Calculating the required sample size or statistical power in a multiple regression with XLSTAT-Power

demoPowerReg.xls

XLSTAT-Pro offers a tool to apply a linear regression model. XLSTAT-Power estimates the power or calculates the necessary number of observations associated with variations of R^2 in the framework of a linear regression.

When testing a hypothesis using a statistical test, there are several decisions to take:

- The null hypothesis H0 and the alternative hypothesis Ha.
- The statistical test to use.
- The type I error also known as alpha. It occurs when one rejects the null hypothesis when it is true. It is set a priori for each test and is 5%.

The type II error or beta is less studied but is of great importance. In fact, it represents the probability that one does not reject the null hypothesis when it is false. We cannot fix it up front, but based on other parameters of the model we can try to minimize it. The power of a test is calculated as 1-beta and represents the probability that we reject the null hypothesis when it is false.
We therefore wish to maximize the power of the test. The XLSTAT-Power module calculates the power (and beta) when other parameters are known. For a given power, it also allows to calculate the sample size that is necessary to reach that power.

The statistical power calculations are usually done before the experiment is conducted. The main application of power calculations is to estimate the number of observations necessary to properly conduct an experiment.

In a future study, we wish to study the weights of children according to size and age of children (as in the following tutorial on Multiple Linear Regression).

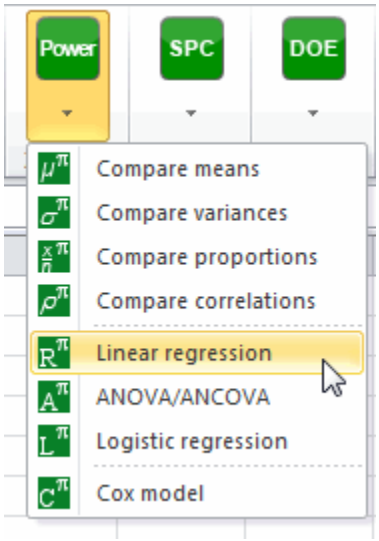
We want to know if the R^2 of this model is significantly different from 0. There will be two independent variables or predictors and we would like to know how many children should be interviewed to obtain a power of 0.9. Since we do not yet know the parameters of our samples, we will use the concept of effect size. Cohen (1988) introduced this concept which provides an order of magnitude for the effect size. So we will test three effect sizes: 0.02 for a small effect, 0.15 for a moderate effect and 0.35 for a strong effect. It is expected that the larger the effect size is, the smaller the sample size required will be.

Dataset for calculating the required sample size or statistical power in a multiple regression

An Excel spreadsheet containing the results of this example can be downloaded by clicking here.

Setting up of the calculation of the required sample size or statistical power in a multiple regression

After opening XLSTAT, click the **Power** icon and choose **linear regression**.

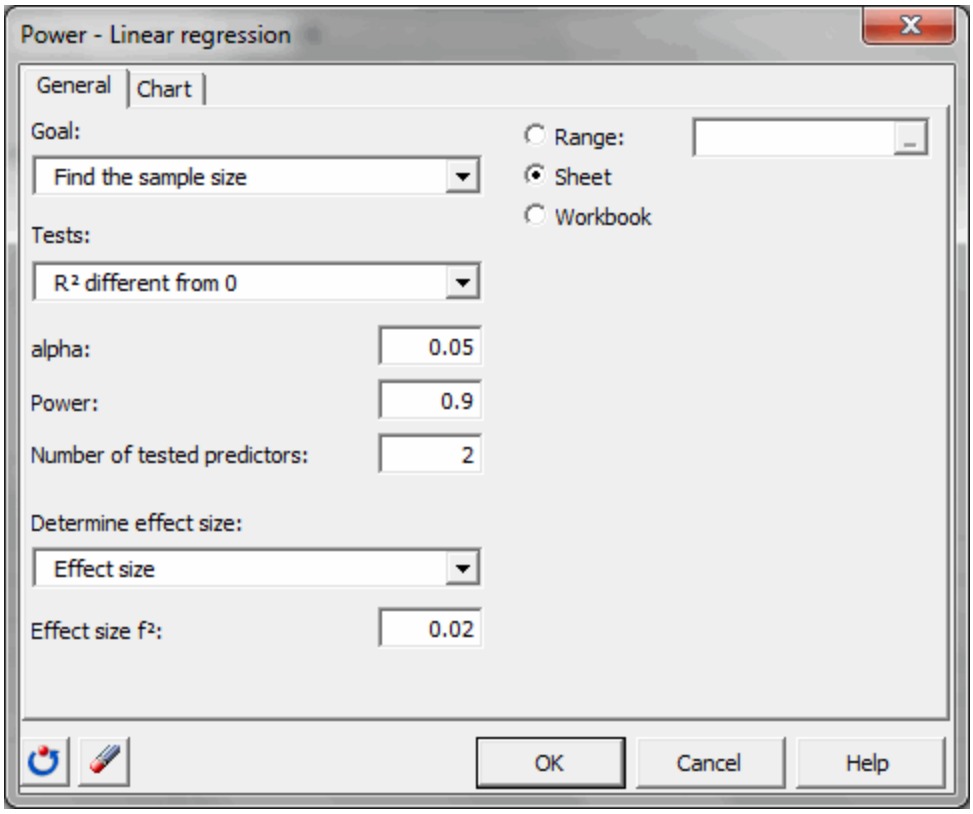


Once the button is clicked, the dialog box appears. You must then choose the objective **Find the sample size**.

Then select the test **R^2 different from 0**. The **alpha is 0.05**.

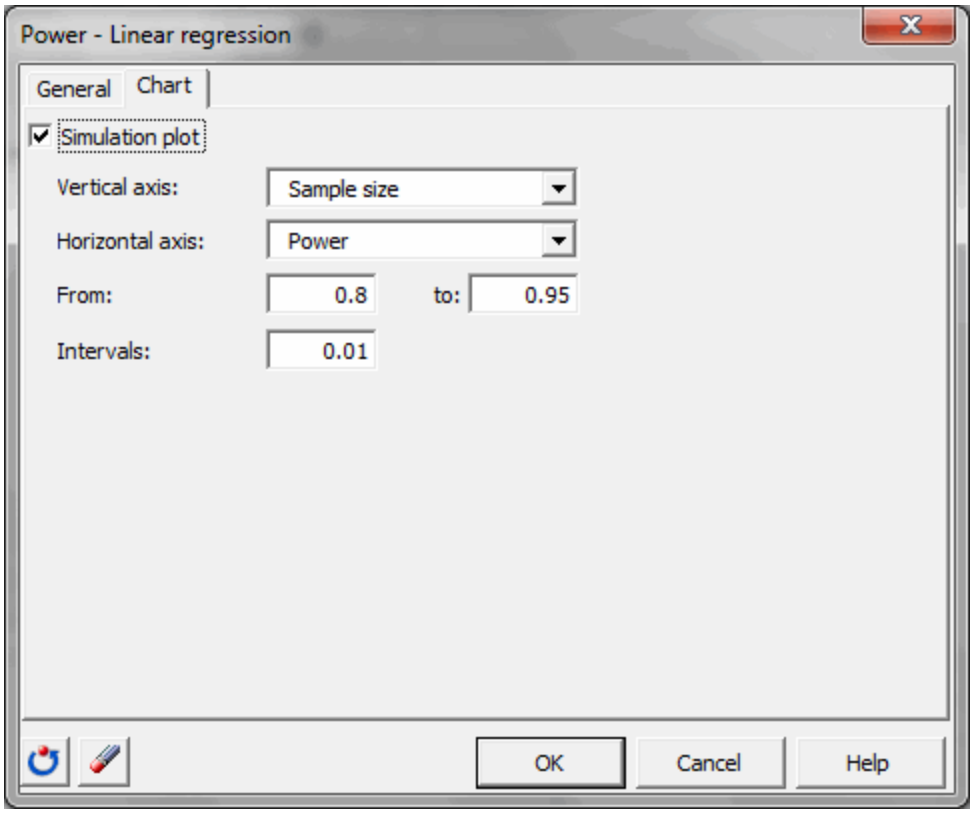
The **desired power is 0.9**.

The number of predictors or explanatory variables is 2. Rather than detailed input parameters, we select the **effect size** option and enter the value 0.02 for a weak effect.



In the **Charts** tab, the option **simulation plot** is activated and the "size of sample 1" will be displayed on the **vertical axis** and the "power" on the **horizontal axis**.

Power varies between 0.8 and 0.95 by increments of 0.01.



Once you have clicked the **OK** button, the calculations are made, and then the results are displayed.

Result of the calculations of the required sample size or statistical power in a multiple regression

The first table shows the parameters used as input. In our case, only the number of predictors is displayed.

Inputs:	
Parameters	Inputs
Number of tested predictors:	2

The second table shows the calculation results and an interpretation of the results.

Results:

Parameters	Results
Power	0,9
alpha	0,05
Effect size	0,02
Sample size	**636**
Power (obtained)	0,900

Test interpretation:

H0: The R^2 is equal to 0.

Ha: The R^2 is different from 0.

The risk to not reject the null hypothesis H0 while it is false is 0,1.

For the given parameters, for an alpha of 0,05, the necessary sample size to reach a power of 0,9 is 636 observations.

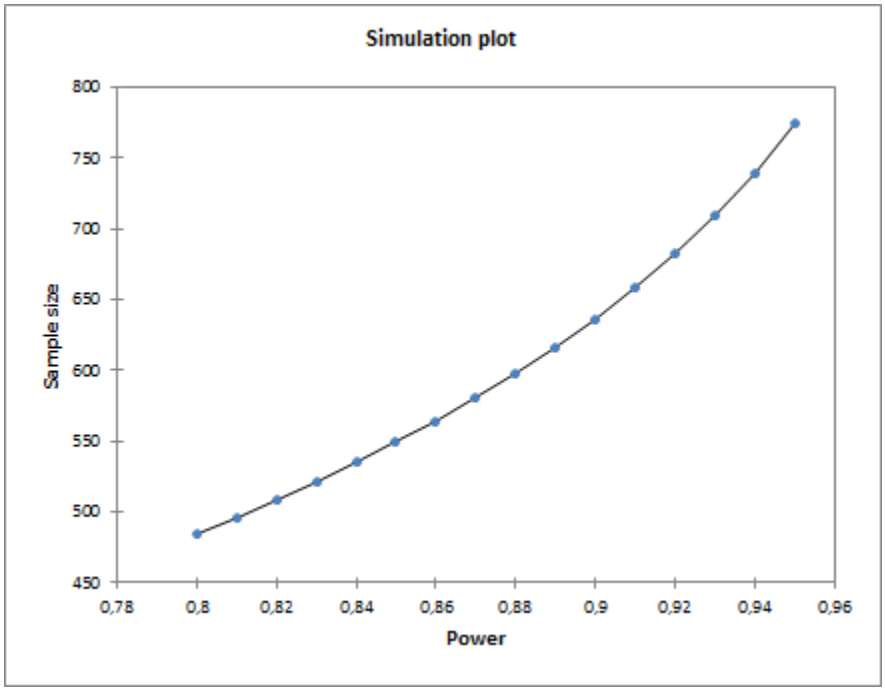
We see it takes 636 observations to obtain a power as close as possible to 0.9.

The following table summarizes the calculations obtained for each value of power between 0.8 and 0.95.

Results (Simulation plot):

Power	Sample size
0,800	485
0,810	496
0,820	509
0,830	521
0,840	535
0,850	549
0,860	564
0,870	580
0,880	597
0,890	616
0,900	636
0,910	658
0,920	682
0,930	709
0,940	739
0,950	775

The simulation plot shows the evolution of the sample size depending on the power. We see that for a power of 0.8, just a little more than 485 observations and that a power for a power of 0.95, 775 observations are needed.



For effect sizes of 0.15 and 0.35, we obtain the following results:

Results:	
Parameters	Results
Power	0,9
alpha	0,05
Effect size	0,15
Sample size	**87**
Power (obtained)	0,898

Results:	
Parameters	Results
Power	0,9
alpha	0,05
Effect size	0,35
Sample size	**39**
Power (obtained)	0,897

The sample size will therefore fall as the R^2 moves away from 0 and we see that for a large difference, 39 observations will be sufficient.

So if we assume that the quality of explanation of the variables age and weight is strong (R^2 close to 1) on the size of a child, 39 observations will be sufficient to obtain a power of 0.9.

XLSTAT-Power is a powerful tool both to investigate the sample size required for an analysis and to calculate the power of a test. Obviously, if the user has more information about the samples or populations, he may give details of the input parameters, rather than using the effect size.