**Assignment 5**

**C2. (i)**

**Probit regression**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| approve | Coef. | | St.Err. | t-value | | p-value | [95% Conf | | Interval] | Sig |
| white | 0.784 | | 0.087 | 9.04 | | 0.000 | 0.614 | | 0.954 | \*\*\* |
| Constant | 0.547 | | 0.075 | 7.25 | | 0.000 | 0.399 | | 0.695 | \*\*\* |
|  | | | | | | | | | | |
| Mean dependent var | | 0.877 | | | SD dependent var | | | 0.328 | |
| Pseudo r-squared | | 0.053 | | | Number of obs | | | 1989.000 | |
| Chi-square | | 78.938 | | | Prob > chi2 | | | 0.000 | |
| Akaike crit. (AIC) | | 1405.755 | | | Bayesian crit. (BIC) | | | 1416.946 | |
|  | | | | | | | | | | |
| *\*\*\* p<0.01, \*\* p<0.05, \* p<0.1* | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| variable | dy/dx | Std.Err. | z | P>z | [ | 95% | C.I. | ] | X |
| white\* | 0.201 | 0.027 | 7.470 | 0.000 | 0.148 | 0.253 | 0.845 |
|  | | | | | | | |

**Marginal effects after probit**  
 y = Pr(approve) (predict)  
 = .8867641

(\*) dy/dx is for discrete change of dummy variable from 0 to 1  
 **Linear regression**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| approve | Coef. | | St.Err. | t-value | | p-value | [95% Conf | | Interval] | Sig |
| white | 0.201 | | 0.020 | 10.11 | | 0.000 | 0.162 | | 0.240 | \*\*\* |
| Constant | 0.708 | | 0.018 | 38.81 | | 0.000 | 0.672 | | 0.744 | \*\*\* |
|  | | | | | | | | | | |
| Mean dependent var | | 0.877 | | | SD dependent var | | | 0.328 | |
| R-squared | | 0.049 | | | Number of obs | | | 1989.000 | |
| F-test | | 102.226 | | | Prob > F | | | 0.000 | |
| Akaike crit. (AIC) | | 1115.081 | | | Bayesian crit. (BIC) | | | 1126.272 | |
|  | | | | | | | | | | |
| *\*\*\* p<0.01, \*\* p<0.05, \* p<0.1* | | | | | | | | | |

For the probit model, when **white=1**, the estimated probability of loan approval for white is equal to:

when **white=0,** the estimated probability of loan approval for white is equal to:

For the linear regression model, when white=1, the estimated probability of loan approval for white is equal to 0.201+0.708\*1=0.909, when white=0, the estimated probability of loan approval for white is 0.708, which are same with the result of probit model. In addition, the variable**,** white, has a significant effect on the probability of loan approval both in the probit model and linear regression model. The marginal effect of probit model is also same with linear regression model.

**(ii)**

**Probit regression**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| approve | Coef. | | St.Err. | t-value | | p-value | [95% Conf | | Interval] | Sig |
| white | 0.520 | | 0.097 | 5.37 | | 0.000 | 0.330 | | 0.710 | \*\*\* |
| hrat | 0.008 | | 0.007 | 1.13 | | 0.258 | -0.006 | | 0.022 |  |
| obrat | -0.028 | | 0.006 | -4.58 | | 0.000 | -0.040 | | -0.016 | \*\*\* |
| loanprc | -1.012 | | 0.237 | -4.27 | | 0.000 | -1.477 | | -0.547 | \*\*\* |
| unem | -0.037 | | 0.017 | -2.10 | | 0.036 | -0.071 | | -0.002 | \*\* |
| male | -0.037 | | 0.110 | -0.34 | | 0.736 | -0.252 | | 0.178 |  |
| married | 0.266 | | 0.094 | 2.82 | | 0.005 | 0.081 | | 0.450 | \*\*\* |
| dep | -0.050 | | 0.039 | -1.27 | | 0.204 | -0.126 | | 0.027 |  |
| sch | 0.015 | | 0.096 | 0.15 | | 0.879 | -0.173 | | 0.202 |  |
| cosign | 0.086 | | 0.246 | 0.35 | | 0.726 | -0.396 | | 0.568 |  |
| chist | 0.585 | | 0.096 | 6.10 | | 0.000 | 0.397 | | 0.773 | \*\*\* |
| pubrec | -0.779 | | 0.126 | -6.17 | | 0.000 | -1.026 | | -0.531 | \*\*\* |
| mortlat1 | -0.188 | | 0.253 | -0.74 | | 0.459 | -0.684 | | 0.308 |  |
| mortlat2 | -0.494 | | 0.327 | -1.51 | | 0.130 | -1.134 | | 0.146 |  |
| vr | -0.201 | | 0.081 | -2.47 | | 0.014 | -0.361 | | -0.041 | \*\* |
| Constant | 2.062 | | 0.313 | 6.58 | | 0.000 | 1.449 | | 2.676 | \*\*\* |
|  | | | | | | | | | | |
| Mean dependent var | | 0.876 | | | SD dependent var | | | 0.329 | |
| Pseudo r-squared | | 0.187 | | | Number of obs | | | 1971.000 | |
| Chi-square | | 275.417 | | | Prob > chi2 | | | 0.000 | |
| Akaike crit. (AIC) | | 1232.542 | | | Bayesian crit. (BIC) | | | 1321.923 | |
|  | | | | | | | | | | |
| *\*\*\* p<0.01, \*\* p<0.05, \* p<0.1* | | | | | | | | | |

Based on the estimated result, the coefficient of white, is equal to 0.52, and it still has a significant effect on the probability of loan approval at 1% level, therefore there is statistically significant evidence of discrimination against nonwhites.

**(iii)**

**Logistic regression**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| approve | Coef. | | St.Err. | t-value | | p-value | [95% Conf | | Interval] | Sig |
| white | 0.938 | | 0.173 | 5.42 | | 0.000 | 0.599 | | 1.277 | \*\*\* |
| hrat | 0.013 | | 0.013 | 1.03 | | 0.303 | -0.012 | | 0.039 |  |
| obrat | -0.053 | | 0.011 | -4.70 | | 0.000 | -0.075 | | -0.031 | \*\*\* |
| loanprc | -1.905 | | 0.460 | -4.14 | | 0.000 | -2.807 | | -1.002 | \*\*\* |
| unem | -0.067 | | 0.033 | -2.03 | | 0.042 | -0.131 | | -0.002 | \*\* |
| male | -0.066 | | 0.206 | -0.32 | | 0.748 | -0.471 | | 0.338 |  |
| married | 0.503 | | 0.178 | 2.83 | | 0.005 | 0.154 | | 0.852 | \*\*\* |
| dep | -0.091 | | 0.073 | -1.24 | | 0.216 | -0.234 | | 0.053 |  |
| sch | 0.041 | | 0.178 | 0.23 | | 0.817 | -0.308 | | 0.391 |  |
| cosign | 0.132 | | 0.446 | 0.30 | | 0.767 | -0.742 | | 1.006 |  |
| chist | 1.067 | | 0.171 | 6.23 | | 0.000 | 0.731 | | 1.402 | \*\*\* |
| pubrec | -1.341 | | 0.217 | -6.17 | | 0.000 | -1.767 | | -0.915 | \*\*\* |
| mortlat1 | -0.310 | | 0.464 | -0.67 | | 0.504 | -1.218 | | 0.599 |  |
| mortlat2 | -0.895 | | 0.569 | -1.57 | | 0.116 | -2.009 | | 0.220 |  |
| vr | -0.350 | | 0.154 | -2.28 | | 0.023 | -0.651 | | -0.049 | \*\* |
| Constant | 3.802 | | 0.595 | 6.39 | | 0.000 | 2.636 | | 4.967 | \*\*\* |
|  | | | | | | | | | | |
| Mean dependent var | | 0.876 | | | SD dependent var | | | 0.329 | |
| Pseudo r-squared | | 0.186 | | | Number of obs | | | 1971.000 | |
| Chi-square | | 274.966 | | | Prob > chi2 | | | 0.000 | |
| Akaike crit. (AIC) | | 1232.992 | | | Bayesian crit. (BIC) | | | 1322.373 | |
|  | | | | | | | | | | |
| *\*\*\* p<0.01, \*\* p<0.05, \* p<0.1* | | | | | | | | | |

The coefficient of white is 0.938, which is significant at 1% level in the logit model. In the probit model, the coefficient of white is 0.520, also has a significant effect of the probability of loan approval.

(iv)

**Marginal effects after probit**  
 y = Pr(approve) (predict)  
 = .92290033

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| variable | dy/dx | Std.Err. | z | P>z | [ | 95% | C.I. | ] | X |
| white\* | 0.106 | 0.024 | 4.430 | 0.000 | 0.059 | 0.153 | 1 |
| hrat | 0.001 | 0.001 | 1.130 | 0.259 | -0.001 | 0.003 | 24.800 |
| obrat | -0.004 | 0.001 | -4.510 | 0.000 | -0.006 | -0.002 | 32.390 |
| loanprc | -0.146 | 0.034 | -4.250 | 0.000 | -0.214 | -0.079 | 0.770 |
| unem | -0.005 | 0.003 | -2.100 | 0.036 | -0.010 | -0.000 | 3.889 |
| male\* | -0.005 | 0.015 | -0.340 | 0.732 | -0.035 | 0.025 | 0.813 |
| married\* | 0.041 | 0.015 | 2.660 | 0.008 | 0.011 | 0.071 | 0.660 |
| dep | -0.007 | 0.006 | -1.270 | 0.205 | -0.018 | 0.004 | 0.772 |
| sch\* | 0.002 | 0.014 | 0.150 | 0.879 | -0.025 | 0.030 | 0.770 |
| cosign\* | 0.012 | 0.032 | 0.370 | 0.710 | -0.050 | 0.074 | 0.029 |
| chist\* | 0.111 | 0.023 | 4.870 | 0.000 | 0.066 | 0.155 | 0.837 |
| pubrec\* | -0.172 | 0.038 | -4.480 | 0.000 | -0.248 | -0.097 | 0.068 |
| mortlat1\* | -0.031 | 0.047 | -0.660 | 0.509 | -0.122 | 0.061 | 0.019 |
| mortlat2\* | -0.098 | 0.084 | -1.180 | 0.240 | -0.262 | 0.066 | 0.011 |
| vr\* | -0.030 | 0.012 | -2.390 | 0.017 | -0.054 | -0.005 | 0.408 |
|  | | | | | | | |

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

**Marginal effects after logit**  
 y = Pr(approve) (predict)  
 = .924884

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| variable | dy/dx | Std.Err. | z | P>z | [ | 95% | C.I. | ] | X |
| white\* | 0.097 | 0.022 | 4.300 | 0.000 | 0.053 | 0.141 | 1 |
| hrat | 0.001 | 0.001 | 1.030 | 0.304 | -0.001 | 0.003 | 24.800 |
| obrat | -0.004 | 0.001 | -4.640 | 0.000 | -0.005 | -0.002 | 32.390 |
| loanprc | -0.132 | 0.032 | -4.140 | 0.000 | -0.195 | -0.070 | 0.770 |
| unem | -0.005 | 0.002 | -2.030 | 0.042 | -0.009 | -0.000 | 3.889 |
| male\* | -0.005 | 0.014 | -0.330 | 0.743 | -0.032 | 0.023 | 0.813 |
| married\* | 0.038 | 0.014 | 2.640 | 0.008 | 0.010 | 0.066 | 0.660 |
| dep | -0.006 | 0.005 | -1.240 | 0.216 | -0.016 | 0.004 | 0.772 |
| sch\* | 0.003 | 0.013 | 0.230 | 0.819 | -0.022 | 0.028 | 0.770 |
| cosign\* | 0.009 | 0.028 | 0.310 | 0.755 | -0.046 | 0.063 | 0.029 |
| chist\* | 0.102 | 0.021 | 4.760 | 0.000 | 0.060 | 0.143 | 0.837 |
| pubrec\* | -0.152 | 0.036 | -4.180 | 0.000 | -0.223 | -0.081 | 0.068 |
| mortlat1\* | -0.024 | 0.041 | -0.590 | 0.554 | -0.105 | 0.056 | 0.019 |
| mortlat2\* | -0.090 | 0.078 | -1.160 | 0.247 | -0.242 | 0.062 | 0.011 |
| vr\* | -0.025 | 0.011 | -2.200 | 0.028 | -0.047 | -0.003 | 0.408 |
|  | | | | | | | |

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

Based on equation and the estimated results with Stata, the partial effect of white on the probability of loan approval is 0.097 in the logit model, and 0.106 in the probit model, which are very similar. Therefore, the sizes of the discrimination on white for probit and logit is almost the same.