Logistic Regression: Analysis, Interpretation, and Visual Representation of Results

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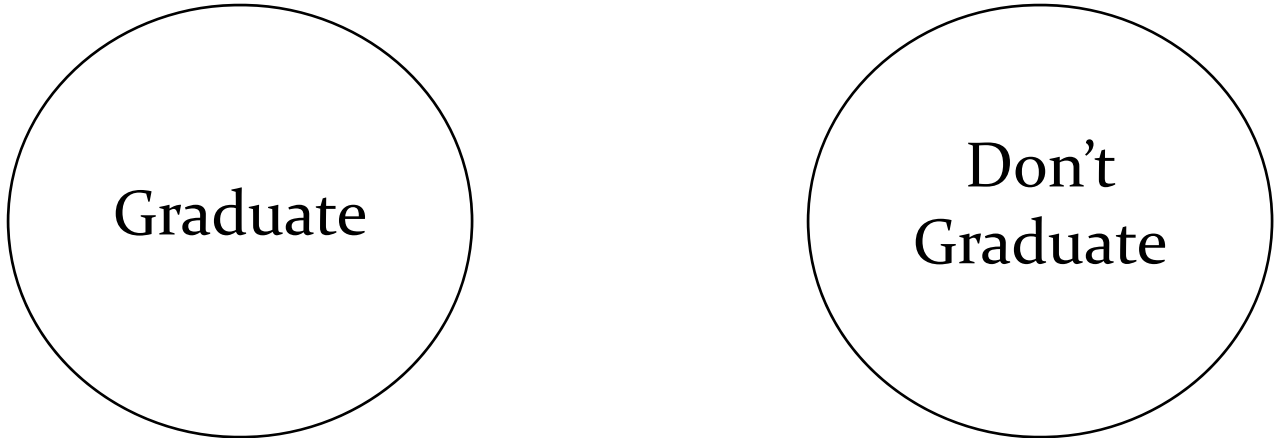
Odds Ratio = $\mathcal{X}$

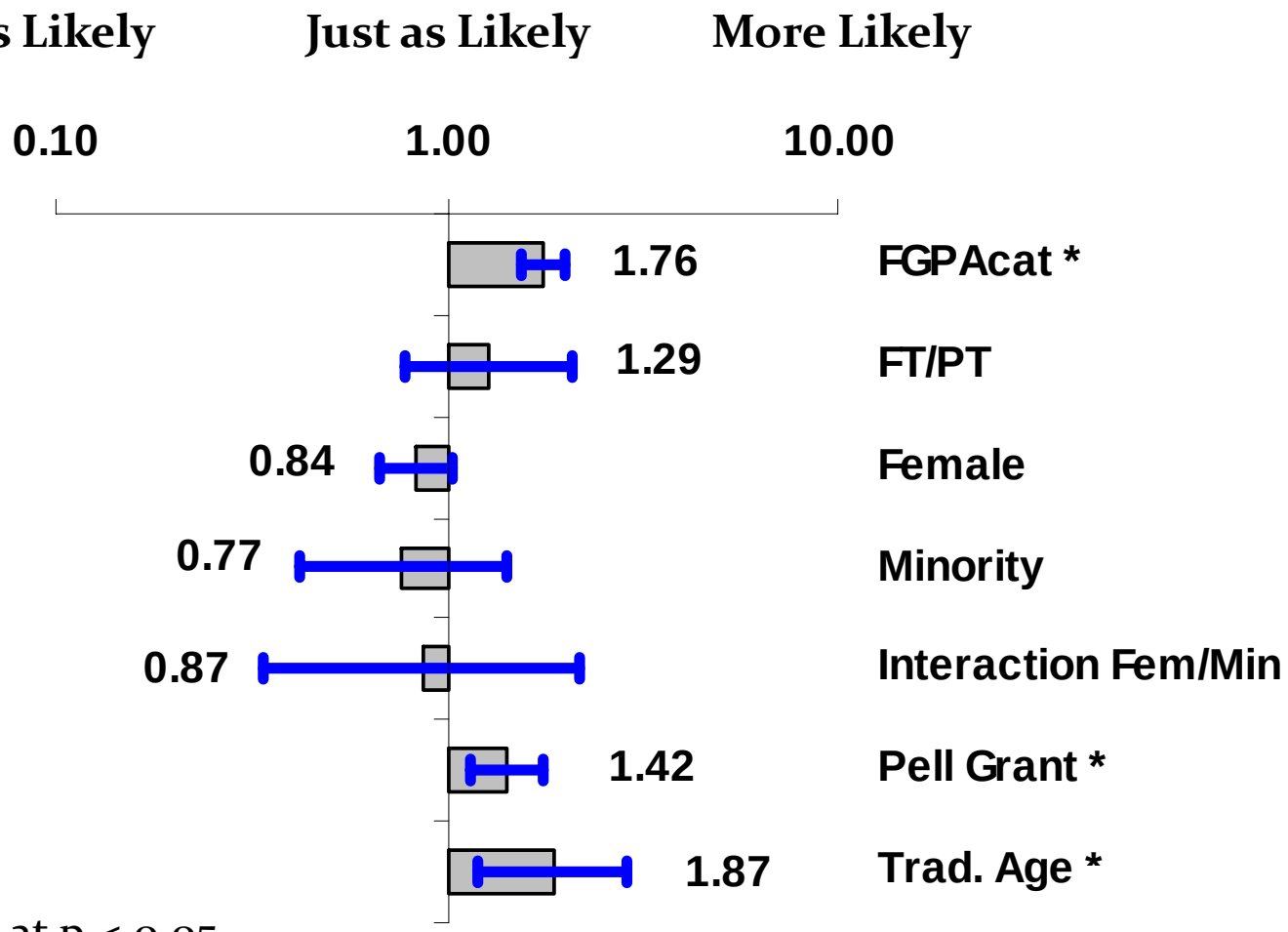
- For each variable, a member of the group is $\mathcal{X}$ times as likely to graduate as a member who is not in the group.
  - If $\mathcal{X}$ is **less than one**, then members of the group are **less likely** to graduate.
  - If $\mathcal{X}$ is **equal to one**, then members of the group are **as likely** to graduate as members not in the group.
  - If $\mathcal{X}$ is **more than one**, then members of the group are **more likely** to graduate.

Model Fit for MU Community College Transfer Students

- 74% of the observations were predicted accurately, compared to a 65% graduation rate (Schmidtke, Eimers, & Jones-White, 2007).

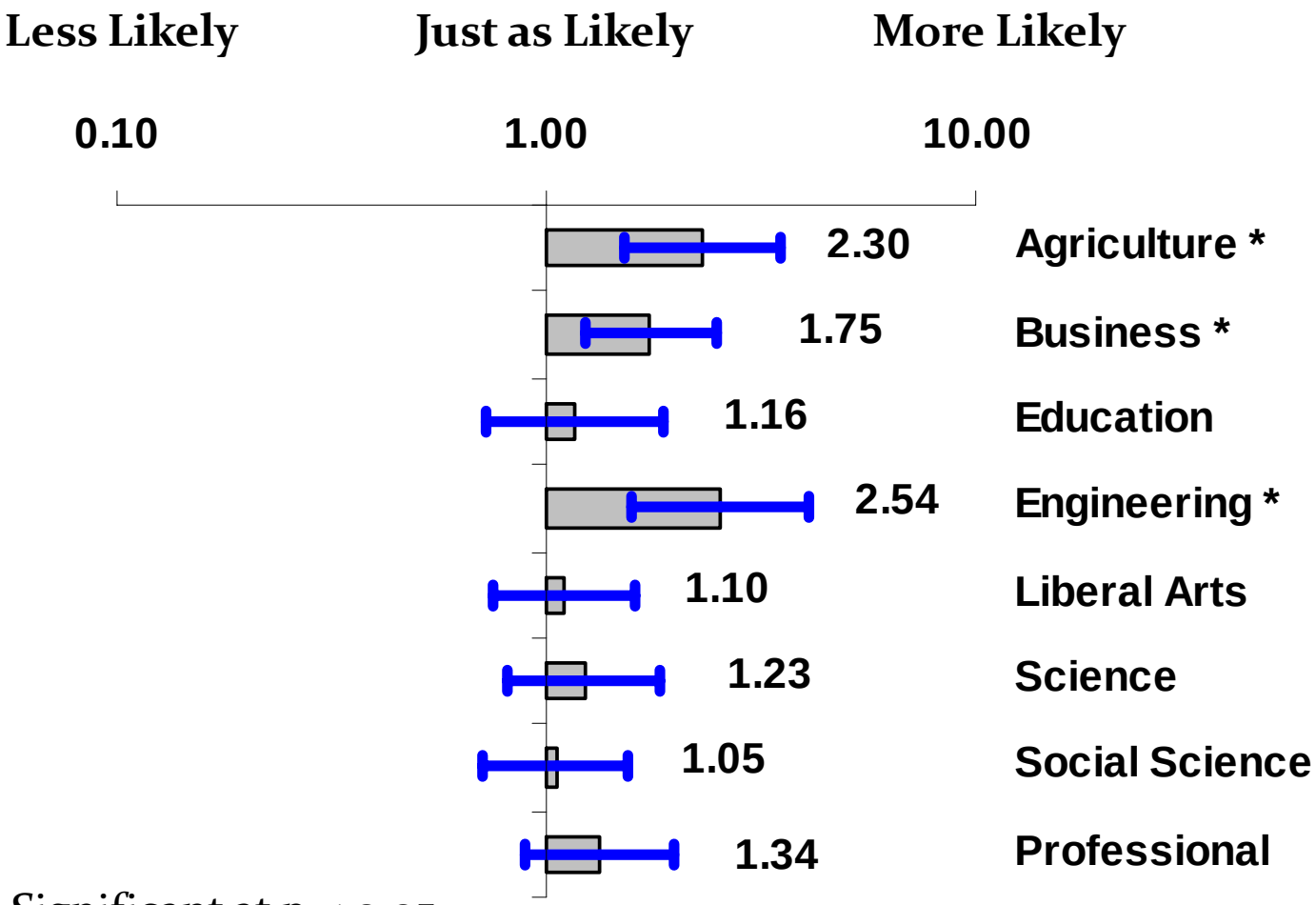


Odds Ratios for Community College Transfer Students to MU



* Significant at $p < 0.05$

Odds Ratios for Community College Transfer Students to MU



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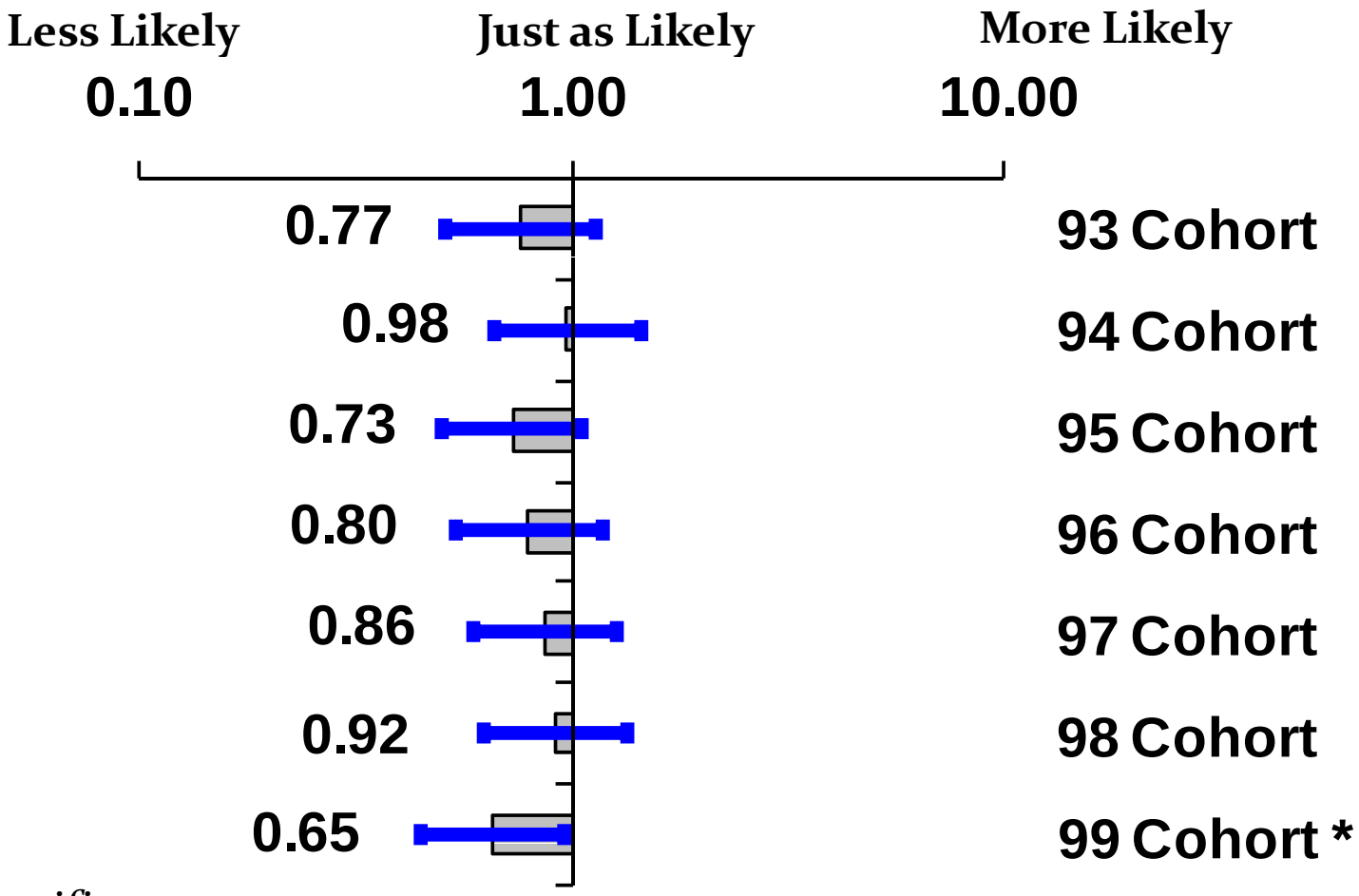
Odds Ratios for Community College Transfer Students to MU



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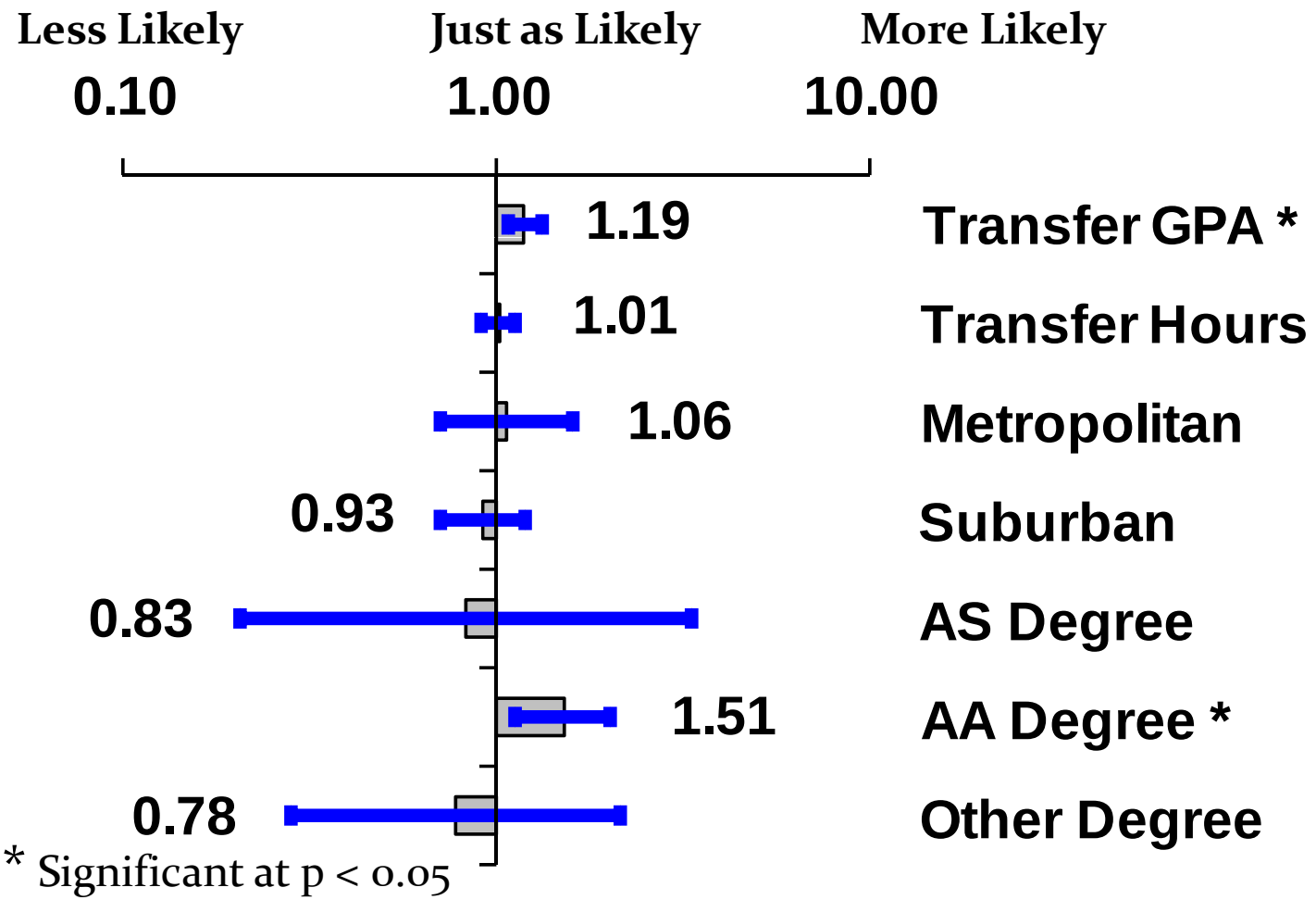
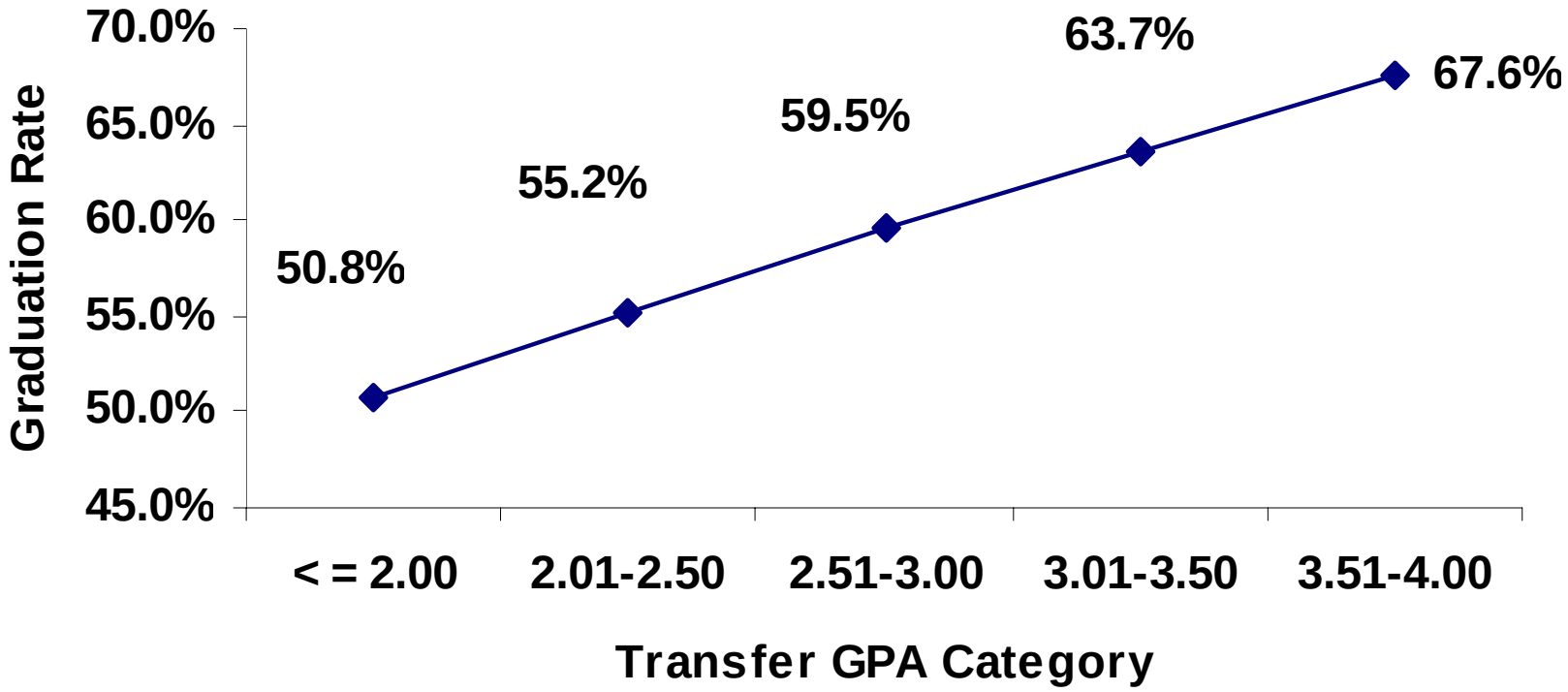
Odds Ratios for Community College Transfer Students to MU



* Significant at $p < 0.05$

Predicted MU CC Transfer Graduation Rate by Transfer GPA Category



Logistic Regression

- Odds ratio
  - Graduation rate is 65%

$$\frac{.65}{1-.65} = 1.86$$

- Odds of graduating are 1.86 to 1

Logistic Regression

- Odds ratio

$$\frac{\hat{p}_i}{1-\hat{p}_i} = e^{(\beta_1 X_i + \beta_0)}$$

Logistic Regression

- Logit Function

$$\ln\left(\frac{\hat{p}_i}{1-\hat{p}_i}\right) = \beta_1 X_i + \beta_0$$

Predicted probability

- Predicted probability

$$\hat{p}_i = \frac{1}{1 + e^{-(\beta_1 X_i + \beta_0)}}$$

Variables

- First Semester GPA Category
- Attendance Status (Full-time/Part-time)
- Gender
- Ethnicity
- Gender/Ethnicity Interaction
- Pell Grant Status
- Traditional Age
- Initial program at MU
- Entering Cohort
- Transfer GPA Category
- Transfer Hour Category
- Location of Community College
- Type of Associate's Degree

SAS Program

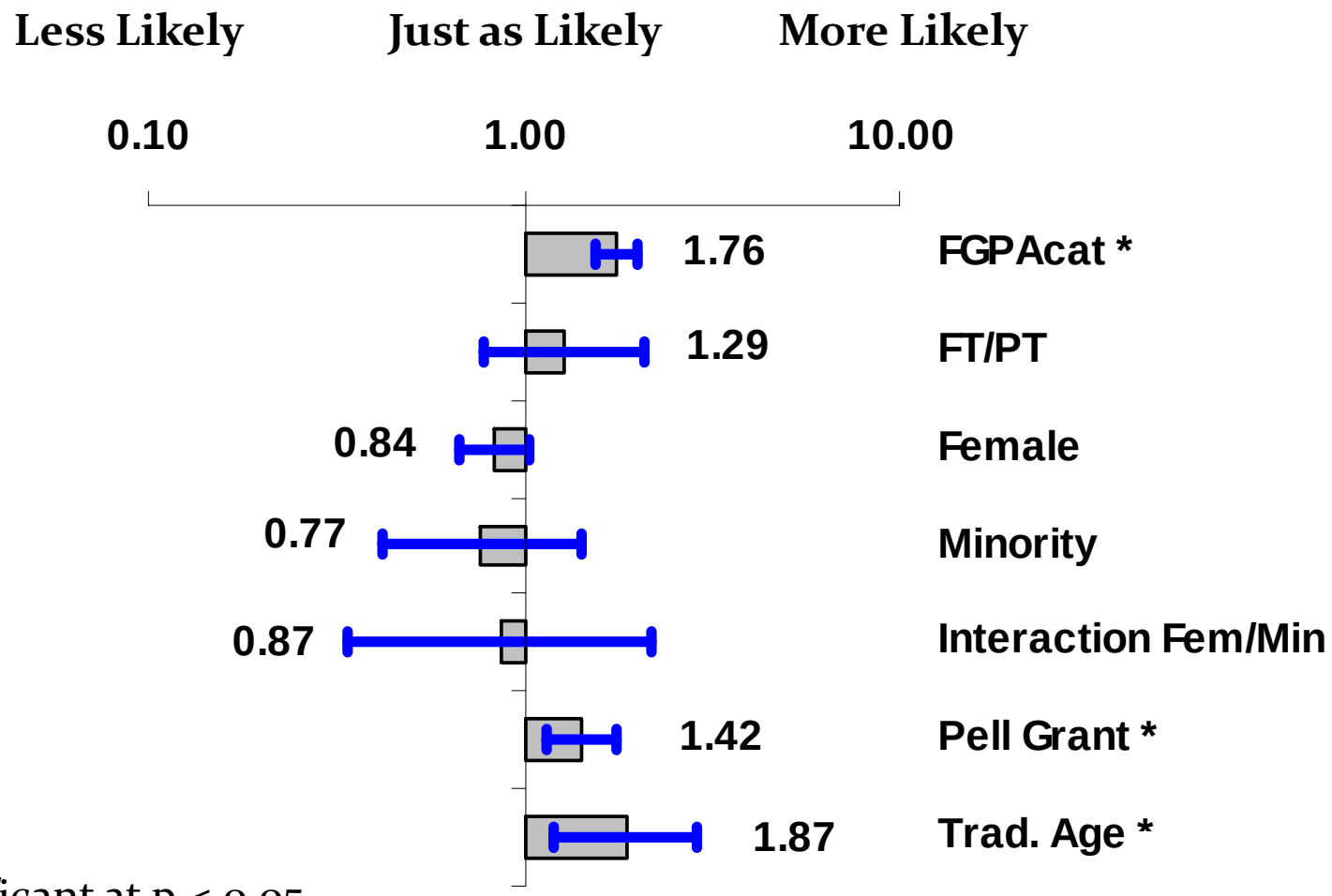
```
proc logistic data=CCTran;
     model degreefix(event='1')=  FGPAcat FHOURcat TGPAcat THOURcat
                ag bus  ed eng  libart sci socsci profess
                metro suburban
                asdeg aadeg aodeg
                female
                minor
                femmin
                Pell
                tradage
                c093 c094 c095 c096 c097 c098 c099


               /
                clparm=pl
                lackfit;
    output out=pred2 p=phat lower=lcl upper=ucl
          predprob=(individual crossvalidate);
  title ' Regression on CC Data - new tran hour cat';
run;
```

SAS Output

- See Handout (page 1-3)

Odds Ratios for Community College Transfer Students to MU (Page 5)



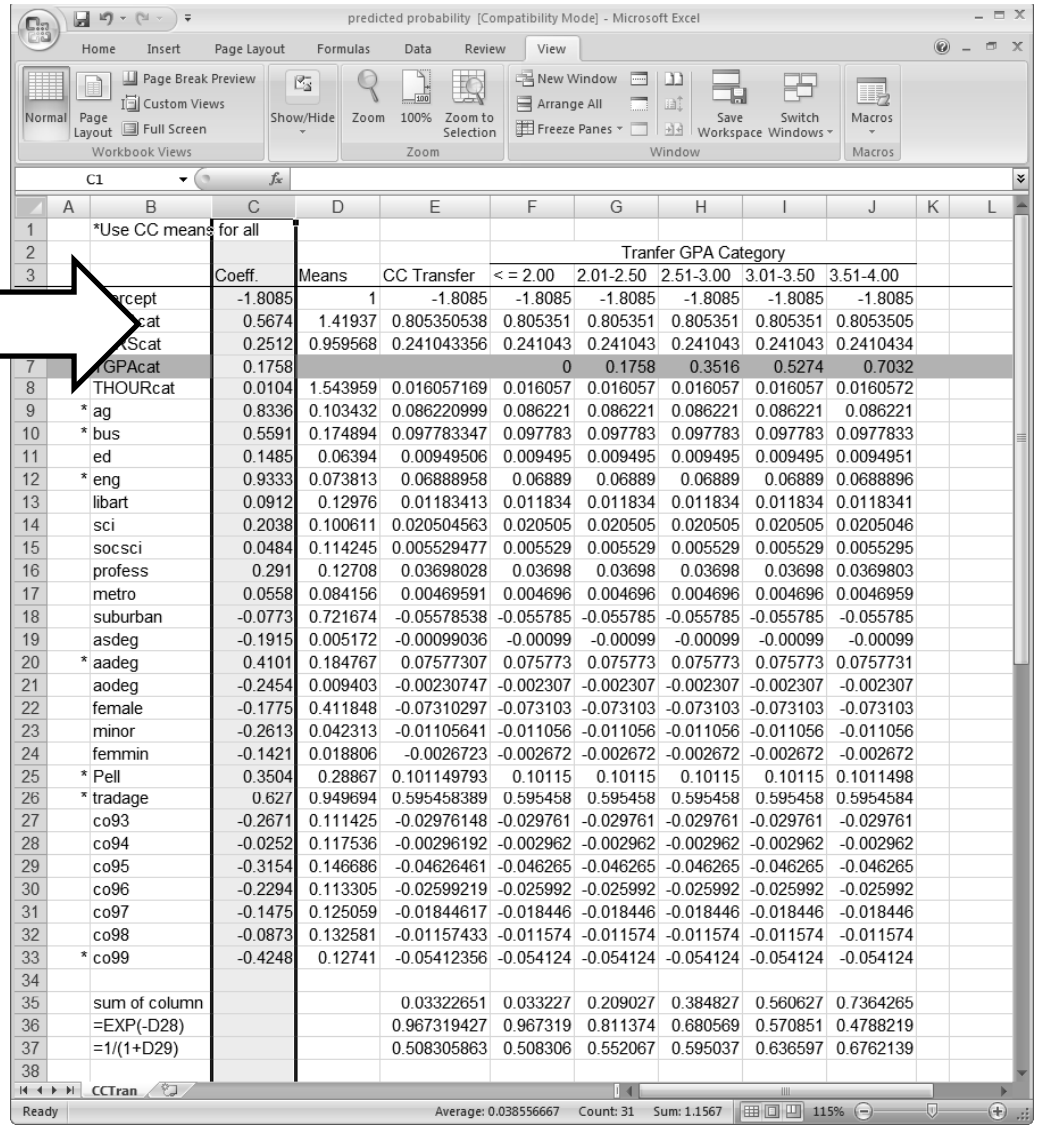
* Significant at $p < 0.05$

Predicted Probabilities (page 4)

Insert SAS "Estimate" into Excel as log-odds regression coefficients

Equation for predicted probabilities

$$\hat{p}_i = \frac{1}{1+e^{-(\beta_1 X_i + \beta_0)}}$$



predicted probability [Compatibility Mode] - Microsoft Excel

1		*Use CC means for all								
2					Tranfer GPA Category					
3			Coeff.	Means	CC Transfer	< = 2.00	2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00
4		rcept	-1.8085	1	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085
5		cat	0.5674	1.41937	0.805350538	0.805351	0.805351	0.805351	0.805351	0.8053505
6		Scat	0.2512	0.959568	0.241043356	0.241043	0.241043	0.241043	0.241043	0.2410434
7		GPAcat	0.1758			0	0.1758	0.3516	0.5274	0.7032
8		THOURcat	0.0104	1.543959	0.016057169	0.016057	0.016057	0.016057	0.016057	0.0160572
9	*	ag	0.8336	0.103432	0.086220999	0.086221	0.086221	0.086221	0.086221	0.086221
10	*	bus	0.5591	0.174894	0.097783347	0.097783	0.097783	0.097783	0.097783	0.0977833
11		ed	0.1485	0.06394	0.00949506	0.009495	0.009495	0.009495	0.009495	0.0094951
12	*	eng	0.9333	0.073813	0.06888958	0.06889	0.06889	0.06889	0.06889	0.0688896
13		libart	0.0912	0.12976	0.01183413	0.011834	0.011834	0.011834	0.011834	0.0118341
14		sci	0.2038	0.100611	0.020504563	0.020505	0.020505	0.020505	0.020505	0.0205046
15		socsci	0.0484	0.114245	0.005529477	0.005529	0.005529	0.005529	0.005529	0.0055295
16		profess	0.291	0.12708	0.03698028	0.03698	0.03698	0.03698	0.03698	0.0369803
17		metro	0.0558	0.084156	0.00469591	0.004696	0.004696	0.004696	0.004696	0.0046959
18		suburban	-0.0773	0.721674	-0.05578538	-0.055785	-0.055785	-0.055785	-0.055785	-0.055785
19		asdeg	-0.1915	0.005172	-0.00099036	-0.00099	-0.00099	-0.00099	-0.00099	-0.00099
20	*	aadeg	0.4101	0.184767	0.07577307	0.075773	0.075773	0.075773	0.075773	0.0757731
21		aodeg	-0.2454	0.009403	-0.00230747	-0.002307	-0.002307	-0.002307	-0.002307	-0.002307
22		female	-0.1775	0.411848	-0.07310297	-0.073103	-0.073103	-0.073103	-0.073103	-0.073103
23		minor	-0.2613	0.042313	-0.01105641	-0.011056	-0.011056	-0.011056	-0.011056	-0.011056
24		femmin	-0.1421	0.018806	-0.0026723	-0.002672	-0.002672	-0.002672	-0.002672	-0.002672
25	*	Pell	0.3504	0.28867	0.101149793	0.10115	0.10115	0.10115	0.10115	0.1011498
26	*	tradage	0.627	0.949694	0.595458389	0.595458	0.595458	0.595458	0.595458	0.5954584
27		co93	-0.2671	0.111425	-0.02976148	-0.029761	-0.029761	-0.029761	-0.029761	-0.029761
28		co94	-0.0252	0.117536	-0.00296192	-0.002962	-0.002962	-0.002962	-0.002962	-0.002962
29		co95	-0.3154	0.146686	-0.04626461	-0.046265	-0.046265	-0.046265	-0.046265	-0.046265
30		co96	-0.2294	0.113305	-0.02599219	-0.025992	-0.025992	-0.025992	-0.025992	-0.025992
31		co97	-0.1475	0.125059	-0.01844617	-0.018446	-0.018446	-0.018446	-0.018446	-0.018446
32		co98	-0.0873	0.132581	-0.01157433	-0.011574	-0.011574	-0.011574	-0.011574	-0.011574
33	*	co99	-0.4248	0.12741	-0.05412356	-0.054124	-0.054124	-0.054124	-0.054124	-0.054124
34										
35		sum of column			0.03322651	0.033227	0.209027	0.384827	0.560627	0.7364265
36		=EXP(-D28)			0.967319427	0.967319	0.811374	0.680569	0.570851	0.4788219
37		=1/(1+D29)			0.508305863	0.508306	0.552067	0.595037	0.636597	0.6762139
38										

CCTran

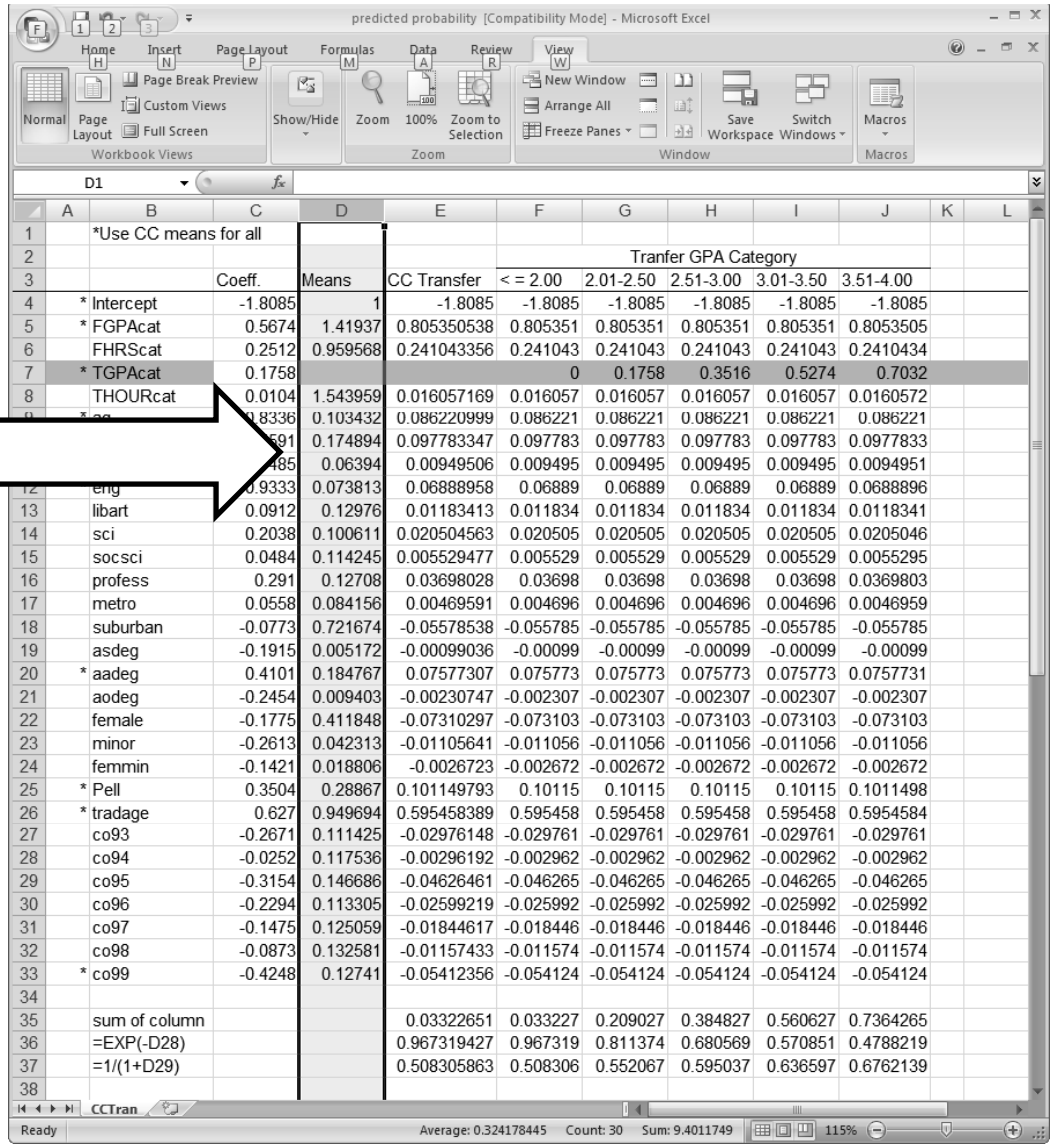
Ready Average: 0.038556667 Count: 31 Sum: 1.1567 115%

Predicted Probabilities

Insert mean value (or chosen values) for all variables except the variable of interest (TranGPA category).

Equation for predicted probabilities

$$\hat{p}_i = \frac{1}{1+e^{-(\beta_1 X_i + \beta_0)}}$$



predicted probability [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L
1		*Use CC means for all										
2						Tranfer GPA Category						
3			Coeff.	Means	CC Transfer	< = 2.00	2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00		
4	*	Intercept	-1.8085	1	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085		
5	*	FGPAcat	0.5674	1.41937	0.805350538	0.805351	0.805351	0.805351	0.805351	0.8053505		
6		FHRScat	0.2512	0.959568	0.241043356	0.241043	0.241043	0.241043	0.241043	0.2410434		
7	*	TGPAcat	0.1758			0	0.1758	0.3516	0.5274	0.7032		
8		THOURcat	0.0104	1.543959	0.016057169	0.016057	0.016057	0.016057	0.016057	0.0160572		
9	*	ag	1.8336	0.103432	0.086220999	0.086221	0.086221	0.086221	0.086221	0.086221		
10			591	0.174894	0.097783347	0.097783	0.097783	0.097783	0.097783	0.0977833		
11			485	0.06394	0.00949506	0.009495	0.009495	0.009495	0.009495	0.0094951		
12		eng	0.9333	0.073813	0.06888958	0.06889	0.06889	0.06889	0.06889	0.0688896		
13		libart	0.0912	0.12976	0.01183413	0.011834	0.011834	0.011834	0.011834	0.0118341		
14		sci	0.2038	0.100611	0.020504563	0.020505	0.020505	0.020505	0.020505	0.0205046		
15		socsci	0.0484	0.114245	0.005529477	0.005529	0.005529	0.005529	0.005529	0.0055295		
16		profess	0.291	0.12708	0.03698028	0.03698	0.03698	0.03698	0.03698	0.0369803		
17		metro	0.0558	0.084156	0.00469591	0.004696	0.004696	0.004696	0.004696	0.0046959		
18		suburban	-0.0773	0.721674	-0.05578538	-0.055785	-0.055785	-0.055785	-0.055785	-0.055785		
19		asdeg	-0.1915	0.005172	-0.00099036	-0.00099	-0.00099	-0.00099	-0.00099	-0.00099		
20	*	aadeg	0.4101	0.184767	0.07577307	0.075773	0.075773	0.075773	0.075773	0.0757731		
21		aodeg	-0.2454	0.009403	-0.00230747	-0.002307	-0.002307	-0.002307	-0.002307	-0.002307		
22		female	-0.1775	0.411848	-0.07310297	-0.073103	-0.073103	-0.073103	-0.073103	-0.073103		
23		minor	-0.2613	0.042313	-0.01105641	-0.011056	-0.011056	-0.011056	-0.011056	-0.011056		
24		femmin	-0.1421	0.018806	-0.0026723	-0.002672	-0.002672	-0.002672	-0.002672	-0.002672		
25	*	Pell	0.3504	0.28867	0.101149793	0.10115	0.10115	0.10115	0.10115	0.1011498		
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28		co94	-0.0252	0.117536	-0.00296192	-0.002962	-0.002962	-0.002962	-0.002962	-0.002962		
29		co95	-0.3154	0.146686	-0.04626461	-0.046265	-0.046265	-0.046265	-0.046265	-0.046265		
30		co96	-0.2294	0.113305	-0.02599219	-0.025992	-0.025992	-0.025992	-0.025992	-0.025992		
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32		co98	-0.0873	0.132581	-0.01157433	-0.011574	-0.011574	-0.011574	-0.011574	-0.011574		
33	*	co99	-0.4248	0.12741	-0.05412356	-0.054124	-0.054124	-0.054124	-0.054124	-0.054124		
34												
35		sum of column			0.03322651	0.033227	0.209027	0.384827	0.560627	0.7364265		
36		=EXP(-D28)			0.967319427	0.967319	0.811374	0.680569	0.570851	0.4788219		
37		=1/(1+D29)			0.508305863	0.508306	0.552067	0.595037	0.636597	0.6762139		
38												

CCTran

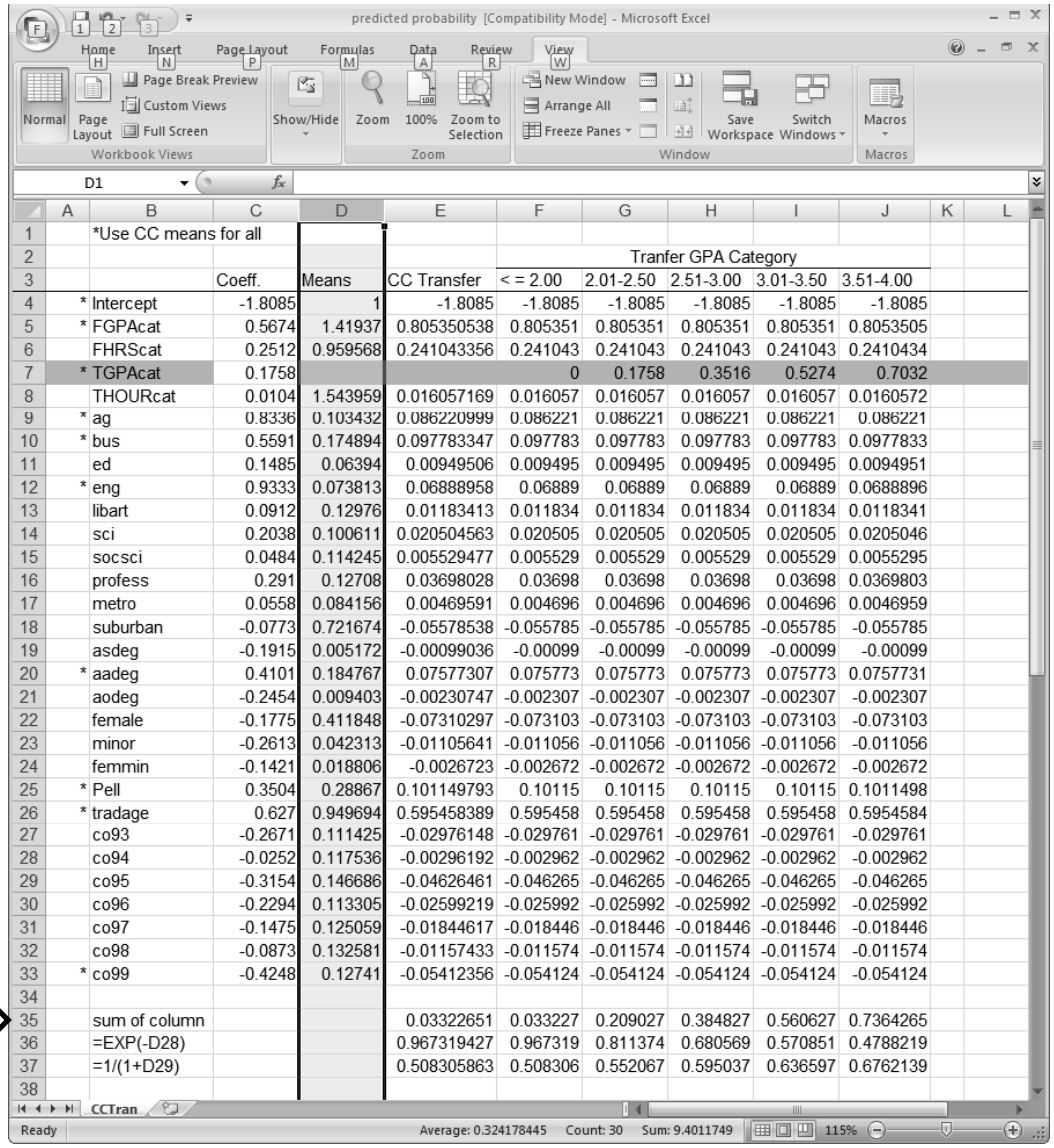
Ready Average: 0.324178445 Count: 30 Sum: 9.4011749 115%

Predicted Probabilities

Solve for predicted probabilities for each transfer GPA category.

Equation for predicted probabilities

$$\hat{p}_i = \frac{1}{1+e^{-(\beta_1 X_i + \beta_0)}}$$



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19		asdeg	-0.1915	0.005172	-0.00099036	-0.00099	-0.00099	-0.00099	-0.00099	-0.00099		
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23		minor	-0.2613	0.042313	-0.01105641	-0.011056	-0.011056	-0.011056	-0.011056	-0.011056		
24		femmin	-0.1421	0.018806	-0.0026723	-0.002672	-0.002672	-0.002672	-0.002672	-0.002672		
25	*	Pell	0.3504	0.28867	0.101149793	0.10115	0.10115	0.10115	0.10115	0.1011498		
26	*	tradage	0.627	0.949694	0.595458389	0.595458	0.595458	0.595458	0.595458	0.5954584		
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28		co94	-0.0252	0.117536	-0.00296192	-0.002962	-0.002962	-0.002962	-0.002962	-0.002962		
29		co95	-0.3154	0.146686	-0.04626461	-0.046265	-0.046265	-0.046265	-0.046265	-0.046265		
30		co96	-0.2294	0.113305	-0.02599219	-0.025992	-0.025992	-0.025992	-0.025992	-0.025992		
31		co97	-0.1475	0.125059	-0.01844617	-0.018446	-0.018446	-0.018446	-0.018446	-0.018446		
32		co98	-0.0873	0.132581	-0.01157433	-0.011574	-0.011574	-0.011574	-0.011574	-0.011574		
33	*	co99	-0.4248	0.12741	-0.05412356	-0.054124	-0.054124	-0.054124	-0.054124	-0.054124		
34												
35		sum of column			0.03322651	0.033227	0.209027	0.384827	0.560627	0.7364265		
36		=EXP(-D28)			0.967319427	0.967319	0.811374	0.680569	0.570851	0.4788219		
37		=1/(1+D29)			0.508305863	0.508306	0.552067	0.595037	0.636597	0.6762139		
38												

Questions

- ????

Contact information

- Kathy Schmidtke Felts
- University of Missouri
- feltsk@missouri.edu
- (573) 882-4078

Paper and handouts will be available: http://ir.missouri.edu/reports-presentations.html

References:

http://staff.washington.edu/glynn/predprob.pdf

Schmidtke, K., Eimers, M., & Jones-White, D., (2007, March). *Success at the University of Missouri-Columbia: A focus on community college transfer students*. Paper presented at the University of Missouri System Community College Transition Conference, Columbia, MO.