Psyc492 Multiple Regression Hypothses Testing Tour

These data were obtained from group of graduating High School seniors from a large eastern school district. All of the students in the data base went to college the fall after they graduated high school. The data for the predictor variables were all collected the week before high school graduation, or were taken from their high school transcript. Each student was contacted at the end of their first semester of college to collect the criterion variables.

Data set → **talent_222_walkthru.sav**

Criterion variables → **College Performance (1st semester gpa)**

Predictor variables → **High School Performance variables (standardized tests in reading, writing, math, science and civics)**

→ **Demographic variables (Neighborhood they grew in urban/riral, Socioeconomic Status, Locus of Control (higher is more external)**

Lets take a look at four of the major kinds of "hypothesis testing" used in multiple regression

- #1 Building a single model
- #2 Comparing nested models
- #3 Comparing non-nested models
- #4 Comparing a model across populations
- #5 Comparing a model across criterion variables

Before we start testing models!!

- Always look at the frequencies, mean, std, skewness, minimum value and maximum value of each variable to see if there is anything "squirrely" (negative values, a multiple-category variable, substantial skewing) and how it may influence how you analyze the data and your results
- Also, get the correlations -- all of them
    - Correlations between the criterion
    - Correlations of each criterion with all the predictors
    - Correlations among the predictors (called collinearities)

#1 – Getting a single model, using "all the predictors" and one criterion

Let's start with the performance variable (gpa) as the criterion variable.

When we say "all the predictors" we don't mean "every variable" or even "all the variables in the data set", we mean "all the variables we have decided to include".

Analyze → Regression → Linear

Load in the criterion and the predictors and click "OK"

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795[a]	.633	.602	.82769

a. Predictors: (Constant), CIVICS SCORE M=50 S=10, NEIGHBORHOOD, HIGH SCHOOL PROGRAM, MATH SCORE   M=50 S=10, SOCIO-ECONOMOC-STATUS, LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	127.508	9	14.168	20.681	.000[b]
	Residual	73.987	108	.685		
	Total	201.496	117			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), CIVICS SCORE M=50 S=10, NEIGHBORHOOD, HIGH SCHOOL PROGRAM, MATH SCORE   M=50 S=10, SOCIO-ECONOMOC-STATUS, LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

The Model Summary table tells us the R-square of the model (what proportion of the variance in the criterion is accounted for by the predictor model)

- This model accounts for about 63% of the variance in the criterion – a very strong model.

ANOVA table reports the test of whether the H0: that   R-square = 0

- The p-value tells us to reject that null and conclude that the "model works better than is expected by chance, taking the sample size into account"

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.014	.625		-4.823	.000
	NEIGHBORHOOD	.147	.158	.056	.930	.354
	SOCIO-ECONOMOC-STATUS	.027	.118	.015	.232	.817
	HIGH SCHOOL PROGRAM	.055	.145	.023	.381	.704
	LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	.030	.119	.016	.252	.802
	READING SCORE M=50 S=10	.033	.007	.403	5.101	.000
	WRITING SCORE M=50 S=10	.033	.012	.264	2.801	.006
	MATH SCORE M=50 S=10	.022	.006	.246	3.587	.001
	SCIENCE SCORE M=50 S=10	.011	.011	.086	1.029	.306
	CIVICS SCORE M=50 S=10	.014	.012	.101	1.164	.247

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

These are the "regression weights" or "coefficients" – we will use these to interpret the model

Note which predictors have significant loadings (H0: B = 0)

- Reading, Writing and Math have (positive) significant regression weights – which means that these have "unique contributions to the model".

The "Beta weights" can be used to consider the "relative importance" of the contributing predictors.

- Reading seems to be somewhat more important to the model than the other two significant predictors.

We would conclude that the model "works" and that Reading, Writing and Math have significant independent contributions to the model!

If we had specific hypotheses about which variables do and don't contribute to the model, we would test those using the regression weights and significance test shown here.

#2 – Comparing nested models

Since the criterion variable is college performance, it makes sense to predict college performance from high school performance! But, do the other variables in the model (demographic and "personality" variables) "add anything"? To do this, we will test nested models!

Full model → reading, writing, math, science, civics, neighborhood, ses, high school prog & Locus of control

Reduced model (the model we want to test if it is "sufficient") → reading, writing, math, science &civics

First we're going to build the **"reduced model",** with just the five high school performance variables, This is the "**reduced model**" because it only has a subset of the predictors in it.

Analyze → Regression → Linear

Put in College Performance as the criterion (Dependent).

Put in five high school performance as the predictors (Independents).

This is the "**reduced model**" because it only has a subset of the predictors in it. **Then click "Next"**

It should now say "Block 2 of 2"

Then, we will build the "**full model**" by adding in the four demographic and personality variables. This will be the "**full model**" because it has all nine of the predictors in it.

Put in the four additional demographic and personality variables.

This is making the "**full model**" by adding in "the rest of the variables"

Now click on the "Statistics" button.

Be sure that all of these are checked

- Estimates
- Model fit
- R squared Change

Then click "**Continue**" on this window and "**OK**" on the main Linear Regression window.

Here's the first part of the output – you have to read these two tables together to understand each model and their comparison.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	.793[a]	.629	.613	.81679	.629	38.005	5	112	.000
2	.795[b]	.633	.602	.82769	.004	.268	4	108	.898

a. Predictors: (Constant), CIVICS SCORE M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

b. Predictors: (Constant), CIVICS SCORE   M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10, NEIGHBORHOOD, HIGH SCHOOL PROGRAM, SOCIO-ECONOMOC-STATUS, LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	126.775	5	25.355	38.005	.000[b]
	Residual	74.721	112	.667		
	Total	201.496	117			
2	Regression	127.508	9	14.168	20.681	.000[c]
	Residual	73.987	108	.685		
	Total	201.496	117			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), CIVICS SCORE M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

c. Predictors: (Constant), CIVICS SCORE M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10, NEIGHBORHOOD, HIGH SCHOOL PROGRAM, SOCIO-ECONOMOC-STATUS, LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)

What about the first model (the reduced model with only the high school performance variables)?

- Look at the Model Summary table – first row. It tells us (on the left) that the reduced model with the five high school performance variables accounts for 62.9% of the variance in college grades
- Look at the top part of the ANOVA – first 3 rows. It tells us that this model "works" (p= .000).

What about the second model (the full model with the demographic and personality variables added in)?

- Look at the Model Summary table – second row. It tells us (on the left) that the full model with all nine predictors in it accounts for 63.3% of the variance in college grades.
- Look at the bottom part of the ANOVA table – bottom 3 rows. It tells us that the full model "works" (p=.000).

What about comparing the models (do the demographic and personality variables add anything to the reduced model using only the high school performance variables)?

- Look at the Model Summary Table – right side, bottom row
- This tells us that the full model (with all 9 predictors) accounts for .4% (R-square change = .004) more variance than the reduced model (with only the high school performance predictors).
- The F- test tell us that there is no difference between the R-square of the two models (p = .858)

So… We would conclude that the reduced model including the 5 high school performance predictors "works as well" to predict College performance as does the full model that also includes the demographic and personality predictors.

Here is the rest of the output – it gives the regression weights for each model and their significance tests.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2.743	.441		-6.224	.000
	READING SCORE M=50 S=10	.034	.006	.410	5.378	.000
	WRITING SCORE M=50 S=10	.032	.012	.256	2.778	.006
	MATH SCORE M=50 S=10	.022	.006	.244	3.639	.000
	SCIENCE SCORE M=50 S=10	.012	.010	.095	1.168	.245
	CIVICS SCORE M=50 S=10	.015	.011	.112	1.347	.181
2	(Constant)	-3.014	.625		-4.823	.000
	READING SCORE M=50 S=10	.033	.007	.403	5.101	.000
	WRITING SCORE M=50 S=10	.033	.012	.264	2.801	.006
	MATH SCORE M=50 S=10	.022	.006	.246	3.587	.001
	SCIENCE SCORE M=50 S=10	.011	.011	.086	1.029	.306
	CIVICS SCORE M=50 S=10	.014	.012	.101	1.164	.247
	NEIGHBORHOOD	.147	.158	.056	.930	.354
	SOCIO-ECONOMOC-STATUS	.027	.118	.015	.232	.817
	HIGH SCHOOL PROGRAM	.055	.145	.023	.381	.704
	LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	.030	.119	.016	.252	.802

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

Looking at Model 1 (the reduced model with the 5 high school performance predictors), we see that Reading, Writing, and Math contribute significantly to the model (have significant p-values) and Science & Civics do not.

Looking at Model 2 (the full model with the 4 demographic and personality predictors added in with the 5 high school performance predictors), we see that again, only Reading, Writing and Civics contribute to the model.

Since none of the variables added in on the second step contribute to the model, it is easy to see why the model fit doesn't improve when the demographic and personality variables are added.

#3 – Comparing non-nested models

When comparing nested models, we usually end up specifying two different models: 1) the model defined by the reduced model (e.g., the 5 high school performance variables) and 2) the model defined by the variables added to the reduced model to form the full model (e.g., the 4 demographic and personality variables).

In addition to asking if one set "adds to" the other, we will probably want to compare them – which model "does better"?

To do that we will first run each model separately – to see how well each model works. Then we will need to get the correlation between the two models (SPSS makes this really easy). Finally, we will use the Computator to perform a Steiger's Z-test to compare the two models, to see if one "accounts for the criterion" better?

Analyze → Regression → Linear

First → Getting the High School Performance model (and the predicted criterion values from it)

Analyze → Regression → Linear

This will look like the first step of the last analysis but I always do it over to I have things together in the output window).
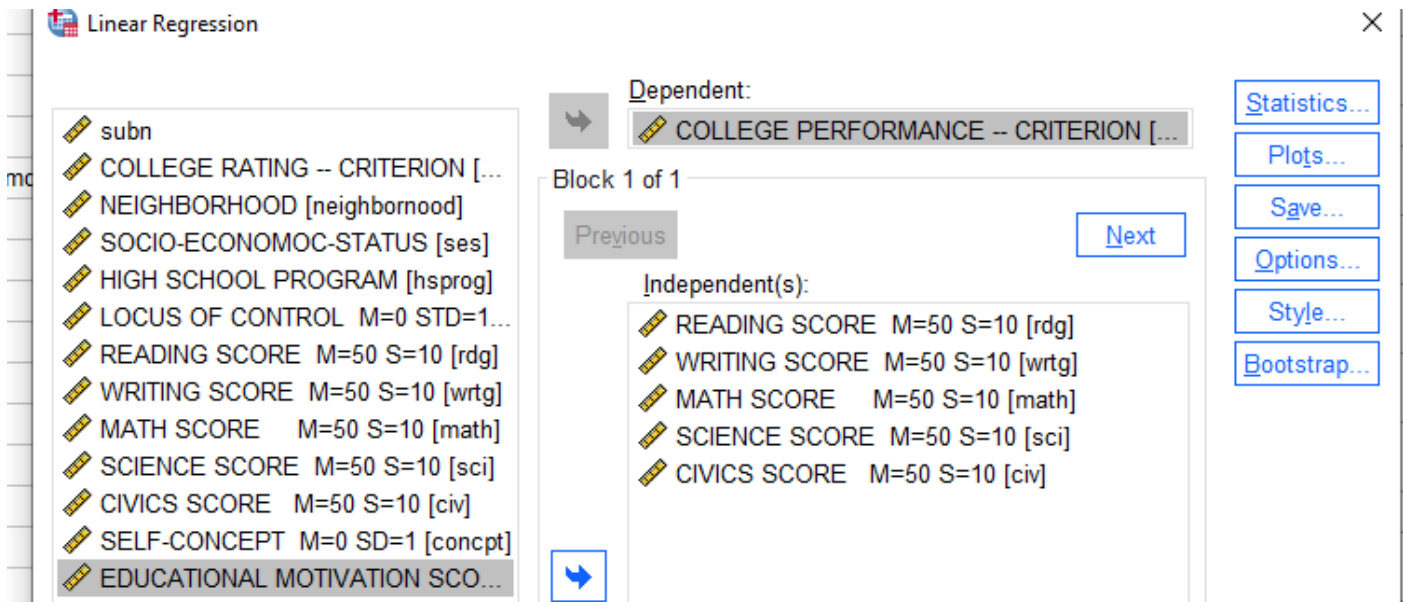
Select the Dependent variable and then select the high school performance variables.

THEN → click on the SAVE button
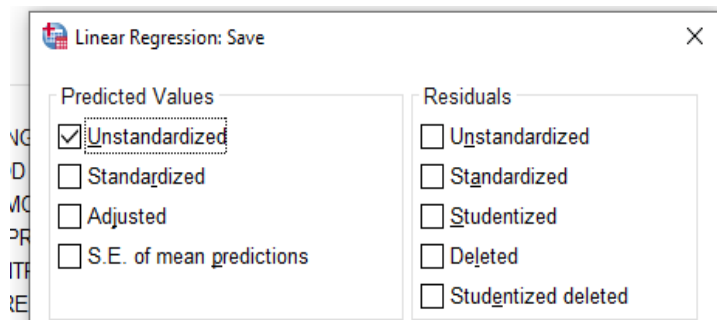
Be sure to check "Unstandardized" box.

SPSS will build the model, and then will use that model to calculate a "predicted college GPA" score for each person.

We'll need that later!

Here's the output for the High School Performance model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.793[a]	.629	.613	.81679

a. Predictors: (Constant), CIVICS SCORE   M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	126.775	5	25.355	38.005	.000[b]
	Residual	74.721	112	.667		
	Total	201.496	117			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), CIVICS SCORE   M=50 S=10, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2.743	.441		-6.224	.000
	READING SCORE M=50 S=10	.034	.006	.410	5.378	.000
	WRITING SCORE M=50 S=10	.032	.012	.256	2.778	.006
	MATH SCORE M=50 S=10	.022	.006	.244	3.639	.000
	SCIENCE SCORE M=50 S=10	.012	.010	.095	1.168	.245
	CIVICS SCORE M=50 S=10	.015	.011	.112	1.347	.181

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

We see that the model has an R-square of .629, which is significant. We can also see that (like before) only Reading, Writing and Science have significant contributions to the model.

Later we will need the R from this analysis → The R = .793 for the High School Performance model

Second → Getting the Demographic and Personality model (and the predicted criterion values from it)

This will different from anything we've run yet (we've never made a model just with these variables).
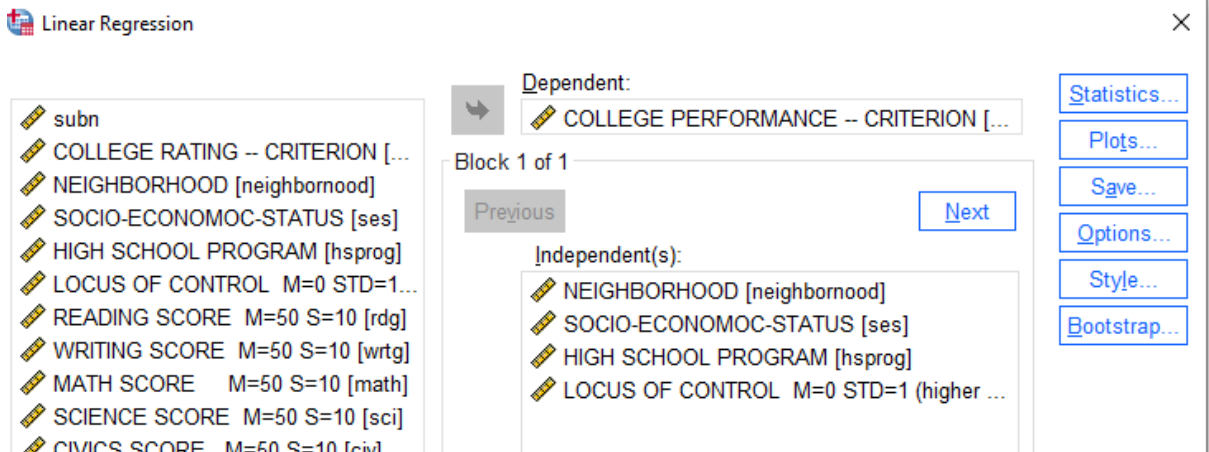
Select the Dependent variable and then select the demographic and personality variables.

THEN → click on the SAVE button

	Be sure to check "Unstandardized" box. Like on the last step, SPSS will build the model, and then will use that model to calculate a "predicted college GPA" score for each person. We'll need that later!

Here's the output for the Demographics & Personality model

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.448[a]	.201	.172	1.19385

a. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS

b. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.439	4	10.110	7.093	.000[b]
	Residual	161.056	113	1.425		
	Total	201.496	117			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS

Coefficients[a]

| Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.806	.595		3.036	.003
	NEIGHBORHOOD	.288	.225	.109	1.280	.203
	SOCIO-ECONOMOC-STATUS	.491	.157	.268	3.138	.002
	HIGH SCHOOL PROGRAM	-.251	.202	-.105	-1.246	.215
	LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	.554	.155	.303	3.569	.001

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

We see that the model has an R-square of .201, which is significant. We can also see that only Socio economic level and Locus of Control have significant contributions to the model.

Later we will need the R from this analysis → The R = .448 for the Demographics and Personality model

Third → We want to compare the R from the two models, to see if one is significantly larger than the other!

We will do that using the Steiger's Z-test page in the Computator, Here's what that part of the Computator looks like.

	A	B	C	D	E	F	G
	Steiger's Z-test - Comparing Correlated Correlations						
			r(1,2) =>	**0.793**			
			r(1,3) =>	**0.448**			
			r(2,3) =>	**0.538**			
			N =>	**118**			
			Z =	**5.574**			
			p =	**2.49E-08**			
	Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. Psy						

To get the necessary values for this, we need the correlations of each model -- r(1,2) & r(1,3). And we also need the correlation between the two models – r()2,3) .

We found R = .793 for the 5 predictor High School Performance model

We found R = .448 for the 4 predictor Demographic & Personality model

All we need is the correlation between the two models! Remember that, when we got each model, we asked SPSS to compute and save the predicted score based on that model? Well, the correlation between the predicted scores for the two models IS the correlation between the models!!

If we look at the bottom of the data set, we will se two new variables – PRE_1 and PRE_2. These are the predicted scores for each model.

11	sci	Numeric	8	2	SCIENCE SCORE M=50 S=10
12	civ	Numeric	8	2	CIVICS SCORE M=50 S=10
13	concpt	Numeric	8	2	SELF-CONCEPT M=0 SD=1
14	motv	Numeric	8	2	EDUCATIONAL MOTIVATION SCORE
15	PRE_1	Numeric	11	5	Unstandardized Predicted Value
16	PRE_2	Numeric	11	5	Unstandardized Predicted Value
17					
18					

I suggest editing the variable name of these, so you'll know what they are in correlation output. Here's what I called them.

1	sci	Numeric	8	2	SCIENCE SCORE M=50 S=10	None
2	civ	Numeric	8	2	CIVICS SCORE M=50 S=10	None
3	concpt	Numeric	8	2	SELF-CONCEPT M=0 SD=1	None
4	motv	Numeric	8	2	EDUCATIONAL MOTIVATION SCORE	None
5	PRE_1	Numeric	11	5	High School model predicted values	None
6	PRE_2	Numeric	11	5	Demo & Personality model predicted valuesValue	None

So, to get the correlation between the models, we need only get the correlation between these predicted score variables

We do that running a regular correlation. I also added in the criterion variable, just to have all the values we need in one place…

Bivariate Correlations   ✕

Variables:
- COLLEGE PERFORMANCE…
- High School model predicted…
- Demo & Personality model p…

Options…
Style…
Bootstrap…

subn
COLLEGE RATING -- CRI…
NEIGHBORHOOD [neighb…
SOCIO-ECONOMOC-STA…
HIGH SCHOOL PROGRA…
LOCUS OF CONTROL M…
READING SCORE M=50 …
WRITING SCORE M=50 …

Correlation Coefficients
☑ Pearson ☐ Kendall's tau-b ☐ Spearman

The results are…

Correlations

		COLLEGE PERFORMANCE -- CRITERION	High School model predicted values	Demo & Personality model predicted valuesValue
COLLEGE PERFORMANCE -- CRITERION	Pearson Correlation	1	.793**	.448**
	Sig. (2-tailed)		.000	.000
	N	118	118	118
High School model predicted values	Pearson Correlation	.793**	1	.538**
	Sig. (2-tailed)	.000		.000
	N	118	118	118
Demo & Personality model predicted valuesValue	Pearson Correlation	.448**	.538**	1
	Sig. (2-tailed)	.000	.000	
	N	118	118	118

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation of college performance and the High School Perf model of .793 matches the R from the High School Perf model from above.

The correlation of college performance and the Demo & Personality model of .448 matches the R from the Demographics and Personalty model from above also.

The correlation of the two models is the correlation between the two sets of predicted score – r = .538.

We will also need the sample size – N = 118

	A	B	C	D	E	F	G
	Steiger's Z-test - Comparing Correlated Correlations						
			r(1,2) =>	0.793			
			r(1,3) =>	0.448			
			r(2,3) =>	0.538			
			N =>	118			
			Z =	5.574			
			p =	2.49E-08			
	Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. Psy						

When we plug in the correlations and the N, we get a Z-value of 5.574, which is significant with a p-value of .0000000249.

We would conclude that models fit the data differentially well. Specifically we would conclude that the High School Performance model predicts College GPA significantly better than does the Demographic and Personality model.

#4 -- Comparing a model across populations

A lot of the time we are working with a single population and want do compare different models within that single population. But, sometime, we have more that one population/group and want to know if a particular model "works differently" for two different populations/groups.

There are two different questions we can ask about if a model "works differently" for two different populations:

- Does the mode "work better" for one population versus the other? Asking if the R-square of the model is higher for one population/group than the other?
- Are the regression weights for the predictors in the model different for the two populations?

What we are going to do is to get the same model for the two different groups and then make these two comparisons.

The two populations/groups we are going to compare are those who were raised in an "Urban" versus raised in a "Rural" neighborhood'

The model we will use is the full model from above (without the Neighborhood variable – since it is the grouping variable).

First → we have to "split" the sample into the two groups/populations. To do that we will use the "Split File" function in SPSS.

Date → Split File
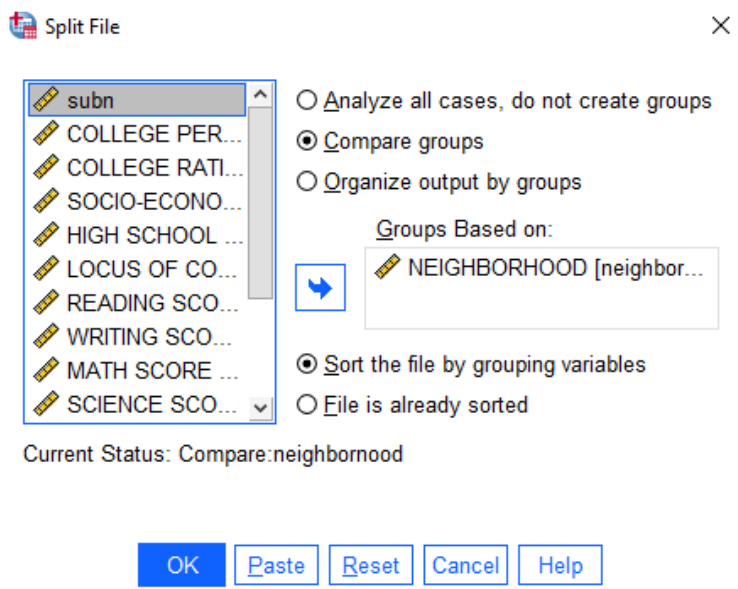
Click the "Compare groups" button

Move the grouping variable into the window and click "OK"

SPSS will sort the data into the two groups. **Every analysis you ask for will now be done twice – once on each group.**

We request the multiple regression model just like before, but now it will do that analysis twice, once for the "Urban" neighborhood group and once for the "Rural" neighborhood group.

Linear Regression   ✕

Dependent: [Statistics...]

➡   ✎ COLLEGE PERFORMANCE -- CRITERION [...

✎ subn   [Plots...]
✎ COLLEGE RATING -- CRITERION [...   Block 1 of 1   [Save...]
✎ NEIGHBORHOOD [neighbornood]
✎ SOCIO-ECONOMOC-STATUS [ses]   [Previous]   [Next]   [Options...]
✎ HIGH SCHOOL PROGRAM [hsprog]   Independent(s):
✎ LOCUS OF CONTROL M=0 STD=1...   [Style...]
✎ READING SCORE M=50 S=10 [rdg]   ✎ READING SCORE M=50 S=10 [rdg]
✎ WRITING SCORE M=50 S=10 [wrtg]   ✎ WRITING SCORE M=50 S=10 [wrtg]   [Bootstrap...]
✎ MATH SCORE   M=50 S=10 [math]   ✎ MATH SCORE   M=50 S=10 [math]
✎ SCIENCE SCORE M=50 S=10 [sci]   ✎ SCIENCE SCORE M=50 S=10 [sci]
✎ CIVICS SCORE   M=50 S=10 [civ]   ✎ CIVICS SCORE   M=50 S=10 [civ]
✎ SELF-CONCEPT M=0 SD=1 [concpt]   ✎ SOCIO-ECONOMOC-STATUS [ses]
✎ EDUCATIONAL MOTIVATION SCO...   ✎ HIGH SCHOOL PROGRAM [hsprog]
✎ High School model predicted values... ➡ ✎ LOCUS OF CONTROL M=0 STD=1 (higher ...
✎ Demo & Personality model predicte...

                                            Method: Enter   ⌄

                                        Selection Variable:
                                   ➡   [Rule...]

                                        Case Labels:
                                   ➡

                                        WLS Weight:
                                   ➡

              [OK]   [Paste]   [Reset]   [Cancel]   [Help]

Here's the first part of the output – for each group.

Model Summary

NEIGHBORHOOD	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
URBAN	1	.883[a]	.780	.737	.74431
RURAL	1	.763[b]	.583	.526	.82455

a. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), SOCIO-ECONOMOC-STATUS, HIGH SCHOOL PROGRAM, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE   M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

b. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, SOCIO-ECONOMOC-STATUS, MATH SCORE   M=50 S=10, WRITING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, CIVICS SCORE M=50 S=10, READING SCORE M=50 S=10

ANOVA[a]

NEIGHBORHOOD	Model		Sum of Squares	df	Mean Square	F	Sig.
URBAN	1	Regression	80.514	8	10.064	18.167	.000[b]
		Residual	22.714	41	.554		
		Total	103.228	49			
RURAL	1	Regression	56.031	8	7.004	10.302	.000[c]
		Residual	40.113	59	.680		
		Total	96.143	67			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), SOCIO-ECONOMOC-STATUS, HIGH SCHOOL PROGRAM, MATH SCORE   M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

c. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, SOCIO-ECONOMOC-STATUS, MATH SCORE   M=50 S=10, WRITING SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, CIVICS SCORE M=50 S=10, READING SCORE M=50 S=10

The model has an R-square of .780 for Urban, which is significant.

The model has an R-square of .583 for Rural, which is also significant

To test if the model fits one group/population better than the other, we will use the Computator to perform a Fisher's Z-test of the correlations associated with each model

Here's what that part of the Computator looks like.

Fisher's Z-test - comparing a corrrelation across groups		
Group 1	r(1,2) =>	0.883
	n =>	50
Group 2	r(1,2) =>	0.763
	n =>	68
	Z =	2.015
	p =	0.0439

Snedcor, G. W. & Cochran, W. G. (1967). Statistical Methods (6th ed.). Iowa State University Press.

Notice! Even though we are intending to compare the R-square from the two models the Fisher's Z-test compares the R values.

Notice that the .883 and .763 are the R values (not the R-square values) from the Urban and Rural models, respectively.

The "N" for each model is derived from the Total degrees of freedom (df) given in the ANOVA table for each model. Total df = N-1, so… N = Total df + 1

The N for the Urban model is 49 + 1 = 50

The N for the Rural model is 67 + 1 = 68

With these values, we get a Z-value of 2.015 and a p of .0439

We would conclude that the model works better for the Rural group than for the Urban group.

Here are the regression weights for the model from the two groups.

NEIGHBORHOOD	Model		Unstandardized Coefficients		Standardized Coefficients		
			B	Std. Error	Beta	t	Sig.
URBAN	1	(Constant)	-4.020	.792		-5.073	.000
		READING SCORE M=50 S=10	.035	.009	.385	3.901	.000
		WRITING SCORE M=50 S=10	.022	.016	.162	1.355	.183
		MATH SCORE M=50 S=10	.033	.011	.288	2.967	.005
		SCIENCE SCORE M=50 S=10	.025	.016	.184	1.615	.114
		CIVICS SCORE M=50 S=10	.030	.017	.204	1.791	.081
		SOCIO-ECONOMOC-STATUS	-.305	.160	-.158	-1.906	.064
		HIGH SCHOOL PROGRAM	.258	.183	.109	1.409	.166
		LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	.069	.174	.033	.398	.693
RURAL	1	(Constant)	-1.945	.768		-2.532	.014
		READING SCORE M=50 S=10	.030	.010	.392	3.072	.003
		WRITING SCORE M=50 S=10	.048	.016	.412	2.923	.005
		MATH SCORE M=50 S=10	.018	.008	.233	2.186	.033
		SCIENCE SCORE M=50 S=10	-.008	.014	-.068	-.571	.570
		CIVICS SCORE M=50 S=10	.001	.016	.009	.070	.944
		SOCIO-ECONOMOC-STATUS	.350	.163	.199	2.145	.036
		HIGH SCHOOL PROGRAM	-.044	.214	-.018	-.208	.836
		LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	-.029	.155	-.018	-.185	.854

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

From looking at the models it appears the "structure" of the models is different for the two groups.

For the Urban model only Reading & Math have significant individual contributions (but look also at the "close" ones)

For the Rural model Reading, Writing, Math & Socio-Economic Status have significant individual contributions.

Interestingly, even though the Rural model has more significant contributors, it has a poorer fit to the model (lower R-square).

But remember, when comparing two things, just because one is "significantly different from zero" and the other isn't, doesn't mean that the two are "significantly different from each other".

We can formally test for regression weight differences between the two models, using the Computator.

Here's what that part of the Computator looks like, with the values to compare Writing in the two models

-test for comparing raw regression weights of models from different groups				
b => 0.002698				
t => 2.145	**Group 1**	**b =>**	0.022	
SE => 0.001258		**SE =>**	0.016	
		df (N-k-1) =>	50	
	Group 2	**b =>**	0.048	
		SE =>	0.016	
		df (N-k-1) =>	68	
	Cohen (1983)	**SEbdif =**	0.016	
		Z =	1.625	
		p =	0.104162559	
	Brame, et al (1995)	**SEbdif =**	0.022627417	
	Clogg, et al (1995)	**Z =**	1.149048519	
		p =	0.250535974	

There has been some disagreement about this significance test over the years. Substantial research has shown that the original formulation (Cohen, 1983) has a "positive bias" and tends to produce a higher Type I error rate than is estimated by the p-value (i.e., creates false alarms!). Currently, most who use this model use the "Brame & Clogg" version of the model, which has more accurate p-value estimates.

Based on the "Brame & Clogg" version, we would conclude that there is no difference between the contribution of Writing to this model for the two populations.

Perhaps the most interesting predictor difference between these models is for Socio-Economic Status, which is marginally negative for the Urban data, and significantly positive for the Rural data. Here's the comparison of the weights of this predictor.

t => 2.145	**Group 1**	**b =>**	-0.305
SE => 0.001258		**SE =>**	0.16
		df (N-k-1) =>	50
	Group 2	**b =>**	0.35
		SE =>	0.163
		df (N-k-1) =>	68
	Cohen (1983)	**SEbdif =**	0.161735608
		Z =	4.049819391
		p =	5.12572E-05
	Brame, et al (1995)	**SEbdif =**	0.228405341
	Clogg, et al (1995)	**Z =**	2.867708767
		p =	0.004134559

Which shows that there is a significant difference in the regression weights for Socio-Economic Status for the Urban and Rural groups.

Last thing ➔ "turn off" the Split Fil ⬅ so your next analysis uses the full data set !!

#5 -- Comparing a model across criterion variables

A lot of the time we are working with a single criterion variable and want do compare different models of that criterion. But, sometime, we have more that one criterion variable and want to know if a particular model "works differently" for two different criteria.

There are two different questions we can ask about if a model "works differently" for two different criteria:

- Does the mode "work better" for one criterion variable versus the other? Asking if the R-square of the model is higher for one criterion variable than the other?
- Are the regression weights for the predictors in the model different for the two criteria?

What we are going to do is to get the same model for the two different criteria and then make these two comparisons.

The two criterion variables we are going to compare are College Performance and College Rating.

The model we will use is the full model from above.

Before we get started computing and comparing the models, it is worth taking a quick look at how correlated are the two criterion variables. The more highly correlated the two criteria are, the less likely they are to be modeled differently by a given set of predictors

Correlations

		COLLEGE RATING -- CRITERION
COLLEGE PERFORMANCE -- CRITERION	Pearson Correlation	.352
	Sig. (2-tailed)	<.001
	N	118

For College Performance, the model is significant and accounts for about 63% of the variance, and Reading, Writing and Math have (positive) significant regression weights.

There is no "split files" or "select cases" for this type of analysis → be sure you've "turned off" any of these!

First → we get the multiple regression model for the first criterion – College Performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795[a]	.633	.602	.82769

a. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS, MATH SCORE M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	127.508	9	14.168	20.681	<.001[b]
	Residual	73.987	108	.685		
	Total	201.496	117			

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

b. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS, MATH SCORE M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-3.014	.625		-4.823	<.001
	READING SCORE M=50 S=10	.033	.007	.403	5.101	<.001
	WRITING SCORE M=50 S=10	.033	.012	.264	2.801	.006
	MATH SCORE M=50 S=10	.022	.006	.246	3.587	<.001
	SCIENCE SCORE M=50 S=10	.011	.011	.086	1.029	.306
	CIVICS SCORE M=50 S=10	.014	.012	.101	1.164	.247
	NEIGHBORHOOD	.147	.158	.056	.930	.354
	SOCIO-ECONOMOC-STATUS	.027	.118	.015	.232	.817
	HIGH SCHOOL PROGRAM	.055	.145	.023	.381	.704
	LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	.030	.119	.016	.252	.802

a. Dependent Variable: COLLEGE PERFORMANCE -- CRITERION

This is the same as the very first model we ran…

For College Performance, the model is significant and accounts for about 63% of the variance, and Civics, SES, High School Program & Locus of Control have (positive) significant regression weights.

Second → we get the multiple regression model for the second criterion – College Rating

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.709[a]	.503	.462	11.99195

a. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS, MATH SCORE M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15736.571	9	1748.508	12.159	<.001[b]
	Residual	15531.152	108	143.807		
	Total	31267.723	117			

a. Dependent Variable: COLLEGE RATING -- CRITERION

b. Predictors: (Constant), LOCUS OF CONTROL M=0 STD=1 (higher scores - more external), HIGH SCHOOL PROGRAM, NEIGHBORHOOD, SOCIO-ECONOMOC-STATUS, MATH SCORE M=50 S=10, READING SCORE M=50 S=10, CIVICS SCORE M=50 S=10, SCIENCE SCORE M=50 S=10, WRITING SCORE M=50 S=10

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	50.734	9.056		5.603	<.001
	READING SCORE M=50 S=10	-.093	.095	-.091	-.985	.327
	WRITING SCORE M=50 S=10	-.138	.172	-.088	-.805	.422
	MATH SCORE M=50 S=10	.049	.089	.044	.548	.585
	SCIENCE SCORE M=50 S=10	.041	.155	.026	.265	.791
	CIVICS SCORE M=50 S=10	.739	.171	.438	4.323	<.001
	NEIGHBORHOOD	-2.833	2.293	-.086	-1.236	.219
	SOCIO-ECONOMOC-STATUS	5.397	1.716	.236	3.145	.002
	HIGH SCHOOL PROGRAM	-8.641	2.100	-.291	-4.114	<.001
	LOCUS OF CONTROL M=0 STD=1 (higher scores - more external)	5.809	1.723	.255	3.372	.001

a. Dependent Variable: COLLEGE RATING -- CRITERION

For College Rating, the model is significant and accounts for about 50% of the variance, and Civics, SES, High School Program & Locus of Control have (positive) significant regression weights.

Third → We want to compare the R from the two models, to see if one is significantly larger than the other

The challenge to this is that there is no agreed-upon significance test for comparing the models predicting two different criteria. The problem is that there are "two sources of differences" between the two models: 1) different criterion variables and 2) different models (the same predictors are used, but the regression weights are different, so "the models" are different).

Fourth → We want to compare the "structure" of the two models, to see if the "contributing variables" for the two models are different

Again, we have the same problem as above, that there is no agreed upon significance test.

What we can do is to "inspect" the results from each model and draw attention the apparent differences between them.

From inspection, the College Rating model accounts for less variance (R-sq = .503) than the College Performance model (R-sq = .633), and the two models have a very different apparent structure.

For the College Rating model, Civics, SES, High School Program & Locus of Control have significant regression weights, while for the College Performance model Civics, SES, High School Program & Locus of Control have significant regression weights. Thus, it would appear that two criterion variables are predicted very differently from this set of predictors.