Lending Mortage Analysis - Modeling

Exploratory Data Analysis

Marjorie Blanco, Joe Thompson, Haodi Tu

Data Discription

The data set includes the following variables:

- APPROVE = 1 if mortgage loan was approved, = 0 otherwise
- GDLIN = 1 if credit history meets guidelines, = 0 otherwise
- LOANPRC = loan amount/purchase price
- OBRAT = other obligations as a percent of total income
- MALE = 1 if male, = 0 otherwise
- MARRIED = 1 if married, = 0 otherwise
- BLACK = 1 if black, = 0 otherwise
- HISPAN = 1 if Hispanic, = 0 otherwise

Logistic Model

$$log(p/1-p) = \beta_0 + \beta_1 * GDLIN + \beta_2 * OBRAT + \beta_3 * BLACK + \beta_4 * HISPAN + \beta_5 * LOANPRC$$

```
## 'log Lik.' -451.2615 (df=6)
```

```
##
## Logistic Regression
## ===============================================
##                         Dependent variable:
##                     ---------------------------
##                                APPROVE
## -----------------------------------------------
## GDLIN1                        3.737***
##                                (0.221)
##
## OBRAT                         -0.031***
##                                (0.011)
##
## BLACK1                        -0.917***
##                                (0.246)
##
## HISPAN1                       -0.827**
##                                (0.324)
##
## LOANPRC                       -0.017**
##                                (0.007)
##
## Constant                       1.533**
##                                (0.699)
##
## -----------------------------------------------
## Observations                    1,888
## Log Likelihood                -451.261
```

```
## Akaike Inf. Crit.           914.523
## ================================================
## Note:             *p<0.1; **p<0.05; ***p<0.01

##
## Odds Ratio
## ================================================
##                        Dependent variable:
##                    ----------------------------
##                              APPROVE
## ------------------------------------------------
## GDLIN1                      41.961***
##                              (0.221)
##
## OBRAT                       0.969***
##                              (0.011)
##
## BLACK1                       0.400
##                              (0.246)
##
## HISPAN1                      0.438
##                              (0.324)
##
## LOANPRC                     0.983***
##                              (0.007)
##
## Constant                    4.631***
##                              (0.699)
##
## ------------------------------------------------
## Observations                  1,888
## Log Likelihood              -451.261
## Akaike Inf. Crit.            914.523
## ================================================
## Note:             *p<0.1; **p<0.05; ***p<0.01
```

For every one unit change in `OBRAT`, the log odds of loan approval (versus non loan approval) decreases by 0.0312188.

For every one unit change in `LOANPRC`, the log odds of loan approval (versus non loan approval) decreases by 0.0167011.

The log odds of loan approval for applicants that meet credit guidelines increases by 3.7367457.

The log odds of loan approval for Black applicants decreases by 0.9171449.

The log odds of loan approval for Hispanic applicants decreases by 0.8266367.

For example, for a black person whose credit history meets guidline (GDLIN = 1), loan amount price is 100 (LOANPRC = 100) and other obligations as a percent of total income is none (OBRAT = 0), the log odds of loan approval is 93.6%

CIs using profiled log-likelihood

```
##                    2.5 %       97.5 %
## (Intercept)  0.19416207  2.937219042
## GDLIN1       3.31229466  4.182112724
## OBRAT       -0.05333480 -0.009301146
```

```
## BLACK1      -1.39135036 -0.426283068
## HISPAN1     -1.43764172 -0.165924717
## LOANPRC     -0.03156216 -0.002916465
```

CIs using standard errors

```
##                   2.5 %       97.5 %
## (Intercept)  0.16272694  2.902760759
## GDLIN1       3.30270694  4.170784503
## OBRAT       -0.05325850 -0.009179045
## BLACK1      -1.39893109 -0.435358718
## HISPAN1     -1.46068910 -0.192584237
## LOANPRC     -0.03101509 -0.002387147
```

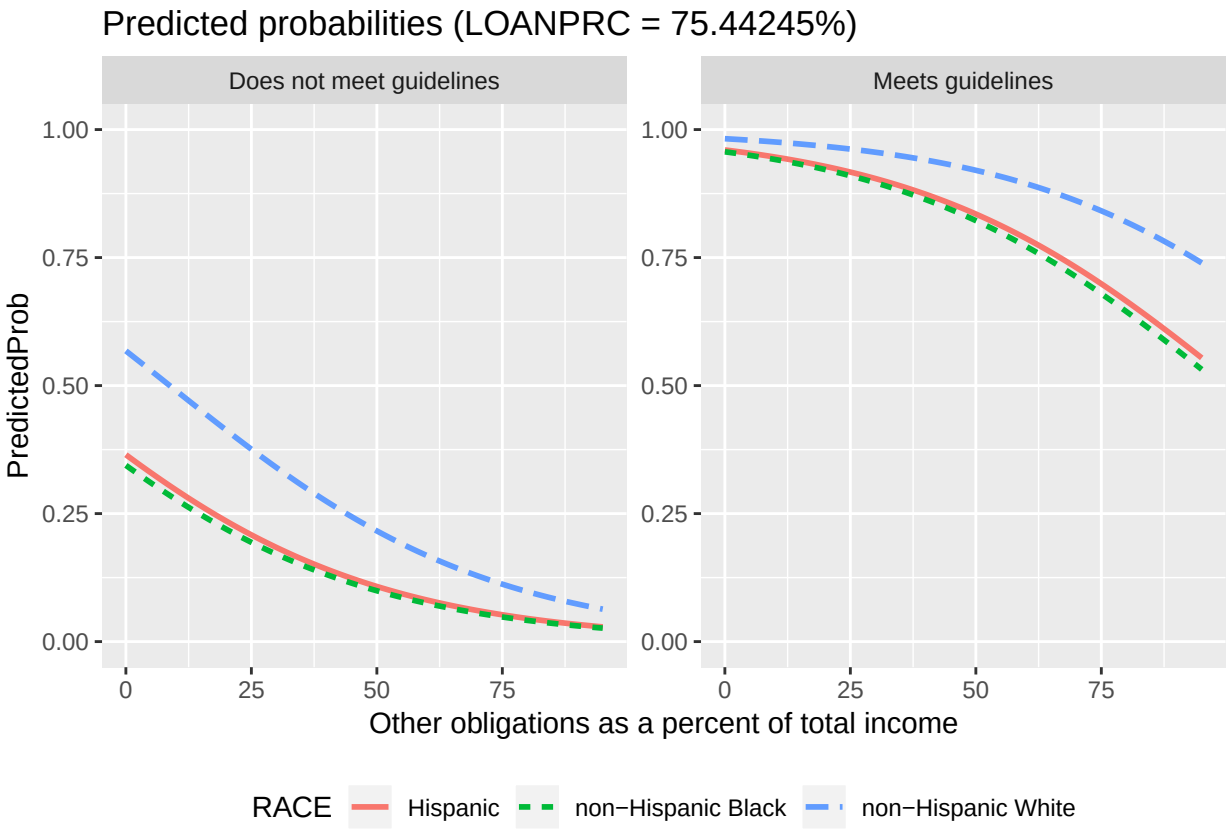
Odds ratios only

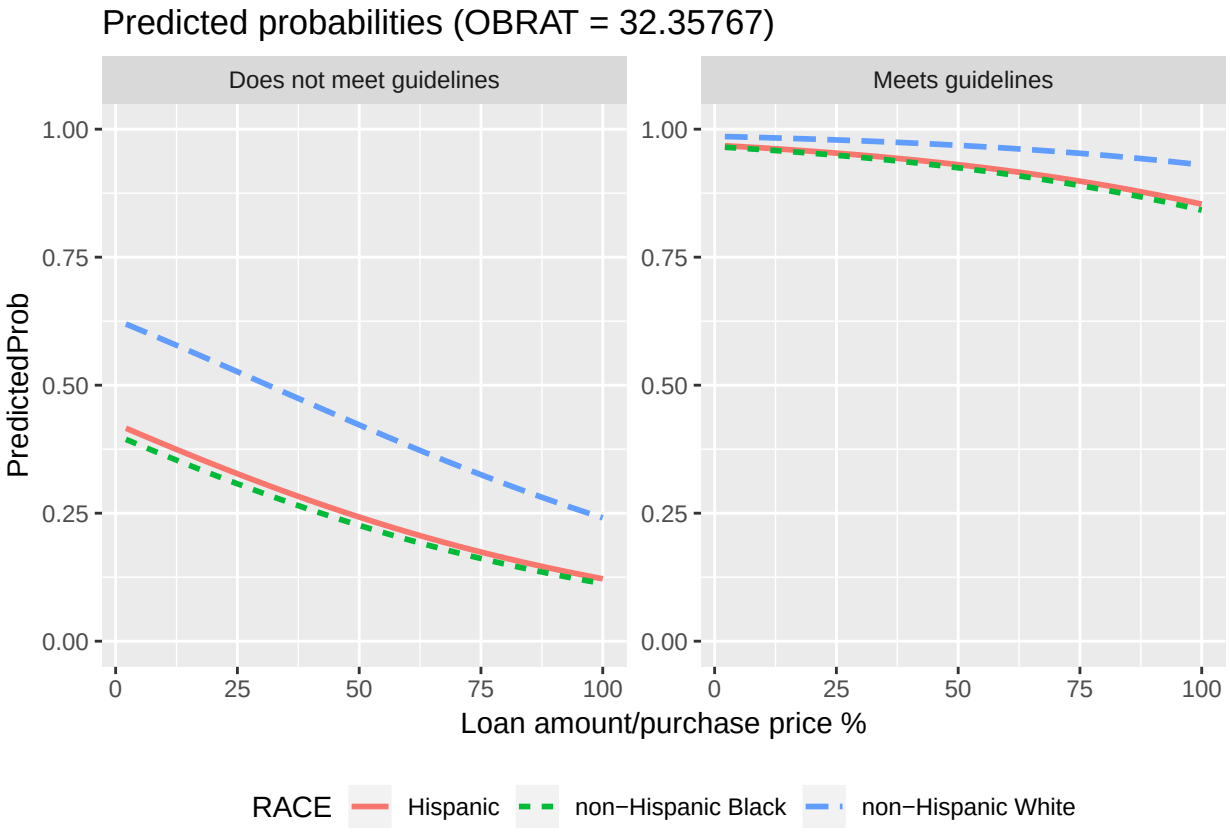
```
## (Intercept)      GDLIN1       OBRAT      BLACK1     HISPAN1     LOANPRC
##   4.6308658  41.9612143   0.9692635   0.3996585   0.4375183   0.9834376
```

Odds ratios and 95% CI

```
##                     OR      2.5 %     97.5 %
## (Intercept)  4.6308658  1.2142931 18.8633152
## GDLIN1      41.9612143 27.4480373 65.5040992
## OBRAT        0.9692635  0.9480625  0.9907420
## BLACK1       0.3996585  0.2487392  0.6529315
## HISPAN1      0.4375183  0.2374872  0.8471100
## LOANPRC      0.9834376  0.9689307  0.9970878
```

GDLIN	OBRAT	BLACK	HISPAN	LOANPRC	fit	PredictedProb
0	32.35767	1	0	75.44245	-1.6545412	0.1604961
1	32.35767	1	0	75.44245	2.0822046	0.8891615
0	32.35767	0	1	75.44245	-1.5640329	0.1730687
1	32.35767	0	1	75.44245	2.1727128	0.8977722
0	32.35767	0	0	75.44245	-0.7373963	0.3235738
1	32.35767	0	0	75.44245	2.9993495	0.9525447


Predicted probabilities (LOANPRC = 75.44245%)
Does not meet guidelines
Meets guidelines
PredictedProb
1.00
0.75
0.50
0.25
0.00
0
25
50
75
Other obligations as a percent of total income
RACE
Hispanic
non−Hispanic Black
non−Hispanic White


Predicted probabilities (OBRAT = 32.35767)
Does not meet guidelines
Meets guidelines
PredictedProb
1.00
0.75
0.50
0.25
0.00
0
25
50
75
100
Loan amount/purchase price %
RACE
Hispanic
non−Hispanic Black
non−Hispanic White

Probit Model

$$Probit(approve) = \beta_0 + \beta_1 * GDLIN + \beta_2 * OBRAT + \beta_3 * BLACK + \beta_4 * HISPAN + \beta_5 * LOANPRC$$

```
##
## Call:
## glm(formula = APPROVE ~ GDLIN + OBRAT + BLACK + HISPAN + LOANPRC,
##     family = binomial(link = "probit"), data = data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.8688   0.2496   0.3144   0.3604   2.1669
##
## Coefficients:
##              Estimate Std. Error z value             Pr(>|z|)
## (Intercept)  0.583275   0.341346   1.709             0.087497 .
## GDLIN1       2.161541   0.124153  17.410 < 0.0000000000000002 ***
## OBRAT       -0.014974   0.005721  -2.617             0.008858 **
## BLACK1      -0.473416   0.129376  -3.659             0.000253 ***
## HISPAN1     -0.422091   0.168680  -2.502             0.012338 *
## LOANPRC     -0.007808   0.003404  -2.294             0.021781 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1391.24  on 1887  degrees of freedom
## Residual deviance:  902.36  on 1882  degrees of freedom
## AIC: 914.36
##
## Number of Fisher Scoring iterations: 6

## 'log Lik.' -451.1823 (df=6)

##
## Probit Regression
## ================================================
##                         Dependent variable:
##                     ---------------------------
##                                APPROVE
## ------------------------------------------------
## GDLIN1                        2.162***
##                                (0.124)
##
## OBRAT                         -0.015***
##                                (0.006)
##
## BLACK1                        -0.473***
##                                (0.129)
##
## HISPAN1                       -0.422**
##                                (0.169)
##
## LOANPRC                       -0.008**
##                                (0.003)
##
```

```
## Constant                    0.583*
##                             (0.341)
##
## ------------------------------------------
## Observations                 1,888
## Log Likelihood             -451.182
## Akaike Inf. Crit.           914.365
## ==========================================
## Note:             *p<0.1; **p<0.05; ***p<0.01
```

For every one unit change in `OBRAT`, the probit odds of loan approval (versus non loan approval) decreases by 0.0149739.

For every one unit change in `LOANPRC`, the probit odds of loan approval (versus non loan approval) decreases by 0.0078082.

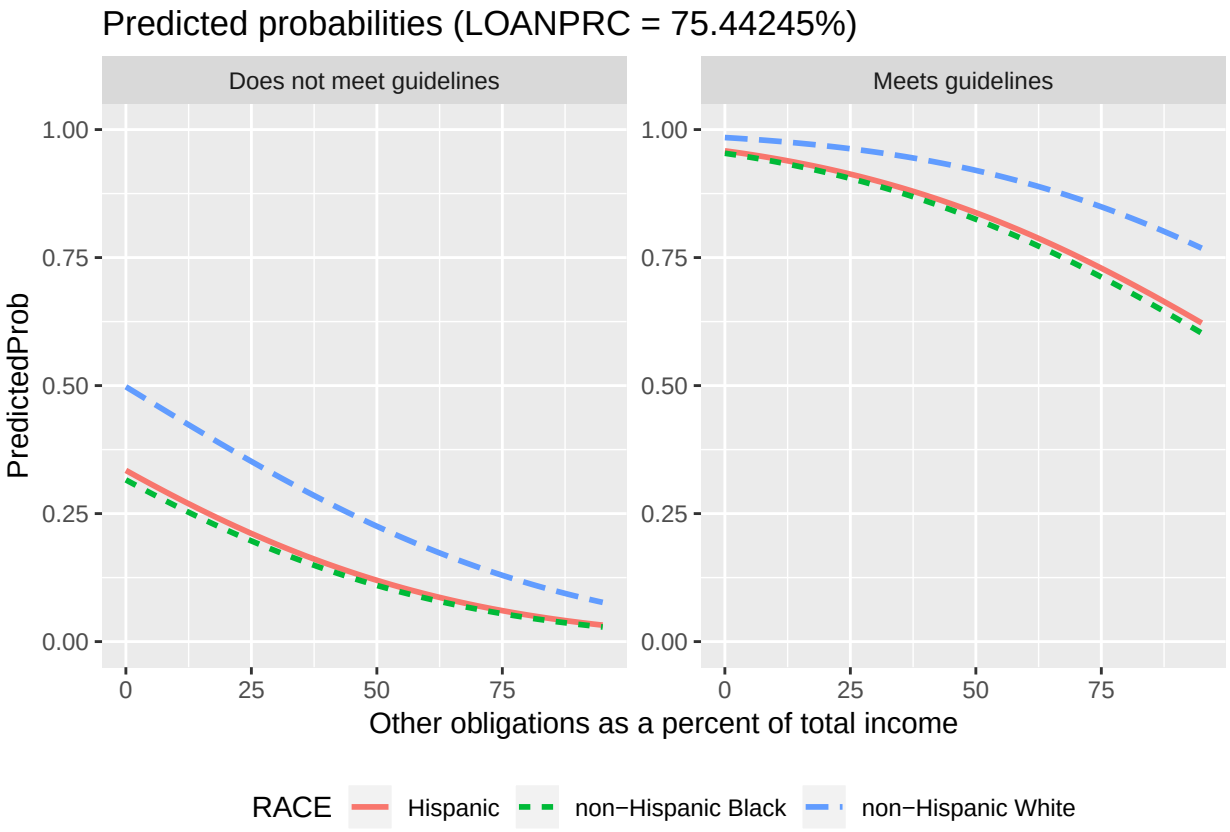
The probit odds of loan approval for applicants that meet credit guidelines increases by 2.1615407.

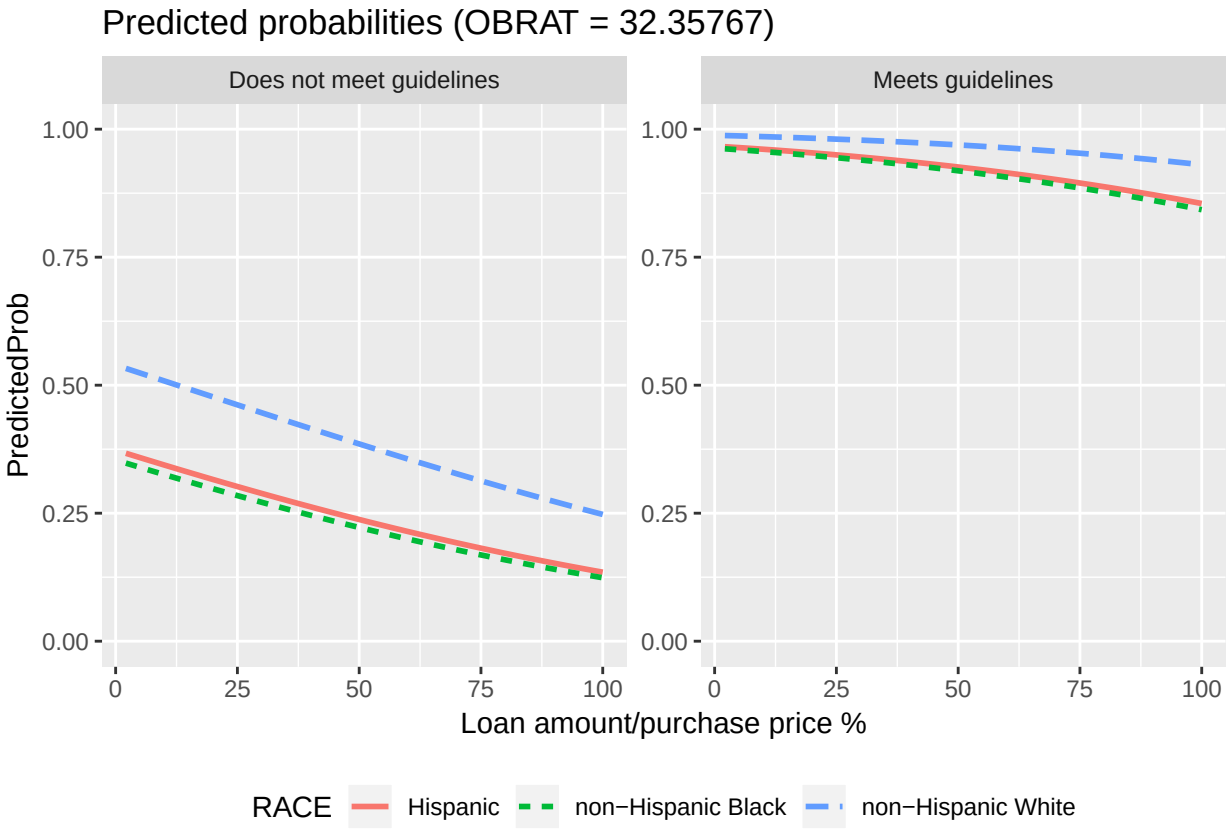
The probit odds of loan approval for Black applicants decreases by 0.4734163.

The probit odds of loan approval for Hispanic applicants decreases by 0.4220909.

For example, for a black person whose credit history meets guidline (GDLIN = 1), loan amount price is 100 (LOANPRC = 100) and other obligations as a percent of total income is none (OBRAT = 0), the probit odds of loan approval is 93.2%

GDLIN	OBRAT	BLACK	HISPAN	LOANPRC	fit	fit
0	32.35767	1	0	75.44245	-0.9637321	0.1675901
1	32.35767	1	0	75.44245	1.1978087	0.8845042
0	32.35767	0	1	75.44245	-0.9124067	0.1807773
1	32.35767	0	1	75.44245	1.2491340	0.8941920
0	32.35767	0	0	75.44245	-0.4903158	0.3119552
1	32.35767	0	0	75.44245	1.6712249	0.9526614


Predicted probabilities (LOANPRC = 75.44245%)
Does not meet guidelines
Meets guidelines
PredictedProb
1.00
0.75
0.50
0.25
0.00
0
25
50
75
Other obligations as a percent of total income
RACE
Hispanic
non−Hispanic Black
non−Hispanic White


Predicted probabilities (OBRAT = 32.35767)
Does not meet guidelines
Meets guidelines
PredictedProb
1.00
0.75
0.50
0.25
0.00
0
25
50
75
100
Loan amount/purchase price %
RACE
Hispanic
non−Hispanic Black
non−Hispanic White

Probablities Comparison

GDLIN	OBRAT	BLACK	HISPAN	LOANPRC	LogitProb	ProbitProb
0	32.35767	1	0	75.44245	0.1604961	0.1675901
1	32.35767	1	0	75.44245	0.8891615	0.8845042
0	32.35767	0	1	75.44245	0.1730687	0.1807773
1	32.35767	0	1	75.44245	0.8977722	0.8941920
0	32.35767	0	0	75.44245	0.3235738	0.3119552
1	32.35767	0	0	75.44245	0.9525447	0.9526614