

Assignment 10

Multivariate Probit Models

The model

In the study of financing choice, three choices have been studied including capital restructuring, dividend cut, and issue new stock. The probit model can be stated as:

$$I_{ji} = \beta_{j0} + \beta_{j1}x_{1i} + \beta_{j2}x_{2i} + \beta_{j3}x_{3i} + \beta_{j4}x_{4i} + u_{ji} \quad (1)$$

and

$$\Pr(Y_{ji} = 1) = \Phi(I_{ji})$$

where: I_{ji} is index variables.

Y_{ji} is decision to choose financial choice J , value equals to 1 if choosing choice J or 0 if not. $J = 1$ for capital restructuring, 2 for dividend cut, 3 for issue new stock.

x_{ki} is independent variable k .

$\Phi(\cdot)$ is multivariate normal probability distribution function.

u_{ji} is disturbance term.

Requirements From data file – assign10.dta:

- Estimate models for Y_{1i} , Y_{2i} , and Y_{3i} assuming that the probability functions follow separate normal distribution function. Interpret your estimated result (sign and meaning, overall test, pseudo R^2 , individual test).

```
. probit y1 x*
Iteration 0:   log likelihood = -45.533775
. . .
Iteration 5:   log likelihood = -34.09209

Probit regression               Number of obs   =           67
                               LR chi2(3)           =           22.88
                               Prob > chi2          =           0.0000
Log likelihood = -34.09209      Pseudo R2       =           0.2513
```

y1	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	2.574932	.7958181	3.24	0.001	1.015157	4.134707
x2	-.5031798	.297949	-1.69	0.091	-1.087149	.0807895
x3	.3449061	.1616015	2.13	0.033	.028173	.6616392
_cons	-2.186903	.6334447	-3.45	0.001	-3.428432	-.9453743

Note: 1 failure and 0 successes completely determined.

According to the estimated result, the firm with the choice x1 and/or x3 tends to choose capital restructuring (y1). From the overall chi-squared test, it suggests that all independent variables can significantly explain whether the firm will choose capital restructuring. Pseudo R2 is quite low; therefore, there exists rooms for improvement. From the individual test (z-test), it implies that each of the independent variable is significant except x2.

```
. probit y2 x*
```

```
Iteration 0: log likelihood = -22.432361
```

```
...
```

```
Iteration 4: log likelihood = -19.678766
```

```
Probit regression                                Number of obs    =          67
                                                LR chi2(3)       =          5.51
                                                Prob > chi2      =          0.1382
Log likelihood = -19.678766                    Pseudo R2       =          0.1228
```

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```

y2	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	1.196021	.8449952	1.42	0.157	-.4601389	2.852182
x2	-.1604507	.1166507	-1.38	0.169	-.3890818	.0681804
x3	.1023406	.2083685	0.49	0.623	-.3060541	.5107354
_cons	.5275558	.5565448	0.95	0.343	-.563252	1.618364

```
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```

According to the estimated result, the firm with the choice x1 and/or x3 tends to choose dividend cut (y2). From the overall chi-squared test, it suggests that all independent variables cannot significantly explain whether the firm will choose dividend cut. Pseudo R2 is quite low; therefore, there exists rooms for improvement. From the individual test (z-test), none of the independent variable is significant. This model should not be employed.

```
. probit y3 x*
```

```
Iteration 0: log likelihood = -39.952416
```

```
...
```

```
Iteration 4: log likelihood = -35.486933
```

```
Probit regression                                Number of obs    =          67
                                                LR chi2(3)       =          8.93
                                                Prob > chi2      =          0.0302
Log likelihood = -35.486933                    Pseudo R2       =          0.1118
```

```
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```

y3	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x1	1.549326	.6925982	2.24	0.025	.1918581	2.906793
x2	-.33157	.2931093	-1.13	0.258	-.9060538	.2429137
x3	.0952456	.1142564	0.83	0.404	-.128693	.3191841
_cons	-1.713771	.5536004	-3.10	0.002	-2.798808	-.6287342

According to the estimated result, the firm with the choice x1 and/or x3 tends to choose issuing new stock (y3). From the overall chi-squared test, it suggests that all independent variables can significantly explain whether the firm will choose issuing new stock. Pseudo R2 is quite low; therefore, there exists rooms for improvement. From the individual test (z-test), it implies that only x1 is significant.

2 Estimate models for Y_{1i} , Y_{2i} , and Y_{3i} assuming that the probability functions follow multivariate normal probability distribution function (MV Probit models). Determine whether MVProbit is appropriated. Why?

```
. mvprobit (y1 x*) (y2 x*) (y3 x*)
```

Iteration 0: log likelihood = -89.257789

...

Iteration 3: log likelihood = -88.982663

Multivariate probit (MSL, # draws = 5) Number of obs = 67
 Wald chi2(9) = 25.03
 Log likelihood = -88.982663 Prob > chi2 = 0.0029

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
y1						
x1	2.592376	.8023984	3.23	0.001	1.019704	4.165048
x2	-.5314422	.3036422	-1.75	0.080	-1.12657	.0636857
x3	.3491611	.1619024	2.16	0.031	.0318383	.6664839
_cons	-2.194319	.6357735	-3.45	0.001	-3.440412	-.9482253

y2

x1		1.221734	.8478931	1.44	0.150	-.4401059	2.883574
x2		-.1557306	.1180077	-1.32	0.187	-.3870215	.0755604
x3		.1054215	.2100288	0.50	0.616	-.3062274	.5170704
_cons		.5119029	.5577948	0.92	0.359	-.5813547	1.605161
-----+-----							
y3							
x1		1.535622	.6913496	2.22	0.026	.1806018	2.890642
x2		-.3542075	.2987204	-1.19	0.236	-.9396887	.2312737
x3		.0956571	.1143892	0.84	0.403	-.1285416	.3198557
_cons		-1.691533	.5520363	-3.06	0.002	-2.773504	-.6095614
-----+-----							
/atrho21		.1028098	.306035	0.34	0.737	-.4970077	.7026274
-----+-----							
/atrho31		.1399288	.2264305	0.62	0.537	-.3038669	.5837245
-----+-----							
/atrho32		.1014794	.268692	0.38	0.706	-.4251472	.628106
-----+-----							
rho21		.1024491	.3028229	0.34	0.735	-.4597606	.6060328
-----+-----							
rho31		.1390226	.2220542	0.63	0.531	-.2948474	.5253672
-----+-----							
rho32		.1011325	.2659439	0.38	0.704	-.4012578	.5567467
-----+-----							

Likelihood ratio test of rho21 = rho31 = rho32 = 0:

chi2(3) = .550251 Prob > chi2 = 0.9077

*In this case, **MV Probit model is not appropriated** since the LR-test cannot be rejected meaning that all rho are equal to zero. Therefore, using the separate model is more suitable.*