MKTG8005 – Hypothesis testing and Analysis of Statistical Outputs

Note: These are the sample examples of how to interpret SPSS outputs for various tests. The proposed steps are the suggestions only and not fixed rules.

A General Procedure for Hypothesis Testing

1. Define the null hypothesis (H_0) and alternative hypothesis (H_1).
2. Select an appropriate statistical test.
3. Choose the level of significance (α), typically 0.05.
4. Calculate the probability (p-value) associated with the test statistic under the null hypothesis (H_0).
5. Make the statistical decision (Accept or Reject Null Hypothesis) by comparing the probability (p value) with the level of of significance (α) [is $p < 0.05$?]
    a. Reject the null hypothesis (H_0), if $p < 0.05$
    b. Do not reject null hypothesis (H_1), if $p \geq 0.05$
6. If the null hypothesis is rejected (which means there is an association…, there is a difference…), describe the pattern (how the association/difference looks like, positive/negative, high/low, strong/weak).
7. Arrive at a conclusion. Express the statistical decision in terms of the research question.

Choose the right analysis

Hypothesis	Independent variable (IV or variable 1)	Dependent variable (DV or variable 2)	Statistical test
Test of association	1 non-metric variable	1 non-metric variable	Chi-square test
Test of differences	1 metric variable compared with 1 (test) constant value		One-sample t-test
	1 metric variable	1 metric variable	Paired samples t-test
	1 non-metric variable with2 groups/levels	1 metric variable	Independent samples t-test
	1 non-metric variable with 3 or more groups/levels	1 metric variable	ANOVA
Test of linear association	1 metric variable	1 metric variable	Correlation
	1 metric variable	1 metric variable	Simple regression
	2 or more metric variables	1 metric variable	Multiple regression

- **Non-metric variable**: measured on nominal or ordinal scale
- **Metric variable**: measure on interval or ratio scale
- Likert scale is treated as ***interval*** in marketing

Test of differences

Independent Samples T-test	
When do I use it?	When you want to compare the mean values of a dependent variable (metric) between two groups of an independent variable (nonmetric)
What are the hypotheses?	H0 = "There is no difference between the two means" H1 = "There is a difference between the two means"
How do I interpret the results on SPSS?	1. Check the Sig. value (p-value) in the column called "Levene's test for equality of variances": a. If p-value < 0.05 → equal variances not assumed b. If p-value ≥ 0.05 → equal variances assumed 2. Check the Sig. value (p-value) in the table called "t-test for equality of means". a. Depending on the results of the Levene's test, look at the appropriate 2-Tailed Sig. value in the respective line: i. If p-value < 0.05 → Reject H0/ Accept H1 ii. If p-value ≥ 0.05 → Accept H0/ Reject H1 3. If p-value < 0.05, check the direction of difference in the mean column: which group is more or less than the other? 4. Formulate your conclusions

Paired Samples T-test	
When do I use it?	When you want to compare the means of the two sets of the same variable (metric) measured under two different circumstances or on two different occasions within the same sample.
What are the hypotheses?	H0 = "There is no difference between the two means in condition 1 and condition 2" H1 = "There is a difference between the two means in condition 1 and condition 2"
How do I interpret the results on SPSS?	1. Check the 2-Tailed Sig. value (p-value) in the Paired samples test table: a. If p-value < 0.05 → Reject H0/ Accept H1 b. If p-value ≥ 0.05 → Accept H0/ Reject H1 2. If p-value < 0.05, check the direction of difference in the mean column: in which condition is the variable higher or lower? 3. Formulate your conclusions.

ANOVA	
When do I use it?	When you want to compare the mean values of a dependent variable (metric) between three or more groups of an independent variable (nonmetric)
What are the hypotheses?	H0 = "There is no difference among the three (or more) means" H1 = "At least one of the means is different from the others"
How do I interpret the results on SPSS?	1. Check the Sig. column (p-value) in the ANOVA table: a. If p-value < 0.05 → Reject H0/ Accept H1 b. If p-value ≥ 0.05 → Accept H0/ Reject H1 2. If p-value < 0.05, check the *Post-Hoc* Tests tables to find out which groups means are more or less than the others. Interpret the *post- hoc* tests in the same way as t-tests (they are simply adjusted t- tests). 3. Formulate your conclusions.
Tips	Note that ANOVA only tells us whether one of the means is different. Deciding what mean requires examination of the post-hoc tests (post- hoc is Latin, meaning "after the event").

Test of association

Crosstabulation/Chi-square Test of Independence	
When do I use it?	When you want to examine the relationship between two nonmetric (nominal or ordinal) variables.
What are the hypotheses?	H0 = "There is no association between the two variables" H1 = "There is a association between the two variables"
How do I interpret the results on SPSS?	1. Look at the Sig. value (p-value) in the Pearson Chi-square table: a. If p-value < 0.05 → Reject H0/ Accept H1 b. If p-value ≥ 0.05 → Accept H0/ Reject H1 2. If p-value < 0.05, check the crosstab and compare the column percentage figures.
Tips	For tables with expected cell frequencies (count) less than 5, the Chi-square approximation may not be valid. A standard rule of thumb is to avoid using the Chi-square test for tables with expected cell frequencies less than 1, or when more than 20% (preferably 0%) of the table cells have expected cell frequencies less than 5. Crosstabulations can also be useful when comparing the distributions of ordinal data. Select the appropriate statistical test in the Options section when setting up your analysis in SPSS.

Bivariate Correlation	
When do I use it?	When you want to examine the relationship between two metric (interval or ratio) variables.
What are the hypotheses?	H0 = "There is no linear association between the two variables" H1 = "There is a linear association between the two variables"
How do I interpret the results on SPSS?	1. Look at the Sig. value (p-value) in the matrix: • If p-value < 0.05 → Reject H0/ Accept H1 • If p-value ≥ 0.05 → Accept H0/ Reject H1 2. If p-value < 0.05, check the Person's R to decide: • The direction of the correlation (negative/positive) • The magnitude of the correlation ○ R > 0.7 = strong correlation ○ 0.4 < R < 0.7 = moderate correlation ○ R < 0.4 = weak correlation

Simple Linear Regression

When do I use it?	When you want to examine the relationship between two metric variables – 1 independent variable (X) and 1 dependent variable (Y). Unlike bivariate correlation, this method allows to find a function that expresses the relationship between the two variables.
How do I interpret the results on SPSS?	1. In the table called **Model Summary** you have to interpret the following values: • **R** = strength of correlation (see handout W10-W11) • **Squared R (R^2)** = this index represents how much the X-variable explains the variance of the Y-variable. A strong regression model would have a R^2 of 0.5 or higher 2. In the **Anova** table, check the column called **Sig.** (p-value): • If p-value < 0.05 → the X-variable has a significant effect on the Y-variable • If p-value ≥ 0.05 → the X-variable has **no** significant effect on the Y-variable 3. From the **Coefficients** table, check the values in the B column of the **unstandardized coefficients to write the regression function**: a. The first line (Constant) gives you the value of the intercept b. The second line (the one which has the name of the X-variable) you the value of the slope

Multiple Linear Regression

When do I use it?	When you want to examine the relationship between **several independent variables** (X_1, X_2, …) **and 1 dependent variable** (Y). All these variable must be **metric**. This method allows to find a function that expresses the relationship between the two variables
How do I interpret the results on SPSS?	1. Run a **bivariate correlation** among all the Independent variables: if any of these have an R higher than 0.7, then you have a **multicollinearity** issue. You should get rid of one of the two variables before carrying out your multiple regression; 2. In the table called **Model Summary** you have to interpret the Squared R (R^2) - see interpretation above 3. In the **Anova** table, check the column called **Sig.** (p-value): • If p-value < 0.05 → **at least one** of the X-variables has a significant effect on the Y-variable • If p-value ≥ 0.05 → no X-variable has a significant effect on the Y-variable 4. From the **Coefficients** table, a lot of interesting information can be retrieved: • Just like for the simple regression, check the values in the B

Reliability Analysis

Cronbach's Alpha	
When do I use it?	When you want to test the reliability of a multi-item construct or scale. **The reliability of a scale is defined as the degree to which measures are free from random error and therefore yield consistent results**
How do I interpret the results on SPSS?	1. Check the **Cronbach's Alpha** value in the **Reliability statistics** tab: an acceptable multi-item scale should have a Cronbach's alpha higher than **0.7** 2. In the **inter-item Correlation Matrix** check the values: if values lower than 0.3 are found, the item to which this value refers is measuring something different 3. In the **Item-Total Statistics** table, check the column called Cronbach's Alpha if Item Deleted: if any of the item provide a value higher than the Cronbach's Alpha showing in the Reliability Statistics tab, then you should consider getting rid of that item to increase the level of reliability of the scale