

Model with Discrete Dependent Variables

Probit & Logit Model

The Model

$$I_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \beta_5 x_{5i} + \varepsilon_i$$

$$P(y_i = 1 | X) = G(I_i)$$

where

$Y_i = 1$ for the firm that paid dividend and $Y_i = 0$ otherwise

x_{1i} = Retained earning to total equity

x_{2i} = Total equity to total asset

x_{3i} = Return on asset

x_{4i} = Ratio of change in revenue last year to last year total revenue

x_{5i} = Percentile of firm in full distribution of market cap in each year

MLE Estimation

```
. logit y x1 x2 x3 x4 x5
```

```
Iteration 0:   log likelihood = -1291.7938
Iteration 1:   log likelihood = -1081.5633
Iteration 2:   log likelihood = -1050.3539
Iteration 3:   log likelihood = -825.33434
Iteration 4:   log likelihood = -758.05835
Iteration 5:   log likelihood = -757.50042
Iteration 6:   log likelihood = -757.49946
Iteration 7:   log likelihood = -757.49946
```

```
Logistic regression               Number of obs   =       1888
                                LR chi2(5)          =      1068.59
                                Prob > chi2           =       0.0000
Log likelihood = -757.49946       Pseudo R2        =       0.4136
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
x1	5.621999	.3310812	16.98	0.000	4.973092 6.270907
x2	1.251322	.3039485	4.12	0.000	.6555939 1.84705
x3	4.945624	1.12468	4.40	0.000	2.741291 7.149957
x4	.3587824	.1571327	2.28	0.022	.0508079 .666757
x5	.7966562	.239171	3.33	0.001	.3278896 1.265423
_cons	-1.796861	.2263828	-7.94	0.000	-2.240563 -1.353159

Note: 69 failures and 0 successes completely determined.

```
. logit y, nolog
```

```
Logistic regression               Number of obs   =       1888
                                LR chi2(0)          =       -0.00
                                Prob > chi2           =       .
Log likelihood = -1291.7938       Pseudo R2        =      -0.0000
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
_cons	.2685516	.0464443	5.78	0.000	.1775224 .3595808

```
. logit y x1 x2 x3 x4 x5, nolog
```

```
Logistic regression                                Number of obs   =      1888
                                                    LR chi2(5)      =     1068.59
                                                    Prob > chi2     =      0.0000
Log likelihood = -757.49946                        Pseudo R2       =      0.4136
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	5.621999	.3310812	16.98	0.000	4.973092	6.270907
x2	1.251322	.3039485	4.12	0.000	.6555939	1.84705
x3	4.945624	1.12468	4.40	0.000	2.741291	7.149957
x4	.3587824	.1571327	2.28	0.022	.0508079	.666757
x5	.7966562	.239171	3.33	0.001	.3278896	1.265423
_cons	-1.796861	.2263828	-7.94	0.000	-2.240563	-1.353159

Note: 69 failures and 0 successes completely determined.

Marginal Effects

```
. mfx
```

```
Marginal effects after logit
y = Pr(y) (predict)
= .01656286
```

variable	dy/dx	Std. Err.	z	P> z	[95% C.I.]		x
x1	.0915741	.01924	4.76	0.000	.053867	.129281	-.638752
x2	.0203822	.00739	2.76	0.006	.005895	.034869	.468602
x3	.080557	.02952	2.73	0.006	.02269	.138424	.050715
x4	.005844	.00292	2.00	0.046	.000112	.011576	.140109
x5	.0129764	.00516	2.52	0.012	.002869	.023083	.522908

```
. sum x1 x2 x3 x4 x5
```

Variable	Obs	Mean	Std. Dev.	Min	Max
x1	1888	-.6387522	10.75936	-335.5922	.9919
x2	1888	.4686022	.2384942	.0008	.9736
x3	1888	.0507147	.0842626	-.838584	.477435
x4	1888	.140109	.7137989	-1.7647	19.1005
x5	1888	.5229084	.2882922	.008	1

```
. mfx, at(median)
```

```
Marginal effects after logit
y = Pr(y) (predict)
= .62470056
```

variable	dy/dx	Std. Err.	z	P> z	[95% C.I.]		x
x1	1.318076	.07849	16.79	0.000	1.16424	1.47191	.19165
x2	.2933722	.07218	4.06	0.000	.151902	.434842	.45625
x3	1.1595	.26399	4.39	0.000	.642097	1.6769	.044221
x4	.0841165	.03706	2.27	0.023	.01148	.156753	.06545
x5	.1867759	.05599	3.34	0.001	.077031	.29652	.522

```
. mfx, predict(xb)
```

```
Marginal effects after logit
y = Linear prediction (predict, xb)
= -4.0838907
```

variable	dy/dx	Std. Err.	z	P> z	[95% C.I.]		x
x1	5.621999	.33108	16.98	0.000	4.97309	6.27091	-.638752
x2	1.251322	.30395	4.12	0.000	.655594	1.84705	.468602
x3	4.945624	1.12468	4.40	0.000	2.74129	7.14996	.050715
x4	.3587824	.15713	2.28	0.022	.050808	.666757	.140109
x5	.7966562	.23917	3.33	0.001	.32789	1.26542	.522908

Statistical Indices

```
. fitstat
```

Measures of Fit for logit of y

Log-Lik Intercept Only:	-1291.794	Log-Lik Full Model:	-757.499
D(1882):	1514.999	LR(5):	1068.589
		Prob > LR:	0.000
McFadden's R2:	0.414	McFadden's Adj R2:	0.409
ML (Cox-Snell) R2:	0.432	Cragg-Uhler(Nagelkerke) R2:	0.580
McKelvey & Zavoina's R2:	0.999	Efron's R2:	0.490
Variance of y*:	3675.508	Variance of error:	3.290
Count R2:	0.827	Adj Count R2:	0.600
AIC:	0.809	AIC*n:	1526.999
BIC:	-12681.442	BIC':	-1030.872
BIC used by Stata:	1560.259	AIC used by Stata:	1526.999

```
. predict pr
```

```
(option pr assumed; Pr(y))
```

```
. g yhat=0 if pr<=0.5
```

```
(1185 missing values generated)
```

```
. replace yhat=1 if pr>0.5
```

```
(1185 real changes made)
```

```
. tabulate y yhat
```

y	yhat		Total
	0	1	
0	597	221	818
1	106	964	1,070
Total	703	1,185	1,888

```
. estat clas
```

Logistic model for y

Classified	True		Total
	D	~D	
+	964	221	1185
-	106	597	703
Total	1070	818	1888

Classified + if predicted $\Pr(D) \geq .5$

True D defined as $y \neq 0$

Sensitivity	$\Pr(+ D)$	90.09%
Specificity	$\Pr(- \sim D)$	72.98%
Positive predictive value	$\Pr(D +)$	81.35%
Negative predictive value	$\Pr(\sim D -)$	84.92%
False + rate for true ~D	$\Pr(+ \sim D)$	27.02%
False - rate for true D	$\Pr(- D)$	9.91%
False + rate for classified +	$\Pr(\sim D +)$	18.65%
False - rate for classified -	$\Pr(D -)$	15.08%
Correctly classified		82.68%

Probit Model

```
. probit y x1 x2 x3 x4 x5, nolog
```

```
Probit regression
```

Number of obs	=	1888
LR chi2(5)	=	1042.01
Prob > chi2	=	0.0000
Pseudo R2	=	0.4033

Log likelihood = -770.78852

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	2.991683	.1628704	18.37	0.000	2.672462	3.310903
x2	.6882851	.1742238	3.95	0.000	.3468128	1.029757
x3	2.600306	.5990625	4.34	0.000	1.426165	3.774446
x4	.1802702	.0649368	2.78	0.006	.0529964	.307544
x5	.4506521	.1374255	3.28	0.001	.1813031	.7200011
_cons	-.9700784	.1261652	-7.69	0.000	-1.217358	-.7227991

Note: 95 failures and 0 successes completely determined.

```
. mfx
```

```
Marginal effects after probit
y = Pr(y) (predict)
= .0151667
```

variable	dy/dx	Std. Err.	z	P> z	[95% C.I.]		x
x1	.1143775	.02894	3.95	0.000	.057651	.171104	-.638752
x2	.0263144	.01081	2.43	0.015	.005118	.047511	.468602
x3	.0994144	.04073	2.44	0.015	.019592	.179236	.050715
x4	.0068921	.00313	2.21	0.027	.000766	.013018	.140109
x5	.0172292	.00746	2.31	0.021	.002605	.031854	.522908

```
. fitstat
```

Measures of Fit for probit of y

Log-Lik Intercept Only:	-1291.794	Log-Lik Full Model:	-770.789
D(1882):	1541.577	LR(5):	1042.011
		Prob > LR:	0.000
McFadden's R2:	0.403	McFadden's Adj R2:	0.399
ML (Cox-Snell) R2:	0.424	Cragg-Uhler(Nagelkerke) R2:	0.569
McKelvey & Zavoina's R2:	0.999	Efron's R2:	0.483
Variance of y*:	1040.916	Variance of error:	1.000
Count R2:	0.826	Adj Count R2:	0.598
AIC:	0.823	AIC*n:	1553.577
BIC:	-12654.863	BIC':	-1004.294
BIC used by Stata:	1586.837	AIC used by Stata:	1553.577

```
. estat clas
```

Probit model for y

Classified	True		Total
	D	~D	
+	963	222	1185
-	107	596	703
Total	1070	818	1888

Classified + if predicted Pr(D) >= .5
True D defined as y != 0

Sensitivity	Pr(+ D)	90.00%
Specificity	Pr(- ~D)	72.86%
Positive predictive value	Pr(D +)	81.27%
Negative predictive value	Pr(~D -)	84.78%
False + rate for true ~D	Pr(+ ~D)	27.14%
False - rate for true D	Pr(- D)	10.00%
False + rate for classified +	Pr(~D +)	18.73%
False - rate for classified -	Pr(D -)	15.22%
Correctly classified		82.57%