Statistical Innovations Online course:

Latent Class Discrete Choice Modeling with Scale Factors

ANSWERS Session 2:

Putting it All Together – Scale Adjusted Latent Class (SALC) Models in Practice

Exercise A1

SPSS syntax:

```
SORT CASES  BY True.
SPLIT FILE LAYERED BY True.

GRAPH
  /SCATTERPLOT(BIVAR)=est_b1 WITH est_b4 BY clu#
  /MISSING=LISTWISE.

SPLIT FILE OFF.
```

Note. An earlier version of SALC_Sim1_Resp.sav mistakenly had 'True=3' coded as 'True=1'.

Question A1.1: Which of the classes (the ones plotted in red, green and/or black) are correctly classified?

The respondents plotted in green. These are classified in segment 3 while they their true class is 3 as well.

Question A1.2: Examining the plot in Figure 1, would you say that these respondents who are correctly classified tend to be *more* or *less* consistent in their responses than the respondents who are misclassified?

The respondents that are correctly classified are more consistent. It makes sense that those who are less consistent in their responses would have a greater chance of being misclassified.

As can be seen from the following crosstab this hypothesis is supported.

```
SORT CASES  BY True.
SPLIT FILE LAYERED BY True.
```

*Select Set=1 to only include each respondent once.

```
CROSSTABS
  /TABLES=clu# BY sclss
  /FORMAT=AVALUE TABLES
  /CELLS=COUNT ROW
  /COUNT ROUND CELL.

SPLIT FILE OFF.
```

Class modal * sclss * True Crosstabulation

True			sclss 1	sclss 2	Total
1	Class modal	1	98	85	183
			53.6%	46.4%	100.0%
		3	1	5	6
			16.7%	83.3%	100.0%
		4	1	10	11
			9.1%	90.9%	100.0%
	Total		100	100	200
			50.0%	50.0%	100.0%
2	Class modal	2	100	94	194
			51.5%	48.5%	100.0%
		4	0	6	6
			0.0%	100.0%	100.0%
	Total		100	100	200
			50.0%	50.0%	100.0%
3	Class modal	1	2	12	14
			14.3%	85.7%	100.0%
		3	98	74	172
			57.0%	43.0%	100.0%
		4	0	14	14
			0.0%	100.0%	100.0%
	Total		100	100	200
			50.0%	50.0%	100.0%

As can be seen among the 200 True=3 respondents, 57% are correctly classified into class 3 truly belong to sclass 1, the *more* consistent population scale class. In contrast, only 14% of those misclassified into class 1 and 0% of those misclassified into class 4 belong to the *more* consistent population scale class.

Question A1.3: How many of the 200 respondents that truly belong to segment 3 are misclassified?

```
*Select Set=1 to only include each respondent once.
COMPUTE filter_$=(Set=1).
VARIABLE LABELS filter_$ 'Set=1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
CROSSTABS
  /TABLES=True BY clu#
  /FORMAT=AVALUE TABLES
  /CELLS=COUNT ROW
  /COUNT ROUND CELL.

FILTER OFF.
USE ALL.
EXECUTE.
```

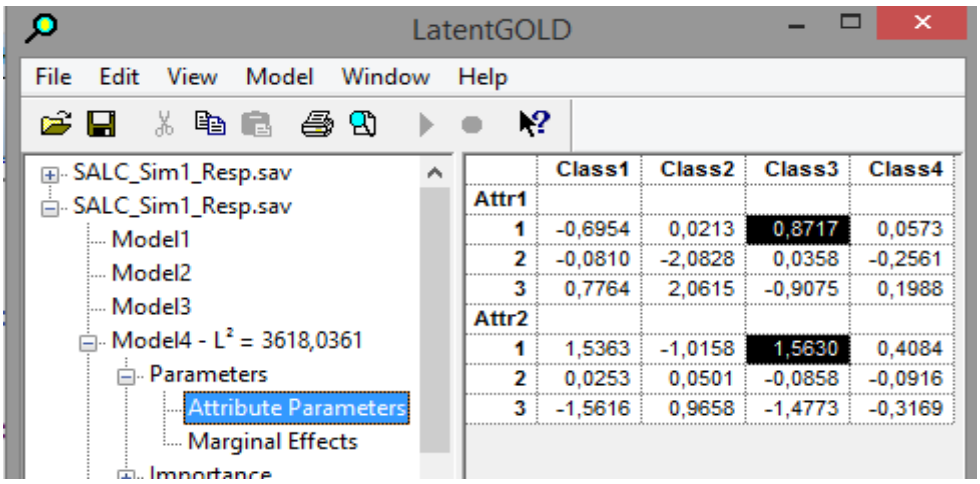
True * Class modal Crosstabulation

			Class modal				
			1	2	3	4	Total
True	1	Count	0	194	0	6	200
		% within True	.0%	97.0%	.0%	3.0%	100.0%
	2	Count	183	0	6	11	200
		% within True	91.5%	.0%	3.0%	5.5%	100.0%
	3	Count	14	0	172	14	200
		% within True	7.0%	.0%	86.0%	7.0%	100.0%
Total		Count	197	194	178	31	600
		% within True	32.8%	32.3%	29.7%	5.2%	100.0%

14+0+14=28 respondents.

Question A1.4: In Figure 1, why do many green points appear at (b1,b2) = (.87, 1.56) rather than at the true population value (b1,b2) = (1,2)?

These respondents are around (.87, 1.56) because the true parameter values of 1 and 2 are estimated as .87 and 1.56, respectively.



	Class1	Class2	Class3	Class4
Attr1				
1	-0,6954	0,0213	0,8717	0,0573
2	-0,0810	-2,0828	0,0358	-0,2561
3	0,7764	2,0615	-0,9075	0,1988
Attr2				
1	1,5363	-1,0158	1,5630	0,4084
2	0,0253	0,0501	-0,0858	-0,0916
3	-1,5616	0,9658	-1,4773	-0,3169

Question A2.1: From the patterns shown in Figure 2, what can you say about the relative scale factors for respondents classified into classes 1, 3 and 4?

Note the following patterns:

1. Respondents in classes 1 and 3 follow a more or less straight line, and therefore differ primarily in scale, the difference in individual coefficients (class 4 has more extreme coefficients) being explainable by a higher scale factor for class 4.

2. Respondents in classes 4 and 3 follow a more or less straight line and therefore differ primarily in scale, the difference in individual coefficients (class 1 has less extreme coefficients, at least with respect to b1) being explainable by a lower scale factor for class 1.

These explanations are supported by the following table.

```
USE ALL.
COMPUTE filter_$=(Set=1).
VARIABLE LABELS filter_$ 'Set=1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.

SORT CASES  BY True.
SPLIT FILE LAYERED BY True.
```

```
MEANS TABLES=norm BY Class#
  /CELLS MEAN COUNT STDDEV.

FILTER OFF.
USE ALL.
EXECUTE.
```

Report

norm

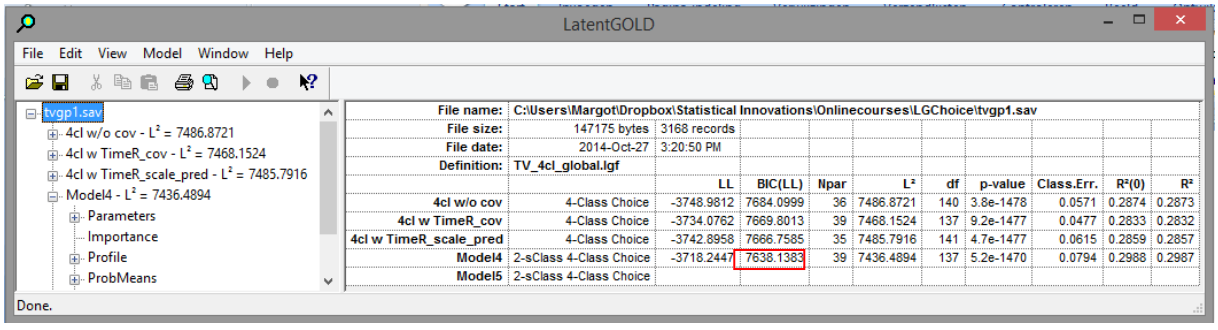
True	Latent Class Modal	Mean	N	Std. Deviation
1	1	.0874	192	.52587
	3	.6208	5	.55978
	4	-.4210	3	.26043
	Total	.0931	200	.53237
2	2	-.0102	200	.56738
	Total	-.0102	200	.56738
3	1	.5983	8	.66951
	3	.3462	75	.46531
	4	-.3614	117	.50756
	Total	-.0577	200	.61599

The mean of the true population log-scale factor ('norm') is highest for class 1, lowest for class 4, and in the middle for class 3.

Question A2.2: What can you conclude about the consequences of ignoring scale factors when these are present in the population?

This increases the number of cases misclassified.

Question B1.1: Which of the 4 estimated models fits best?

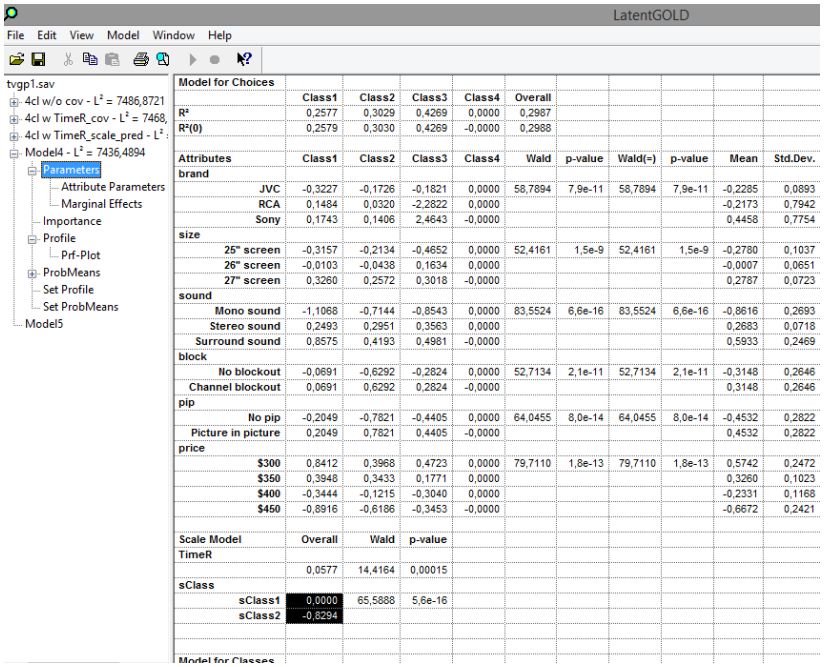


The new hybrid model fits best (lowest BIC value).

Question B1.2 For the new SALC model:

a) Which of the 2 sClasses is associated with the higher scale factor?

From the parameter output can be seen that sCLass 1 has a scale factor of 0 and sClass 2 has a scale factor of -.8294. sCLass 1 has the highest scale factor.



Model for Choices										
	Class1	Class2	Class3	Class4	Overall					
R^2	0,2577	0,3029	0,4269	0,0000	0,2987					
$R^2(0)$	0,2579	0,3030	0,4269	-0,0000	0,2988					
Attributes	**Class1**	**Class2**	**Class3**	**Class4**	**Wald**	**p-value**	**Wald(=)**	**p-value**	**Mean**	**Std.Dev.**
brand										
JVC	-0,3227	-0,1726	-0,1821	0,0000	58,7894	7,9e-11	58,7894	7,9e-11	-0,2285	0,0893
RCA	0,1484	0,0320	-2,2822	0,0000					-0,2173	0,7942
Sony	0,1743	0,1406	2,4643	-0,0000					0,4458	0,7754
size										
25" screen	-0,3157	-0,2134	-0,4652	0,0000	52,4161	1,5e-9	52,4161	1,5e-9	-0,2780	0,1037
26" screen	-0,0103	-0,0438	0,1634	0,0000					-0,0007	0,0651
27" screen	0,3260	0,2572	0,3018	-0,0000					0,2787	0,0723
sound										
Mono sound	-1,1068	-0,7144	-0,8543	0,0000	83,5524	6,6e-16	83,5524	6,6e-16	-0,8616	0,2693
Stereo sound	0,2493	0,2951	0,3563	0,0000					0,2683	0,0718
Surround sound	0,8575	0,4193	0,4981	-0,0000					0,5933	0,2469
block										
No blockout	-0,0691	-0,6292	-0,2824	0,0000	52,7134	2,1e-11	52,7134	2,1e-11	-0,3148	0,2646
Channel blockout	0,0691	0,6292	0,2824	-0,0000					0,3148	0,2646
pip										
No pip	-0,2049	-0,7821	-0,4405	0,0000	64,0455	8,0e-14	64,0455	8,0e-14	-0,4532	0,2822
Picture in picture	0,2049	0,7821	0,4405	-0,0000					0,4532	0,2822
price										
$300	0,8412	0,3968	0,4723	0,0000	79,7110	1,8e-13	79,7110	1,8e-13	0,5742	0,2472
$350	0,3948	0,3433	0,1771	0,0000					0,3260	0,1023
$400	-0,3444	-0,1215	-0,3040	0,0000					-0,2331	0,1168
$450	-0,8916	-0,6186	-0,3453	-0,0000					-0,6672	0,2421

Scale Model	Overall	Wald	p-value
TimeR			
	0,0577	14,4164	0,00015
sClass			
sClass1	0,0000	65,5888	5,6e-16
sClass2	-0,8294		

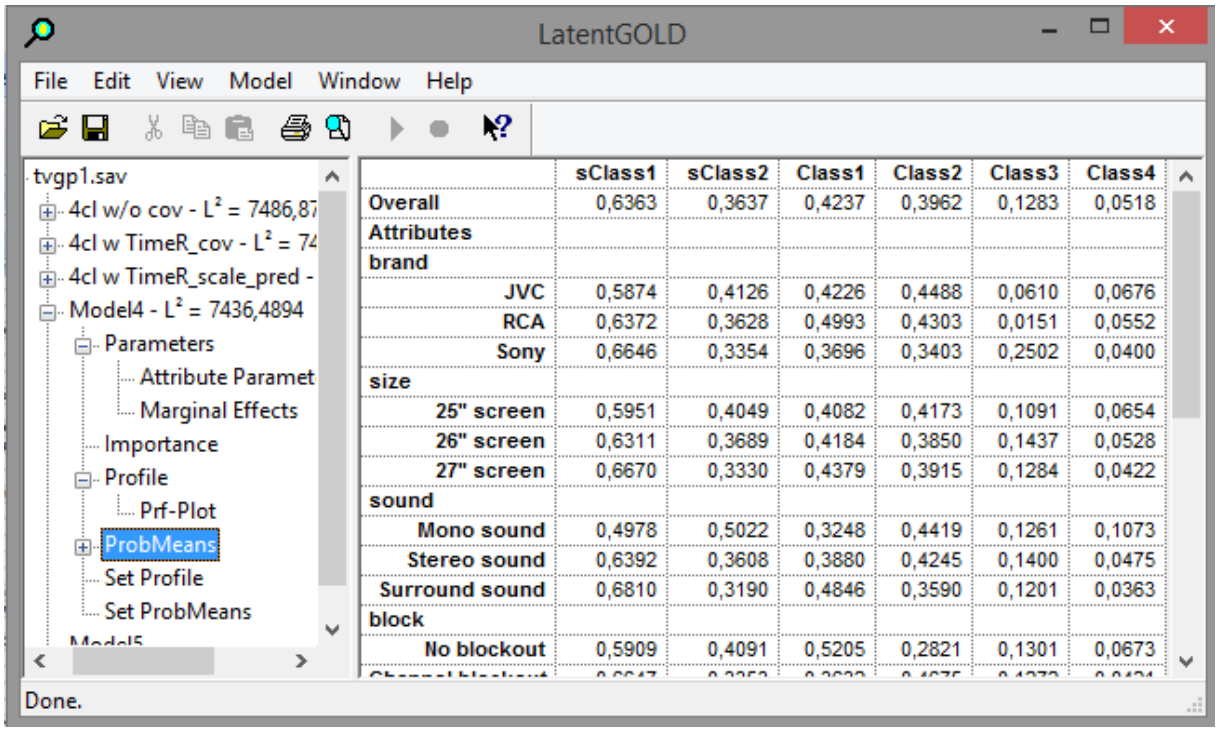
Model for Classes

b) What is the p-value associated with the effect of the sClasses in the scale model?

From the parameter output can be seen that p=5.6E-16.

c) Which of the 2 sClasses is larger?

From the ProbMeans output it can be seen that sClass 1 is larger than sClass 2 (class sizes are .6363 and .3637, respectively).

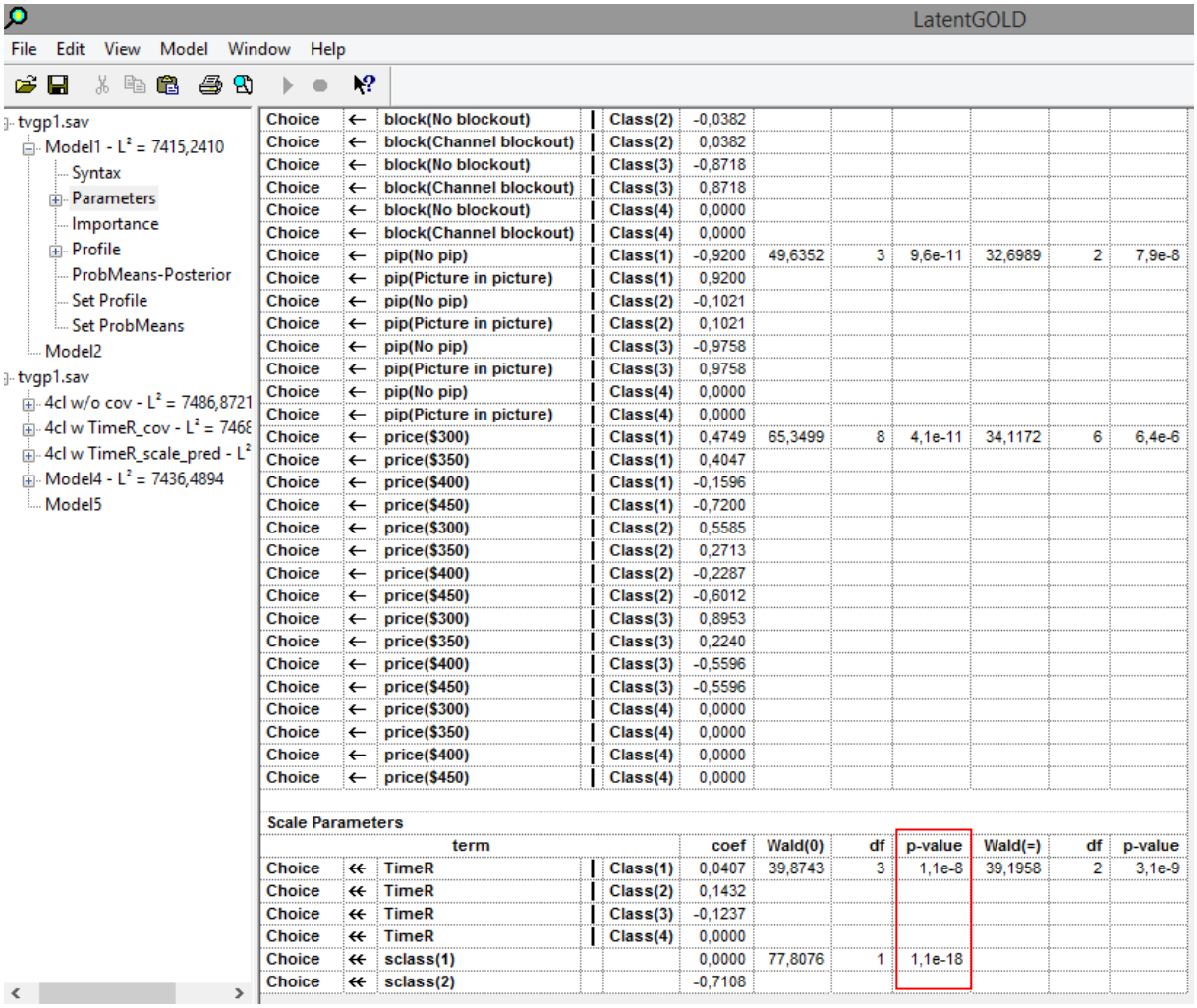


	sClass1	sClass2	Class1	Class2	Class3	Class4
Overall	0,6363	0,3637	0,4237	0,3962	0,1283	0,0518
Attributes						
brand						
JVC	0,5874	0,4126	0,4226	0,4488	0,0610	0,0676
RCA	0,6372	0,3628	0,4993	0,4303	0,0151	0,0552
Sony	0,6646	0,3354	0,3696	0,3403	0,2502	0,0400
size						
25" screen	0,5951	0,4049	0,4082	0,4173	0,1091	0,0654
26" screen	0,6311	0,3689	0,4184	0,3850	0,1437	0,0528
27" screen	0,6670	0,3330	0,4379	0,3915	0,1284	0,0422
sound						
Mono sound	0,4978	0,5022	0,3248	0,4419	0,1261	0,1073
Stereo sound	0,6392	0,3608	0,3880	0,4245	0,1400	0,0475
Surround sound	0,6810	0,3190	0,4846	0,3590	0,1201	0,0363
block						
No blockout	0,5909	0,4091	0,5205	0,2821	0,1301	0,0673

Question B2.1: Does this updated model improve the fit to the data?

The BIC value for the new model is 7622 which is lower than the BIC values of the other models. Therefore, the updated model yields a better a fit to the data.

Question B2.2: Which scale model effect is more significant – the 'TimeR | class' effect or the 'sClass' effect?



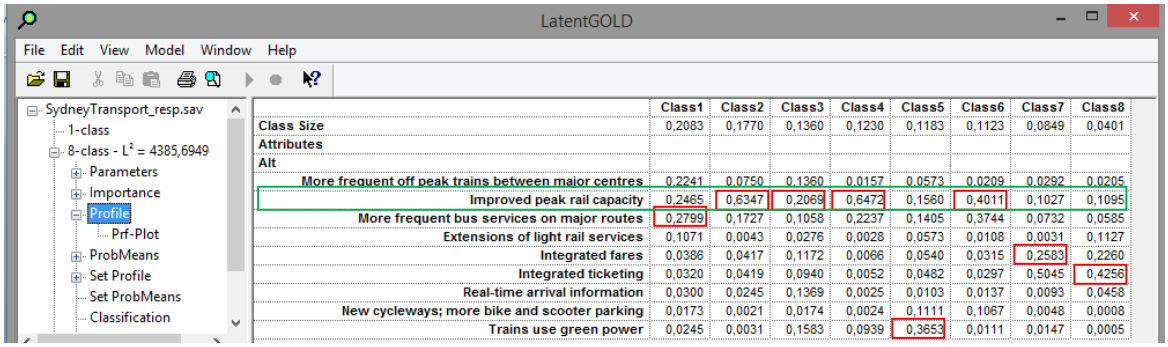
Choice	←	block(No blockout)	Class(2)	-0,0382						
Choice	←	block(Channel blockout)	Class(2)	0,0382						
Choice	←	block(No blockout)	Class(3)	-0,8718						
Choice	←	block(Channel blockout)	Class(3)	0,8718						
Choice	←	block(No blockout)	Class(4)	0,0000						
Choice	←	block(Channel blockout)	Class(4)	0,0000						
Choice	←	pip(No pip)	Class(1)	-0,9200	49,6352	3	9,6e-11	32,6989	2	7,9e-8
Choice	←	pip(Picture in picture)	Class(1)	0,9200						
Choice	←	pip(No pip)	Class(2)	-0,1021						
Choice	←	pip(Picture in picture)	Class(2)	0,1021						
Choice	←	pip(No pip)	Class(3)	-0,9758						
Choice	←	pip(Picture in picture)	Class(3)	0,9758						
Choice	←	pip(No pip)	Class(4)	0,0000						
Choice	←	pip(Picture in picture)	Class(4)	0,0000						
Choice	←	price($300)	Class(1)	0,4749	65,3499	8	4,1e-11	34,1172	6	6,4e-6
Choice	←	price($350)	Class(1)	0,4047						
Choice	←	price($400)	Class(1)	-0,1596						
Choice	←	price($450)	Class(1)	-0,7200						
Choice	←	price($300)	Class(2)	0,5585						
Choice	←	price($350)	Class(2)	0,2713						
Choice	←	price($400)	Class(2)	-0,2287						
Choice	←	price($450)	Class(2)	-0,6012						
Choice	←	price($300)	Class(3)	0,8953						
Choice	←	price($350)	Class(3)	0,2240						
Choice	←	price($400)	Class(3)	-0,5596						
Choice	←	price($450)	Class(3)	-0,5596						
Choice	←	price($300)	Class(4)	0,0000						
Choice	←	price($350)	Class(4)	0,0000						
Choice	←	price($400)	Class(4)	0,0000						
Choice	←	price($450)	Class(4)	0,0000						

Scale Parameters

		term		coef	Wald(0)	df	p-value	Wald(=)	df	p-value
Choice	↞	TimeR	Class(1)	0,0407	39,8743	3	1,1e-8	39,1958	2	3,1e-9
Choice	↞	TimeR	Class(2)	0,1432						
Choice	↞	TimeR	Class(3)	-0,1237						
Choice	↞	TimeR	Class(4)	0,0000						
Choice	↞	sclass(1)		0,0000	77,8076	1	1,1e-18			
Choice	↞	sclass(2)		-0,7108						

The sClass effect has a lower p-value so is more important.

Question C1.1: From the 8-class model, which classes have "Improved Peak Rail Capacity' as their highest priority?



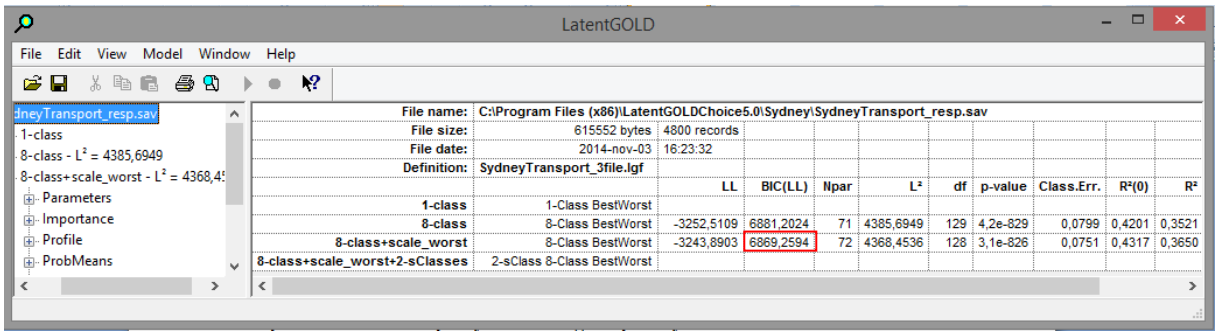
	Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8
Class Size	0,2083	0,1770	0,1360	0,1230	0,1183	0,1123	0,0849	0,0401
Attributes								
Alt								
More frequent off peak trains between major centres	0,2241	0,0750	0,1360	0,0157	0,0573	0,0209	0,0292	0,0205
Improved peak rail capacity	0,2465	0,6347	0,2069	0,6472	0,1560	0,4011	0,1027	0,1095
More frequent bus services on major routes	0,2799	0,1727	0,1058	0,2237	0,1405	0,3744	0,0732	0,0585
Extensions of light rail services	0,1071	0,0043	0,0276	0,0028	0,0573	0,0108	0,0031	0,1127
Integrated fares	0,0386	0,0417	0,1172	0,0066	0,0540	0,0315	0,2583	0,2260
Integrated ticketing	0,0320	0,0419	0,0940	0,0052	0,0482	0,0297	0,5045	0,4256
Real-time arrival information	0,0300	0,0245	0,1369	0,0025	0,0103	0,0137	0,0093	0,0458
New cycleways; more bike and scooter parking	0,0173	0,0021	0,0174	0,0024	0,1111	0,1067	0,0048	0,0008
Trains use green power	0,0245	0,0031	0,1583	0,0939	0,3653	0,0111	0,0147	0,0005

This information can be retrieved from the Profile output. Classes 2, 3, 4, and 6 have "Improved Peak Rail Capacity' as their highest priority.

Question C1.2: What percentage of the respondents are predicted by this model to have "Improved Peak Rail Capacity' as their highest priority?

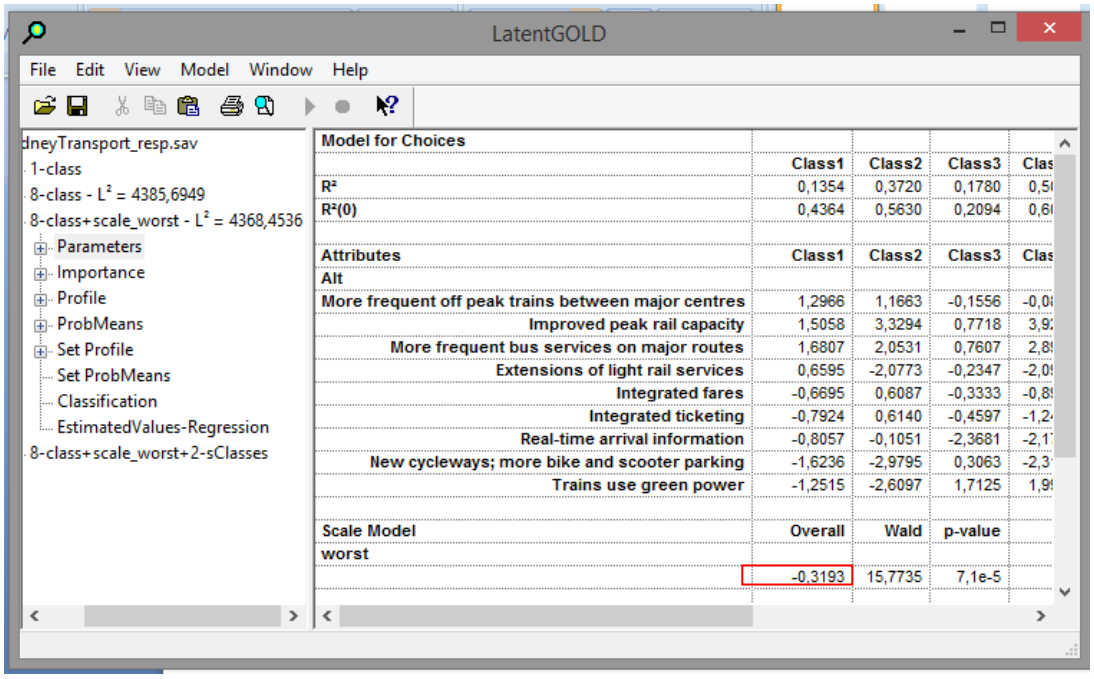
This is computed by adding the class sizes from the Profile output of Class 2, 3, 4, and 6 and multiplying this number by 100: (.1770+.1360+.1230+.1123)*100=25.9372%.

Question D1.1: Does this model improve model fit compared to the 8-class model without the scale factors?



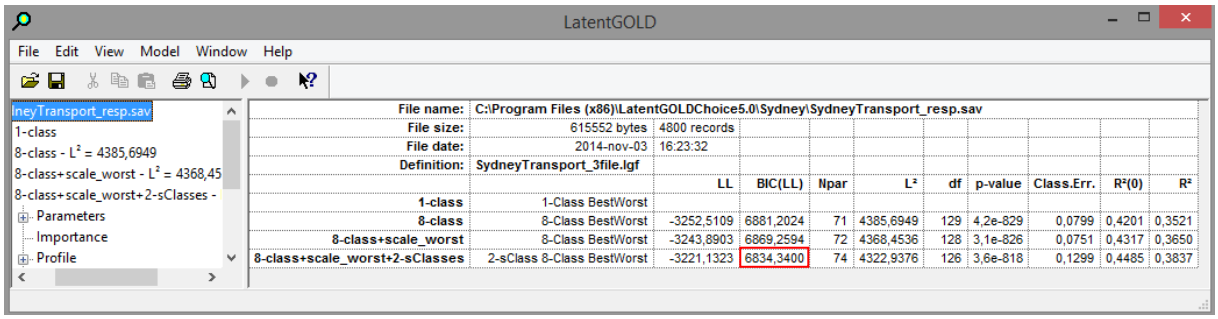
Yes, since the BIC is lower for the model with the scale factors.

Question D1.2: Is the Worst response associated with a higher or lower scale factor than Best response?



From the Parameters output can be seen that the scale parameter of the Worst response is negative (-.3193) on the log scale. Since the Scale factor for the Best response is 1 and EXP(-.3193)< 1, the Scale factor for the Worst response is lower.

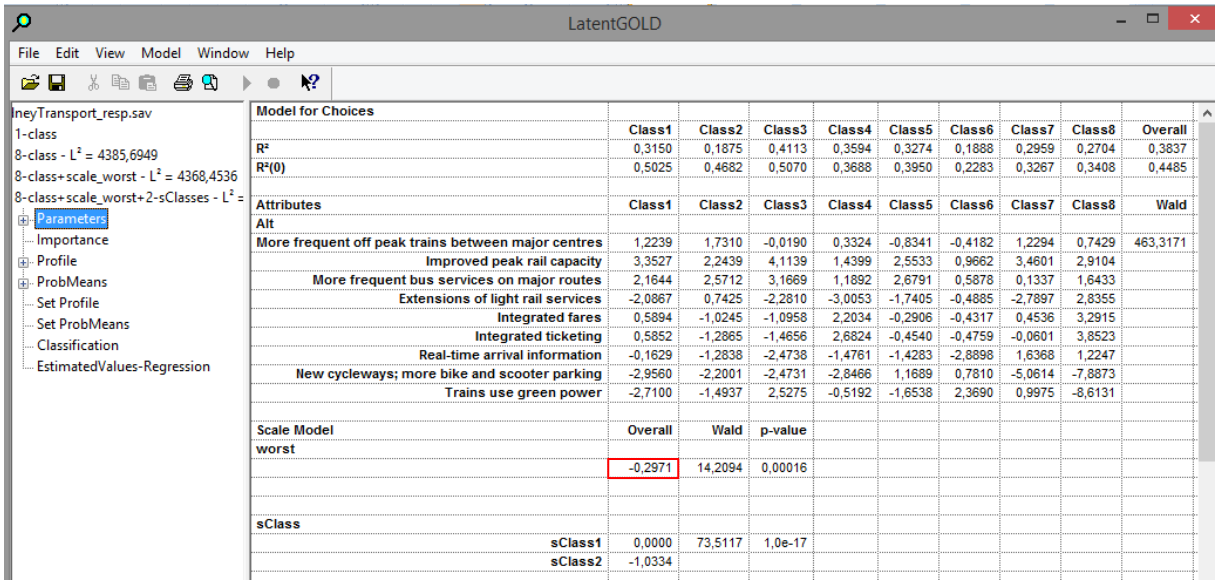
Question D1.3: Does including these scale classes improve the fit of the model?



File name:	C:\Program Files (x86)\LatentGOLDChoice5.0\Sydney\SydneyTransport_resp.sav									
File size:	615552 bytes	4800 records								
File date:	2014-nov-03	16:23:32								
Definition:	SydneyTransport_3file.lgf									
		LL	BIC(LL)	Npar	L²	df	p-value	Class.Err.	R²(0)	R²
1-class	1-Class BestWorst									
8-class	8-Class BestWorst	-3252,5109	6881,2024	71	4385,6949	129	4,2e-829	0,0799	0,4201	0,3521
8-class+scale_worst	8-Class BestWorst	-3243,8903	6869,2594	72	4368,4536	128	3,1e-826	0,0751	0,4317	0,3650
8-class+scale_worst+2-sClasses	2-sClass 8-Class BestWorst	-3221,1323	6834,3400	74	4322,9376	126	3,6e-818	0,1299	0,4485	0,3837

Yes, since the BIC value is lower.

Question D1.4: Is the Worst response associated with a higher or lower scale factor than Best response?



Model for Choices									
	Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8	Overall
R²	0,3150	0,1875	0,4113	0,3594	0,3274	0,1888	0,2959	0,2704	0,3837
R²(0)	0,5025	0,4682	0,5070	0,3688	0,3950	0,2283	0,3267	0,3408	0,4485

Attributes	Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8	Wald
Alt									
More frequent off peak trains between major centres	1,2239	1,7310	-0,0190	0,3324	-0,8341	-0,4182	1,2294	0,7429	463,3171
Improved peak rail capacity	3,3527	2,2439	4,1139	1,4399	2,5533	0,9662	3,4601	2,9104	
More frequent bus services on major routes	2,1644	2,5712	3,1669	1,1892	2,6791	0,5878	0,1337	1,6433	
Extensions of light rail services	-2,0867	0,7425	-2,2810	-3,0053	-1,7405	-0,4885	-2,7897	2,8355	
Integrated fares	0,5894	-1,0245	-1,0958	2,2034	-0,2906	-0,4317	0,4536	3,2915	
Integrated ticketing	0,5852	-1,2865	-1,4656	2,6824	-0,4540	-0,4759	-0,0601	3,8523	
Real-time arrival information	-0,1629	-1,2838	-2,4738	-1,4761	-1,4283	-2,8898	1,6368	1,2247	
New cycleways; more bike and scooter parking	-2,9560	-2,2001	-2,4731	-2,8466	1,1689	0,7810	-5,0614	-7,8873	
Trains use green power	-2,7100	-1,4937	2,5275	-0,5192	-1,6538	2,3690	0,9975	-8,6131	

Scale Model	Overall	Wald	p-value
worst			
	-0,2971	14,2094	0,00016
sClass			
sClass1	0,0000	73,5117	1,0e-17
sClass2	-1,0334		

From the Parameters output it can be seen that the scale parameter for the Worst response is negative (-.2971) on the log scale. Since the Scale factor for the Best response is 1 and EXP(-.2971)< 1, the Scale factor for the Worst response is lower. Note that this parameter estimate has not changed much compared to the previous model.

Question D1.5: Which scale model effect is more important – the 'Worst' effect or the 'sClass' effect?

The p-value for the 'sClass' effect (p=1.0E-17) is lower than the p-value for the 'Worst' effect (p=.00016), so the answer is the 'sClass' effect.

Question D1.6: Question D1.6: Does including scale effects improve the hit rate of the Best and Worst response?

Yes, the 8-class model without scale effects has the lowest hit rates. Note: the hit rate can be computed from Latent GOLD's summary output from either 1) the Prediction Error or 2) the Prediction Table as shown below:

1) Compute 1 minus the prediction error

Model	Best	Worst
8-class	1-.2838=.7162	1-.2533=.7467
8-class + scale_worst	1-.2767=.7233	1-.2638=.7362
8-class + scale_worst+2sClasses	1-.2771=.7229	1-.2646=.7354

or

2) Divide the sum of the off the diagonals of the prediction table by the overall total

Model	Best	Worst
8-class	(1161+303+255)/2400=.7163	(233+627+932)/2400=.7467
8-class + scale_worst	(1148+318+270)/2400=.7233	(232+619+916)/2400=.7363
8-class + scale_worst+2sClasses	(1160+309+266)/2400=.7229	(224+631+910)/2400=.7354