed Securities", *Journal of Finance*, 44 (5), pp. 375-392
- Stanhouse, B., Stock, D. (2007). *Managing the risk of loan prepayments and the optimal structure of short term lending rates*, Berlin: Springer-Verlag
- Stanton, R. (1995). "Rational Prepayment and the Valuation of Mortgage-Backed Securities", *The Review of Financial Studies*, 8 (3), pp. 677-708