**Robert H. Smith School of Business**

**University of Maryland**

**BUFN 747 Asset-Liability and Nonfinancial Risk Management**

**Spring 2023**

**Case Study 1: Estimating Mortgage Prepayment & Implications for Interest Rate** **Risk**

This is a team-based exercise. Using the fixed-rate mortgage loan level data set: Copy of test\_data\_final\_BUFN 747 Case Study 1.csv; estimate a prepayment model using a logistic regression specification. Use the variable; prepay, as your dependent variable. You may use whatever software (e.g., Python, SAS, R or other) you are comfortable for the analysis. Your team must provide a Word document of your own length along with any model output and Excel spreadsheet on the 4 mortgage product durations (not using your prepayment model for this part) you will calculate that adequately addresses the request for analysis below.

* Variables in the data are defined as follows:
  + loan\_id – unique loan identification number
  + **orig\_chn** – origination channel (Retail, Correspondent, Third Party Originator, Broker)
  + seller – originating lender
  + **orig\_rt** – origination note rate for the borrower
  + orig\_amt – loan origination amount in dollars
  + **orig\_trm** – origination term for the loan (e.g., 360 months)
  + **oltv** – origination loan amount to property value ratio
  + **ocltv** – origination combined LTV (1st lien mortgage plus and second lien mortgages)
  + **num\_bo** – numbers of borrowers for the mortgage
  + **dti** – debt-to-income ratio
  + **cscore\_b** – borrower credit score
  + **fthb\_flg** – first time homebuyer flag (1 = FTHB, 0 = not FTHB)
  + **purpose** – loan purpose – e.g., purchase, rate and term refinance, cashout refinance
  + **prop\_type** – property type – e.g., single family, condo, coop, manufactured housing MH, planned unit development (PUD)
  + **num\_unit** – number of units for the property – 1, 2, 3, 4
  + **occ\_stat** – occupancy status – e.g., owner-occupied, 2nd home, investor
  + state – state where the property is located
  + orig\_dte – origination date
  + orig\_val – origination property value
  + prepay – 1 = loan prepaid, 0 = not prepaid
  + **rela\_upb** = relative median unpaid principal balance (measured against where the property is located compared to other properties in the area)
  + **seller\_cat** – seller category (0 = other, 1 = bank, 2 = nonbank)
  + **servicer\_cat** – servicer category (0 = other, 1 = bank, 2 = nonbank)
  + **current\_ltv\_nsa** – current LTV not seasonally adjusted
  + **last\_dte** – last observed date for the loan

**Request for Analysis**

* Create a variable defined as INCENT (Borrower Note Rate – Market Rate) where Borrower Note Rate is orig\_rt from the loan data and Market Rate is the weekly Freddie Mac Primary Mortgage Market (PMMS) rate in the PMMS\_History.csv file. You will need to merge the loan level file in with the PMMS data. You can define the Market Rate as the PMMS rate with the closest weekly date to the last\_dte observed for the loan. Use the variable INCENT as an independent variable in your model.
* Estimate a logistic regression prepayment model using as candidate independent variables those noted in bold in the list above. Note – you will not want to include all variables, but rather a subset based on a model that results in variables that are statistically significant, carry the expected sign in predicting prepayment and have good overall model discriminatory power. You may need to iterate (testing different variable combinations) on the best model in terms of its ability to distinguish between loans that prepay from loans that do not (the c-statistic will be helpful here).
* Provide your hypothesis of how each of your variables affects prepayment and why it should be included in the model.
* Provide the model output including estimated coefficients, statistical significance for each independent variable. Provide your overall assessment of the model’s discriminatory power (i.e., ability to distinguish between prepay and no prepay loans) – you may provide an area under the curve C-statistic for this.
* What is your model’s overall predicted probability of prepayment for the sample? How does that compare to the actual prepayment percentage?
* Provide the odds ratios for each variable (odds ratios are defined as exp(b) where b is the variable’s estimated coefficient. (see p. 158 of the textbook for an interpretation).
* Are all of your variables consistent with your priors in terms of effect on prepayment?
* Assume that Market Rate declines by 1%. What impact on your model’s probability of prepayment would that have?

Apart from your prepayment modeling above, please answer provide the durations for the following mortgage products:

The CEO and Executive Committee of SIFI Bank has been struggling to pursue a strategy that would promote the long-term viability of the bank while managing its risk consistent to the Board-approved risk appetite statement. Recently, at a bank product committee meeting, the head of the mortgage division presented a product proposal designed to increase assets by 10% in the next 12 months. After considerable analysis and market assessment, her team came up with 4 potential mortgage products. The products were described as follows:

* Product 1 – prime adjustable-rate mortgages (ARMs) with a target weighted average loan-to-value (LTV) for the product of 85% and this product would be held on the balance sheet and not be sold.
* Product 2 – prime fixed-rate mortgages with a target weighted average LTV of 90%. SIFI Bank would sell all of these loans to Fannie Mae and receive a mortgage-backed security (MBS). This asset would remain on balance sheet but would be available for sale.
* Product 3 – prime fixed-rate mortgages with a target weighted LTV of 70% would be held on balance sheet and not be sold.
* Product 4 – subprime ARMs with a target weighted average LTV of 92% and these loans would be held on balance sheet and not be sold.

Additional details regarding each of the 4 proposed products is as follows. The origination volume for your analysis is $100 million for each product. The term for each product is 10 years and payments are made annually. The rates (in percent) for each product are shown in Table 1.

Note that Product 1 is an ARM that is priced at the 5-year US Treasury rate plus 75 basis points. The forward curve for UST5 (in percent) to be used in your analysis is presented in Table 2.

Moreover, the annual prepayment rates are as follows for each product; Product 1 = 5%; Product 2 = 10%; Product 3 = 2.5%; Product 4 = 0%. Prepayments occur annually for the life of the loans and are applied against the remaining balance of the loans.

| Table 1 |  |
| --- | --- |
| Product | Coupon (%) |
| Product 1 | UST5+ 75 |
| Product 2 | 4 |
| Product 3 | 4.25 |
| Product 4 | 8 |
|  |  |
| Table 2 |  |
| Year | UST 5 |
| 1 | 2.55 |
| 2 | 2.75 |
| 3 | 2.85 |
| 4 | 2.90 |
| 5 | 3.10 |
| 6 | 3.00 |
| 7 | 2.90 |
| 8 | 2.80 |
| 9 | 2.75 |
| 10 | 2.80 |

The US Treasury curve is shown below that may be used for constructing discount rates



**Due Date: Monday 2/13**