Comparing k proportions with XLSTAT

demoKProp.xls

Comparing k proportions

A proportion is a way to measure on a [0, 1] scale, how many observations belong to a given category, compared with the total population size. It is computed as the ratio between the number of observations that belong to the category of interest and the total population size.

To compare k proportions, the statistical methods require that you know the population sizes. So the inputs can either be the proportions and the corresponding population sizes, or the number of observations that belong to the category of interest, and the corresponding population sizes.

Dataset for comparing k proportions

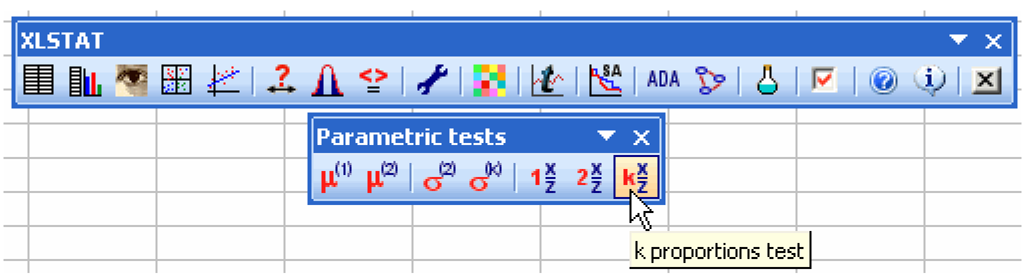
An Excel sheet containing both the data and the results for use in this tutorial can be downloaded by clicking here.

The data correspond to 6 different series of screws used on rally cars. The number of screws that pass the quality tests correspond to “Success” and the other to “Failed”.

Our goal is to determine if the quality of the 6 series can be considered as different or not, and if there is a difference, we want to determine if there is one or more series responsible for the difference, in order to make the necessary adjustments for the next productions.

Setting up a test to compare k proportions

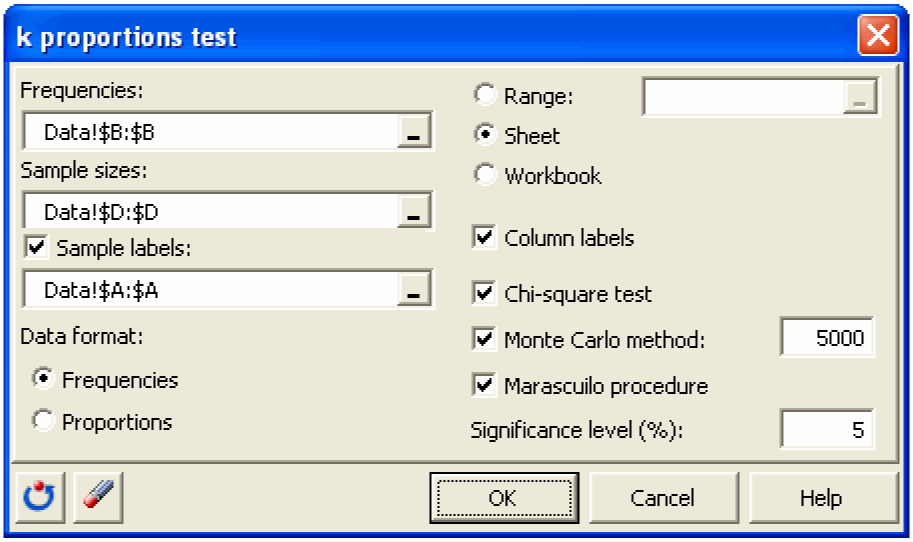
After opening XLSTAT, select the **XLSTAT / Parametric tests / k proportions test** command in the XLSTAT menu, or click on the corresponding button of the "Parametric tests" toolbar (see below).



Once you've clicked on the button, the dialog box appears. Select the data on the Excel sheet.

Select first the **frequencies** of **Success** events (column B), then the **Sample sizes** (column D), which are here the total number of screws produced in a given series.

The **Sample labels** are also selected (column A). All the tests are selected. The **Column labels** option is activated as the first row of the selected data contain a column header.



The computations begin once you have clicked on **OK**.

Interpreting the results of a test comparing k proportions

The first results that are being displayed correspond to the Chi-square test. The Chi-square test is used on contingency tables to test if columns and rows are independent. In this particular case where we are studying a binary event (success/failure), independence of rows and columns is equivalent to no difference between the proportions of successes across the series. The contingency table is automatically reconstructed by XLSTAT from the input data.

The Chi-square test concludes that there that there is at least one series that differs from the others. However, we notice that the p-value is very close to the significance level.

Chi-square test:

Chi-square	12.088
Chi-square	11.070
DF	5
p-value	0.034
alpha	0.05

Test interpretation:
H0: The proportions are equal.
Ha: At least one proportion is significantly different from another.
As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
The risk to reject the null hypothesis H0 while it is true is lower than 3.36%.

We know that the Chi-square test is an asymptotical test that should better not be used when too many cells of the contingency table have low values. As this is the case here, it is recommended to run the simulations based test (Monte Carlo test). The principle is to generate many random contingency tables that have the same marginal sums and to compute the chi-square distances on these tables. Then, we determine how many tables give lower chi-square values so that we can see how "extreme" our table is.

Monte Carlo method (Number of simulations = 5000):	
Chi-square	12.088
Chi-square	11.133
DF	5
p-value	0.034
alpha	0.05

Test interpretation:
H0: The proportions are equal.
Ha: At least one proportion is significantly different from another.
As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
The risk to reject the null hypothesis H0 while it is true is lower than 3.38%.

We see that the Monte Carlo test with 5000 simulations gives almost the same result as the Chi-square test, and confirms the fact that at least one series is different from the other.

In order to identify which series differ, we use the Marascuilo procedure. The results are displayed below.

Marascuilo procedure:

Contrast	Value	Critical value	Significant
|p(S1) - p(S2)|	0.043	0.083	No
|p(S1) - p(S3)|	0.066	0.122	No
|p(S1) - p(S4)|	0.044	0.117	No
|p(S1) - p(S5)|	0.024	0.111	No
|p(S1) - p(S6)|	0.015	0.112	No
|p(S2) - p(S3)|	0.109	0.105	Yes
|p(S2) - p(S4)|	0.087	0.099	No
|p(S2) - p(S5)|	0.067	0.093	No
|p(S2) - p(S6)|	0.058	0.093	No
|p(S3) - p(S4)|	0.022	0.134	No
|p(S3) - p(S5)|	0.043	0.129	No
|p(S3) - p(S6)|	0.051	0.129	No
|p(S4) - p(S5)|	0.021	0.124	No
|p(S4) - p(S6)|	0.029	0.124	No
|p(S5) - p(S6)|	0.009	0.119	No

We see that the two most different series are S2 and S3. As S2 is not different from the other series, we conclude that the series that S3 is responsible for the rejection of the H0 hypothesis of the k proportions test. The reasons why the S3 production had a better quality should be further investigated.