



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

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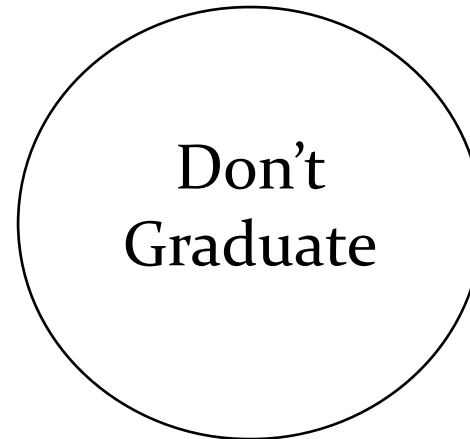
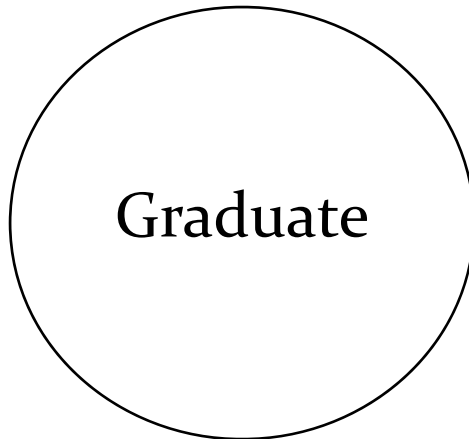
# Odds Ratio = $\mathcal{X}$

- 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.

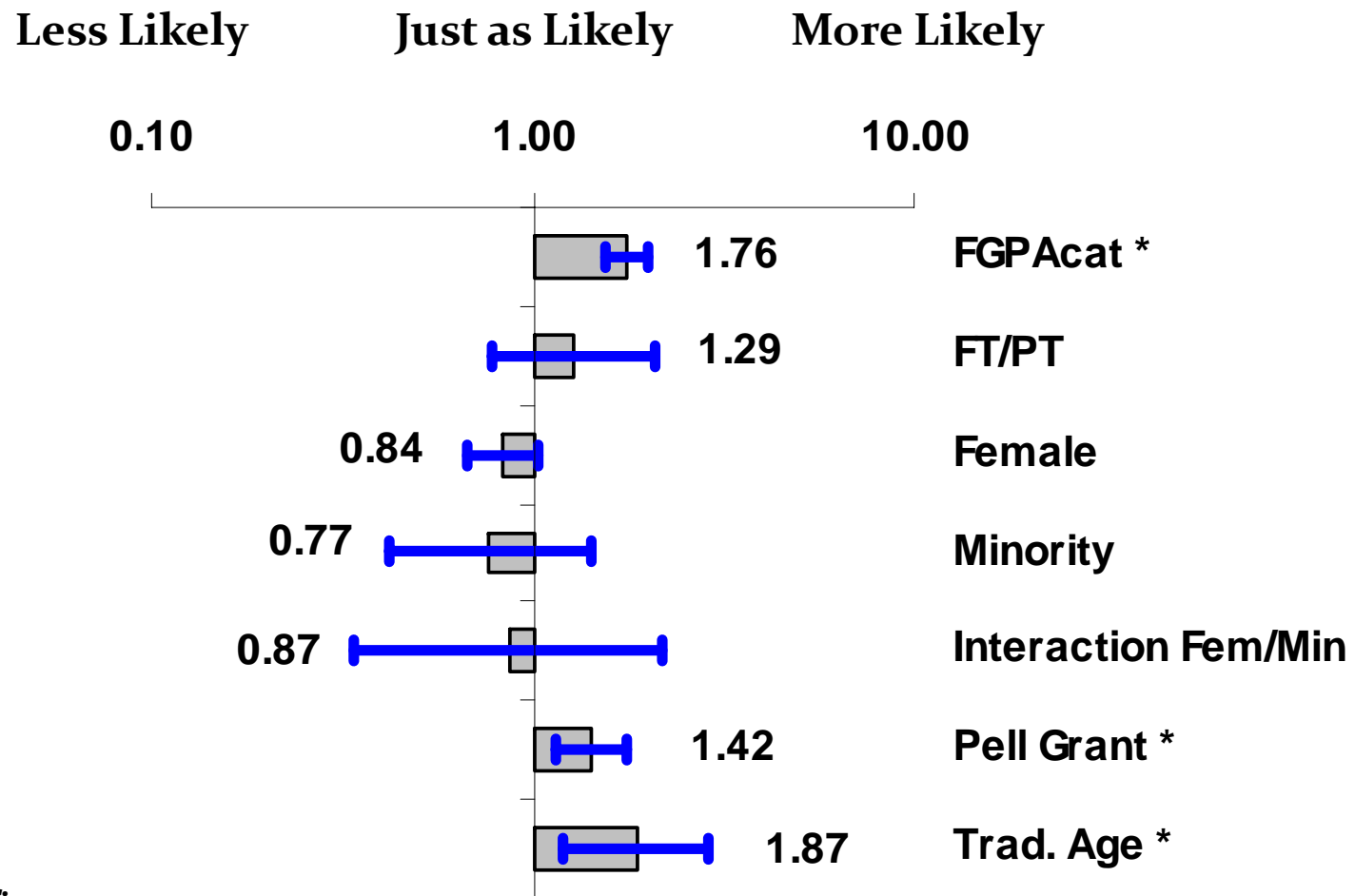


# Model Fit for MU Community College Transfer Students

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



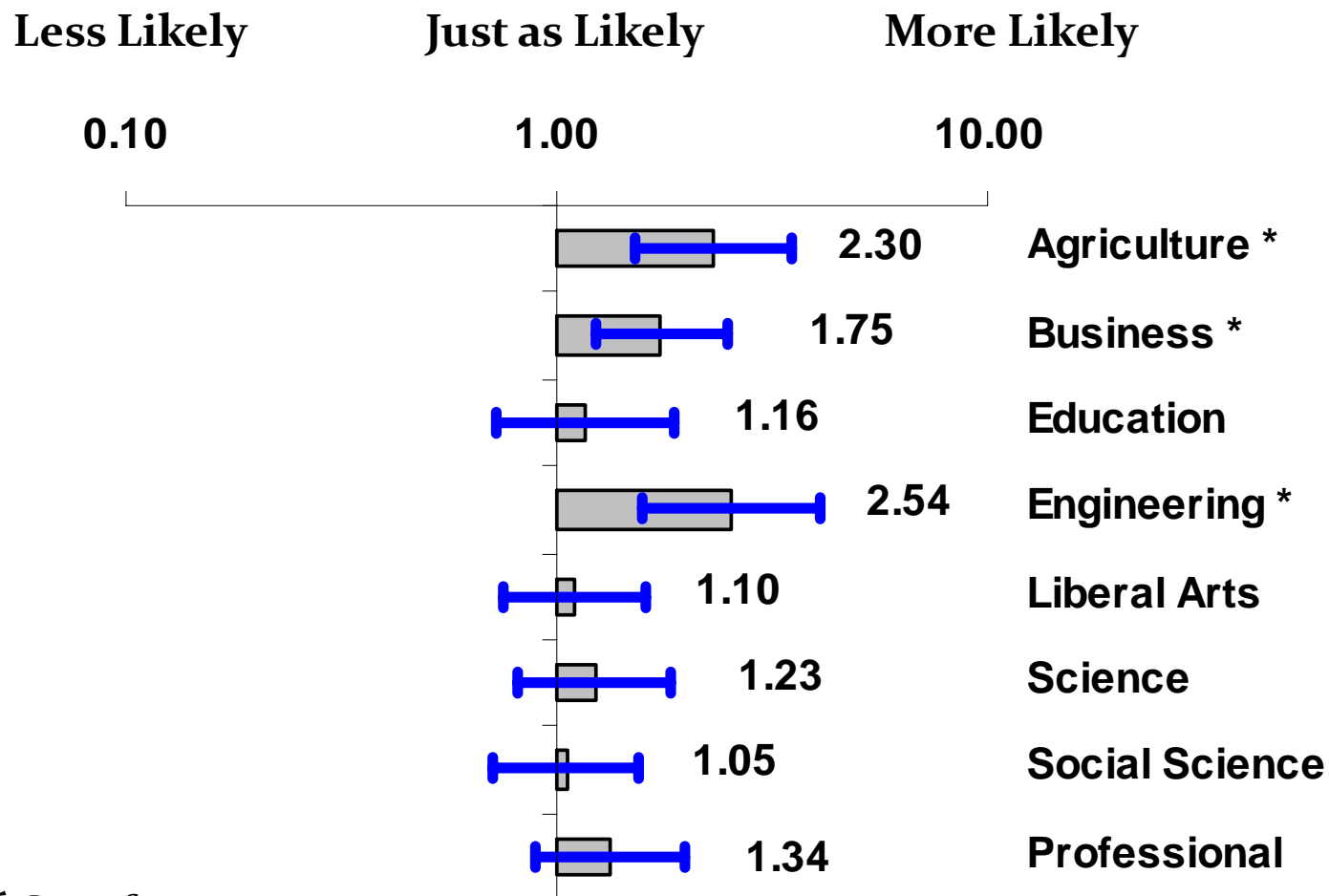
# Odds Ratios for Community College Transfer Students to MU



\* Significant at  $p < 0.05$



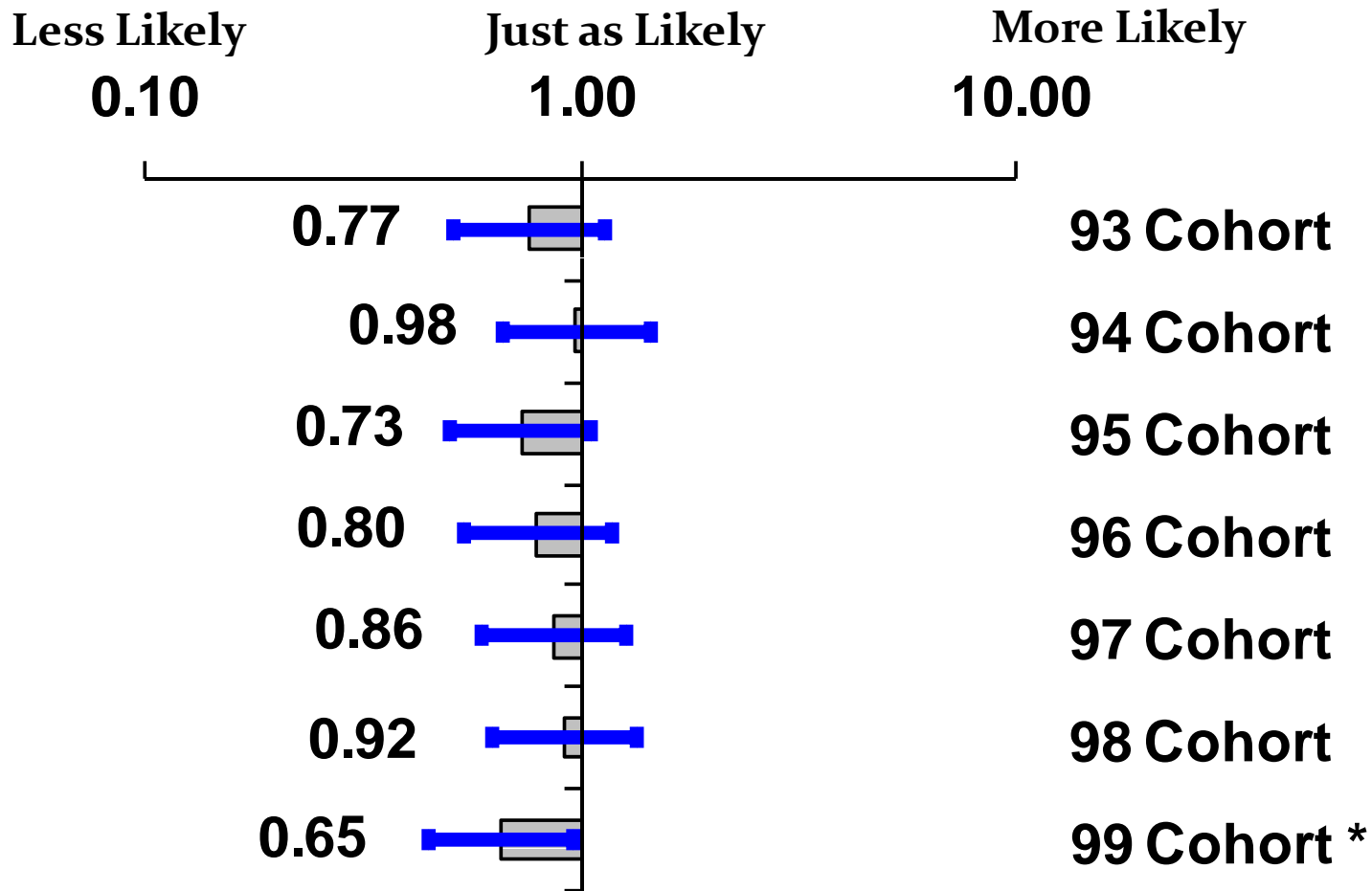
# Odds Ratios for Community College Transfer Students to MU



\* Significant at  $p < 0.05$



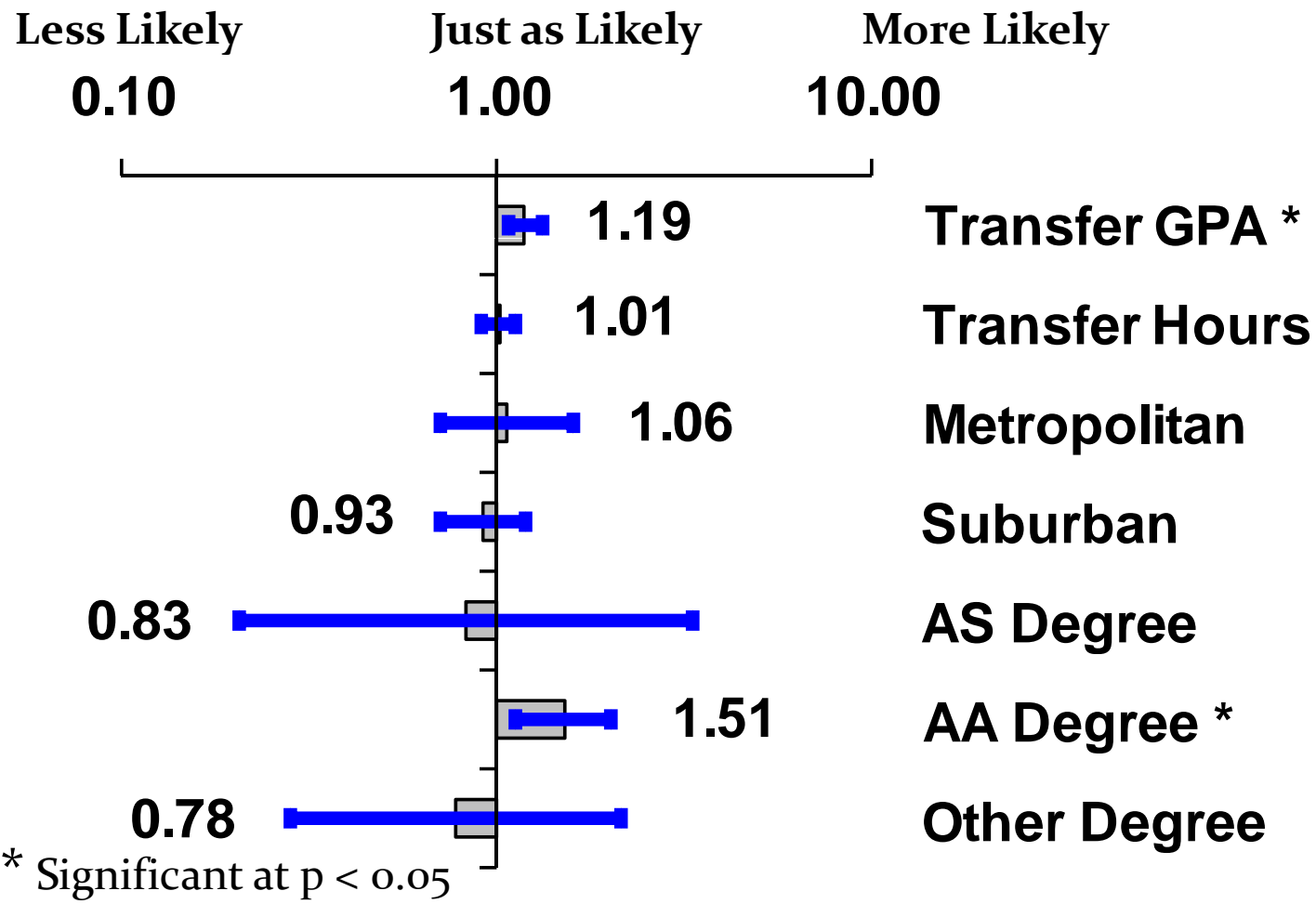
# Odds Ratios for Community College Transfer Students to MU



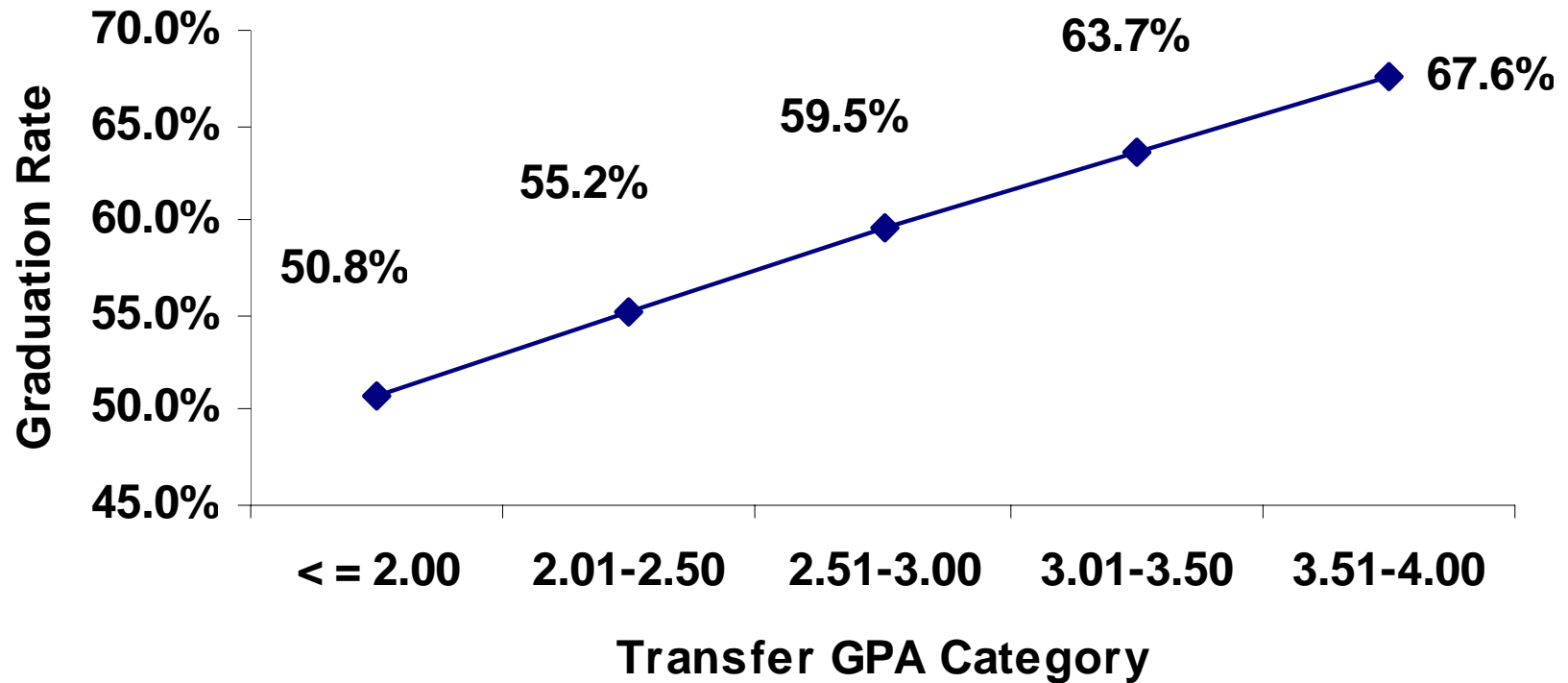
\* Significant at  $p < 0.05$



# Odds Ratios for Community College Transfer Students to MU



# 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

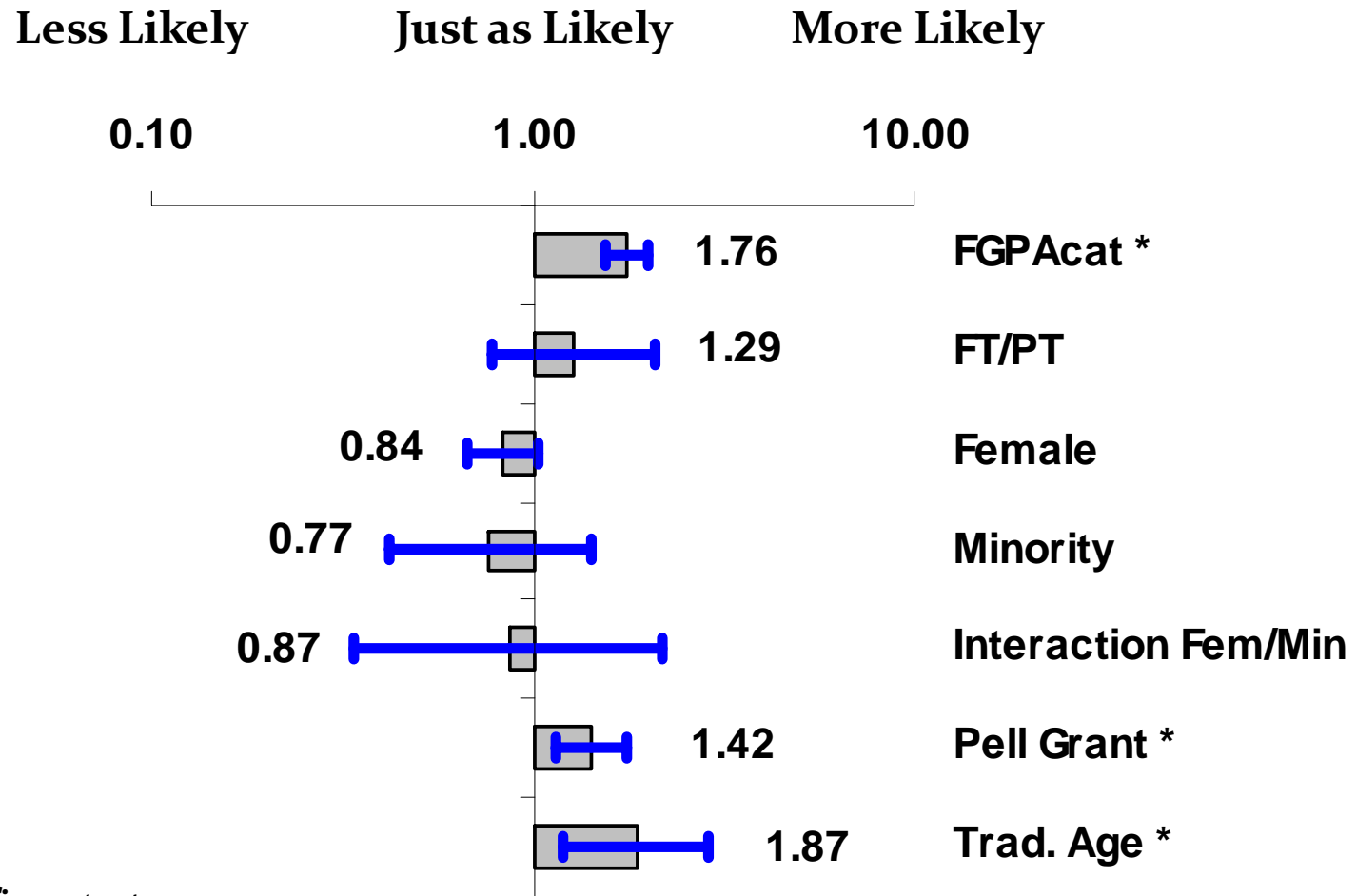
```
proc logistic data=CCTran;  
  model degreefix(event='1')= FGPAcat FHOURLcat TGPAcat THOURLcat  
    ag bus ed eng libart sci socsci profess  
    metro suburban  
    asdeg aadeg aodeg  
    female  
    minor  
    femmin  
    Pell  
    tradage  
    c093 c094 c095 c096 c097 c098 c099  
  
  /  
  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  $p < 0.05$

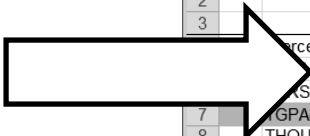


# Predicted Probabilities (page 4)

Insert SAS  
“Estimate” into Excel  
as log-odds  
regression  
coefficients

Equation for  
predicted  
probabilities

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





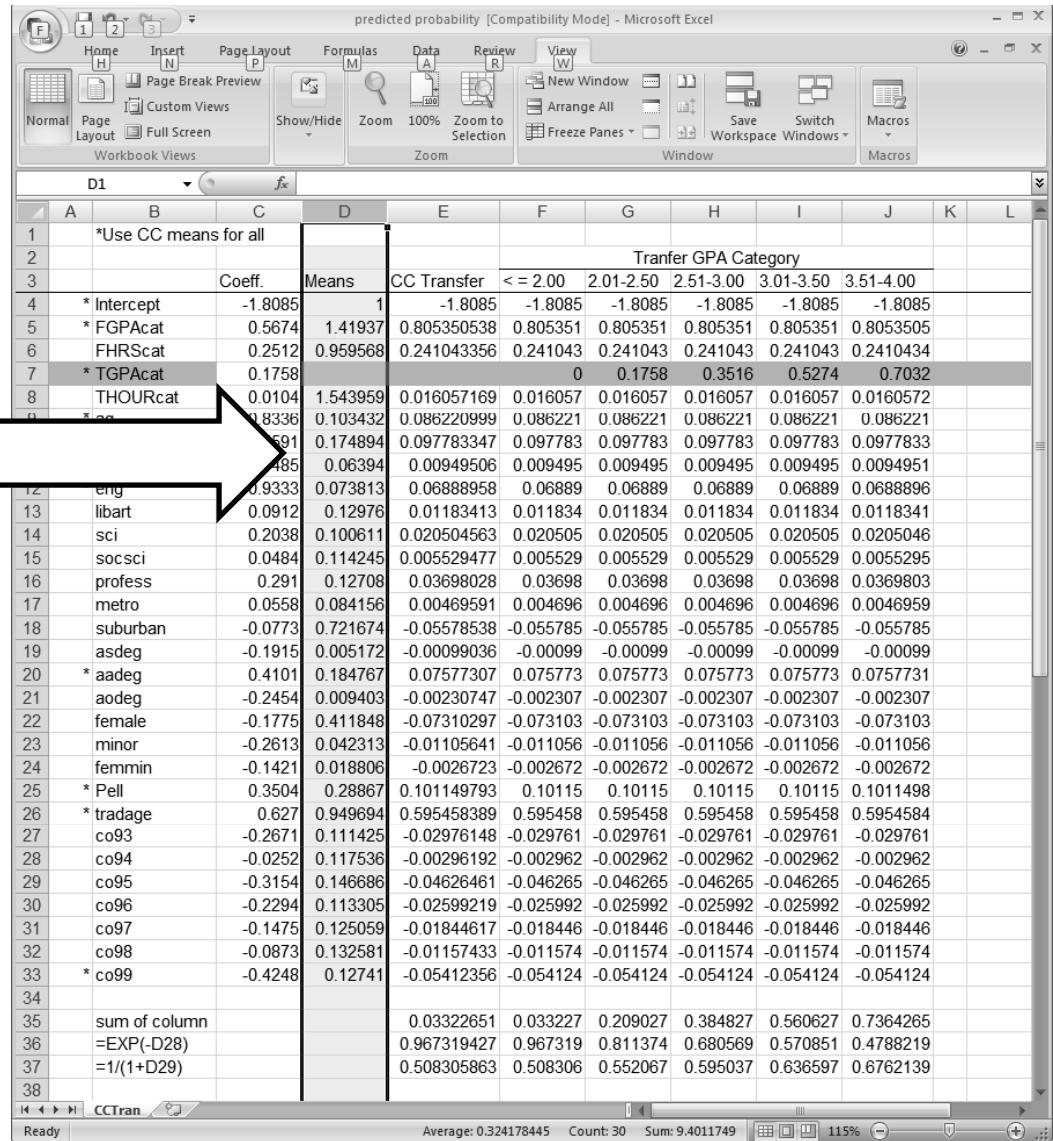
	Coeff.	Means	CC Transfer	<= 2.00	2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00
*Use CC means for all								
concept	-1.8085	1	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085
cat	0.5674	1.41937	0.805350538	0.805351	0.805351	0.805351	0.805351	0.8053505
Scat	0.2512	0.959568	0.241043356	0.241043	0.241043	0.241043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

# Predicted Probabilities

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

Equation for predicted probabilities

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




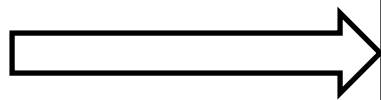
	Coeff.	Means	CC Transfer	<= 2.00	2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00
*Intercept	-1.8085	1	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085	-1.8085
*FGPACat	0.5674	1.41937	0.805350538	0.805351	0.805351	0.805351	0.805351	0.8053505
FHRScat	0.2512	0.959568	0.241043356	0.241043	0.241043	0.241043	0.241043	0.2410434
*TGPACat	0.1758		0	0.1758	0.3516	0.5274	0.7032	
THOURcat	0.0104	1.543959	0.016057169	0.016057	0.016057	0.016057	0.016057	0.0160572
eng	0.8336	0.103432	0.086220999	0.086221	0.086221	0.086221	0.086221	0.086221
libart	0.591	0.174894	0.097783347	0.097783	0.097783	0.097783	0.097783	0.0977833
sci	0.485	0.06394	0.00949506	0.009495	0.009495	0.009495	0.009495	0.0094951
socsci	-0.9333	0.073813	0.06888958	0.06889	0.06889	0.06889	0.06889	0.0688896
profess	0.0912	0.12976	0.01183413	0.011834	0.011834	0.011834	0.011834	0.0118341
metro	0.2038	0.100611	0.020504563	0.020505	0.020505	0.020505	0.020505	0.0205046
suburban	0.0484	0.114245	0.005529477	0.005529	0.005529	0.005529	0.005529	0.0055295
asdeg	0.291	0.12708	0.03698028	0.03698	0.03698	0.03698	0.03698	0.0369803
aadeg	0.0558	0.084156	0.00469591	0.004696	0.004696	0.004696	0.004696	0.0046959
aodeg	-0.0773	0.721674	-0.05578538	-0.055785	-0.055785	-0.055785	-0.055785	-0.055785
female	-0.1915	0.005172	-0.00099036	-0.00099	-0.00099	-0.00099	-0.00099	-0.00099
minor	0.4101	0.184767	0.07577307	0.075773	0.075773	0.075773	0.075773	0.0757731
femmin	-0.2454	0.009403	-0.00230747	-0.002307	-0.002307	-0.002307	-0.002307	-0.002307
Pell	-0.1775	0.411848	-0.07310297	-0.073103	-0.073103	-0.073103	-0.073103	-0.073103
tradage	-0.2613	0.042313	-0.01105641	-0.011056	-0.011056	-0.011056	-0.011056	-0.011056
co93	-0.1421	0.018806	-0.0026723	-0.002672	-0.002672	-0.002672	-0.002672	-0.002672
co94	0.3504	0.28867	0.101149793	0.10115	0.10115	0.10115	0.10115	0.1011498
co95	0.627	0.949694	0.595458389	0.595458	0.595458	0.595458	0.595458	0.5954584
co96	-0.2671	0.111425	-0.02976148	-0.029761	-0.029761	-0.029761	-0.029761	-0.029761
co97	-0.0252	0.117536	-0.00296192	-0.002962	-0.002962	-0.002962	-0.002962	-0.002962
co98	-0.3154	0.146686	-0.04626461	-0.046265	-0.046265	-0.046265	-0.046265	-0.046265
co99	-0.2294	0.113305	-0.02599219	-0.025992	-0.025992	-0.025992	-0.025992	-0.025992
sum of column	-0.1475	0.125059	-0.01844617	-0.018446	-0.018446	-0.018446	-0.018446	-0.018446
=EXP(-D28)	-0.0873	0.132581	-0.01157433	-0.011574	-0.011574	-0.011574	-0.011574	-0.011574
=1/(1+D29)	-0.4248	0.12741	-0.05412356	-0.054124	-0.054124	-0.054124	-0.054124	-0.054124
Average			0.03322651	0.033227	0.209027	0.384827	0.560627	0.7364265
Count			0.967319427	0.967319	0.811374	0.680569	0.570851	0.4788219
Sum			0.508305863	0.508306	0.552067	0.595037	0.636597	0.6762139

# Predicted Probabilities

Solve for predicted probabilities for each transfer GPA category.

Equation for predicted probabilities

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



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												
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	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												

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



# Questions

- ????



# Contact information

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- (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.