

# Program Evaluation Toolkit Calculator: User's Guide

## Table of Contents

---

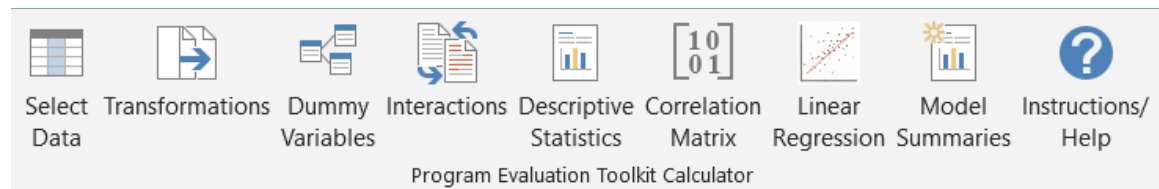
Overview .....	2
Getting Started.....	2
<i>Loading the ToolPaks</i> .....	2
<i>Preparing the Dataset</i> .....	2
<i>Access</i> .....	3
Using the Program Evaluation Toolkit Calculator.....	5
Select Data.....	5
Transformations .....	5
Dummy Variables .....	5
Interactions .....	6
Descriptive Statistics .....	6
Correlation Matrix.....	6
Linear Regression.....	6
Regression Statistics .....	6
Model Summaries .....	9
Instructions/Help .....	10

## Overview

---

The Program Evaluation Toolkit Calculator is a free Microsoft Excel add-in that serves as a statistical tool for multivariate descriptive data and regression analysis. It was developed to accompany an online course for program evaluation. This user’s guide provides an overview of the features in the Program Evaluation Toolkit Calculator as well as additional details and definitions.

In Version 1.3 of the Program Evaluation Toolkit Calculator, the following user-friendly ribbon controls every aspect of generating, navigating, and presenting your data analysis.



The first four buttons on the ribbon—“Select Data,” “Transformations,” “Dummy Variables,” and “Interactions”—allow you to select and preprocess the data elements in a dataset. The next three buttons—“Descriptive Statistics,” “Correlation Matrix,” and “Linear Regression”—allow you to analyze the data and perform regression analysis. The “Instructions/Help” button provides you with an abbreviated set of instructions on how to use the tool.

## Getting Started

### *Loading the ToolPaks*

To ensure that the Program Evaluation Toolkit Calculator operates optimally, first confirm that the Analysis ToolPak and Analysis ToolPak – VBA add-ins have been loaded in Excel. The Microsoft Office support site has detailed directions on how to load these ToolPaks [here](#).

Once the ToolPaks have been loaded, launch the Program Evaluation Toolkit Calculator by either opening the associated XLAM file or installing it on the Excel Add-ins menu. To access the Add-ins menu, go to the “File” tab, select “Options,” and click the “Add-ins” category. On a PC, a newly downloaded file must be unblocked before it will work (see the “Access” section below), and the macro security level in Excel must be set to “disable all macros with notification.”

When the tool is running, a “Program Evaluation Toolkit Calculator” tab is added to the menu bar at the top of Excel. Clicking the tab reveals the ribbon pictured above.

### *Preparing the Dataset*

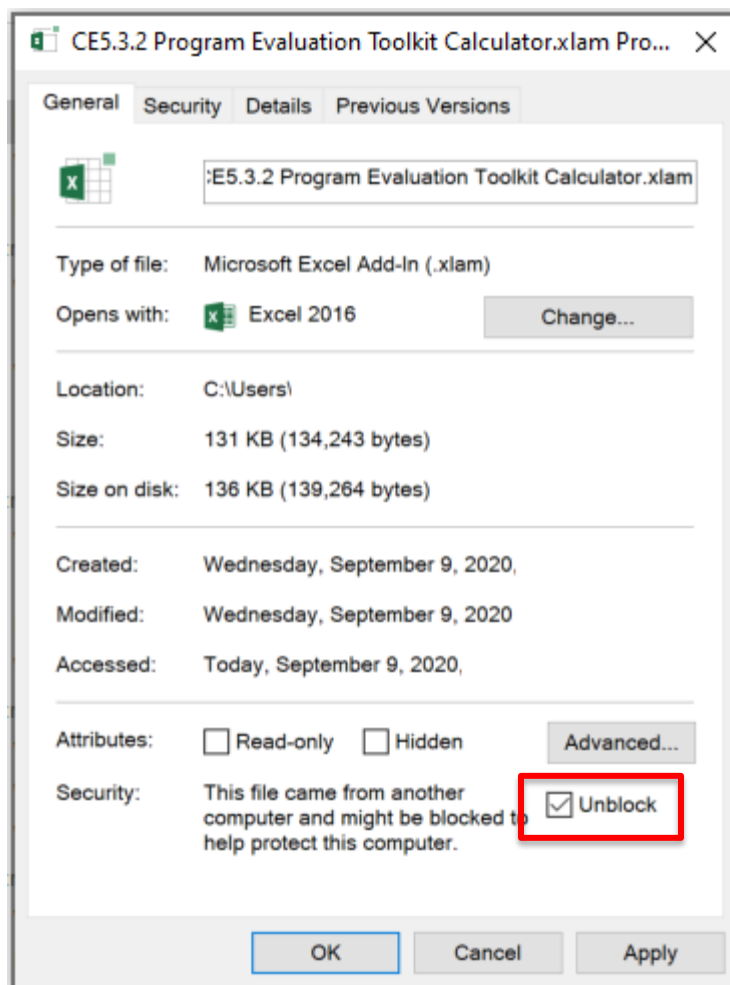
To analyze data and perform regression analysis, first open and prepare your dataset. The only requirements are that all variables have the same number of elements and that variable names appear in row 1 of your data worksheet.

If a dataset has rows with missing values, the Program Evaluation Toolkit Calculator will only analyze data and perform regression analysis on complete cases (that is, it will only include rows with no missing values).

### *Access*

Some external XLAM files are automatically blocked due to system settings. If you have trouble accessing the Program Evaluation Toolkit Calculator, right-click the XLAM file in Windows Explorer and choose “Properties.” In the “General” tab, select “Unblock,” and then click “Apply” to have full access to the tool (figure 1).

Figure 1. Unblocking the Program Evaluation Toolkit Calculator



If you encounter a run-time error “1004” message, confirm that the Analysis ToolPak and Analysis ToolPak – VBA add-ins have been loaded in Excel and are currently enabled with a checkmark in the “Excel Add-ins” dialog box on the “Developer” ribbon. If the “Developer” ribbon is not visible to you, you can add it by clicking on the “File” tab, click on “Options”, and click on “Customize Ribbon.” Under “Main Tabs,” check the box next to “Developer.” If the

“1004” error still appears after loading and enabling both ToolPak add-ins, try disabling both add-ins by deselecting them in the “Excel Add-ins” box on the “Developer” ribbon, clicking “OK,” and closing Excel. Finally, restart Excel and enable the ToolPak add-ins again.

If the above steps do not resolve the “1004” error, click on the “File” tab, click on “Options,” and click on “Add-ins.” By “Manage” click “Go…” check the box next to “Analysis ToolPak” and “Analysis ToolPak – VBA,” and click “OK.”

If the above steps do not resolve the “1004” error, add an explicit reference to the atpvbaen.xls file in the Analysis ToolPak. To do this, click the “Visual Basic” button on the “Developer” ribbon in Excel. When the window opens, click the “Tools” tab and then select “References.” Scroll down the list and check the box next to “atpvbaen.xls,” but do not deselect any other options that are checked. Finally, click “OK.”

## Using the Program Evaluation Toolkit Calculator

---

This section explains the functionality of the Program Evaluation Toolkit Calculator. Each subheading corresponds to a button on the ribbon.

### Select Data

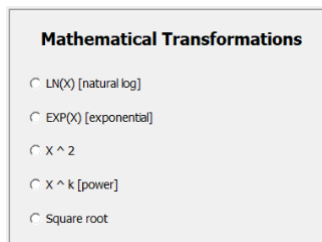
Clicking the “Select Data” button highlights all variable names and data elements in the dataset. You will be informed that variable names were created from the top row of the selected data.

The tool allows missing values for data elements but will prompt you if any variable names are missing.

### Transformations

Transformations are commonly used to make non-normal data fit the normality assumption of regression more closely.

Clicking the “Transformations” button on the ribbon opens a dialog box with a drop-down list of all numeric variables that can be transformed and radio buttons for five mathematical transformations:



After selecting a variable and a mathematical transformation, click “Transform Variable.” A new column of data is created for the newly transformed variable. This new column is inserted next to the column of the parent variable on the data worksheet (for example, “age.Sqr”).

### Dummy Variables

To incorporate a qualitative predictor (also known as a categorical predictor or factor) into your regression model, first create an indicator or dummy variable. A dummy variable has only two possible values: 0 and 1. Once created, the dummy variable has numerical values, so it can be included alongside quantitative predictors in your regression model.

Clicking the “Dummy Variables” button on the ribbon opens a dialog box with a drop-down list of all categorical variables. Select a categorical variable from the drop-down list and click the “Create Dummy Variable” button. This results in a new 0-1 column for each value of the selected categorical variable. For example, creating dummy variables for a “SchoolType” column that contains two unique values—“Elementary” and “Secondary”—results in two new 0-1 variables: “SchoolType.Eq.Elementary” and “SchoolType.Eq.Secondary.” Elementary schools

in the file will have “SchoolType.Eq.Elementary” equal to 1 and “SchoolType.Eq.Secondary” equal to 0. Conversely, secondary schools in the file will have “SchoolType.Eq.Elementary” equal to 0 and “SchoolType.Eq.Secondary” equal to 1.

You can create dummy variables for any categorical variable with 12 or fewer unique values.

## Interactions

Clicking the “Interactions” button on the ribbon opens a dialog box where you can select any two numeric variables between which an interaction effect can be applied via multiplication. The new column of data for the interaction is inserted on the data worksheet, and the corresponding variable name includes both variables included in the interaction (for example, “age.Times.bmi”).

## Descriptive Statistics

Clicking the “Descriptive Statistics” button on the ribbon allows you to generate a new worksheet containing a table of descriptive statistics based on selected variables from the dataset. The calculations include all rows containing complete cases for the selected variables, and the descriptive statistics include mean, standard error, median, mode, standard deviation, sample variance, skewness, range, minimum, maximum, sum, and count.

## Correlation Matrix

Clicking the “Correlation Matrix” button on the ribbon allows you to generate a new worksheet displaying the lower-left triangle of the correlation matrix for the selected variables from the dataset. The correlation matrix is based on all rows containing complete cases for the selected variables.

## Linear Regression

Clicking the “Linear Regression” button on the ribbon allows you to specify a dependent variable and independent variables on which to run regression analysis for all complete cases in the dataset.

## Regression Statistics

For each model, a numbered Model worksheet is created that includes the following:

**R-SQUARED:** *R*-squared is the fraction by which the sample variance of the model’s errors is less than the sample variance of the dependent variable. That is, *R*-squared is the fractional reduction in error variance compared to what would be obtained with a constant-only model. It is equal to 1 minus the square of the sample standard deviation of the errors divided by the sample standard deviation of the dependent variable.

*R*-squared is the proportion of variance in the dependent variable that is explained by the independent variables in the model.

There is no absolute standard for an acceptable value of  $R$ -squared. The value depends on the nature of the data, the variance-changing transformations (if any) that have already been applied to the dependent variable, the decision or inference context in which the model is to be used, and the reasonableness of the model's assumptions in that context.

If the context is one in which the model equation is given (as in a designed experiment) and interest centers on whether the effects of independent variables are non-zero rather than on their predictive accuracy in individual cases, then a low value of  $R$ -squared may not be a cause for concern. The  $F$ -statistic may be relatively more important in that case.

- **F-STATISTIC:**  $F$ -statistics can assess multiple coefficients simultaneously and help answer the question “Is at least one predictor useful?” The  $F$ -test of the overall significance compares a model with no predictors (also known as the intercept-only model) to the model you specify.

The formula for the  $F$ -statistic incorporates the residual sum of squares (RSS; the sum of squared errors of prediction) and total sum of squares (TSS; the total variance in the outcome or dependent variable), as well as the number of observations ( $n$ ) and predictors ( $p$ ).

$$F = \frac{(TSS - RSS)/p}{RSS/(n - p - 1)}$$

where  $TSS = \Sigma(y_i - \bar{y})^2$  and  $RSS = \Sigma(y_i - \hat{y})^2$ .

- **RESIDUAL STANDARD ERROR:** “A fitted regression model uses the parameters to generate point estimate predictions, which are the means of observed responses if you were to replicate the study with the same  $X$  values an infinite number of times (and when the linear model is true). The difference between these predicted values and the ones used to fit the model are called “residuals,” which, when replicating the data collection process, have properties of random variables with 0 means.

The observed residuals are then used to subsequently estimate the variability in these values and the sampling distribution of the parameters. When the residual standard error is exactly 0, the model fits the data perfectly (likely due to overfitting). If the residual standard error cannot be shown to be significantly different from the variability in the unconditional response, then there is little evidence to suggest the linear model has any predictive ability.”<sup>1</sup>

- **OBSERVATIONS:** This is the count of complete cases in your dataset that include the dependent variable and all independent variables.

---

<sup>1</sup> AdamO. (2013, April 30). *A fitted regression model uses the parameters to generate point estimate predictions which are the means of observed responses* [Comment on the online forum post *What is residual standard error?*]. StackExchange. <https://stats.stackexchange.com/questions/57746/what-is-residual-standard-error>.



- **COEFFICIENT:** The coefficient of an independent variable is the change in the predicted value of the dependent variable per unit of change in that variable, holding the other variables fixed at any values of their own. In a multiple regression model, the value of the coefficient depends to some extent on which other variables are included, and its magnitude or sign may change if other variables with which it is correlated are added or removed.

In all linear regression models, the intercept has the same definition: the mean of the response,  $Y$ , when all predictors equal 0. The intercept is not always meaningful because there are cases in which some predictors in the model do not have any values near 0.<sup>2</sup> For instance, when using retirement age as a predictor to estimate social security benefits, the retirement age has a minimum value of 62.

The coefficient is measured in units of the dependent variable divided by units of the independent variable, so its value depends on how the variables are scaled as well as on the estimated strength of their statistical relationships.

If the coefficient of an important variable is very large or very small relative to the number of digits visible in the cell in all of your models, then, for easier reading of the results, you might consider changing its units by rescaling it by several powers of 10 before doing your analysis.

- **STANDARD ERROR:** The standard error is the estimated standard deviation of a coefficient from the given sample of data.

In general, standard error becomes smaller in proportion to 1 divided by the square root of the sample size as the sample size increases. Thus, you would expect four times as many data to reduce the standard errors of all the coefficient estimates by a factor of two (approximately), assuming that the additional data are described by the same model.

- **$t$ -STATISTIC:** The  $t$ -statistic of an independent variable is its estimated coefficient divided by the coefficient's own standard error—that is, its number of standard errors away from 0. The  $t$ -statistic value (which has the same sign as the coefficient) is an indicator of whether that variable has been found to have a measurably non-zero effect in explaining or predicting variations in the dependent variable, in the context of other variables included in the same model.

The  $t$ -statistic associated with any variable is model-dependent. Its value may change, sometimes significantly, if other related variables are added or removed. Also, the  $t$ -statistic of a variable whose true coefficient is non-zero tends to grow larger in magnitude as the sample size increases because standard errors of coefficients grow smaller as the sample size increases.

---

<sup>2</sup> Grace-Martin, K. (n.d.) *How to interpret the intercept in 6 linear regression examples*. The Analysis Factor. <https://www.theanalysisfactor.com/interpret-the-intercept/>.

A commonly used rule of thumb is that a variable's contribution to a model is not statistically significant if its  $t$ -statistic is less than 2 in absolute value—that is, if its estimated value is less than 2 standard errors away from 0, which is the approximate standard for significance at the 0.05 level. This is not a hard-and-fast rule, but as a practical matter the removal of a variable whose  $t$ -statistic is much less than 2 in magnitude will probably not increase the standard error of the regression by very much.

- **p-VALUE:** The  $p$ -value of a coefficient is determined from its  $t$ -statistic. It is the probability of obtaining a  $t$ -statistic that is as large or larger in magnitude than the observed  $t$ -statistic if the true coefficient of that variable is 0 and the model assumptions are otherwise correct. Under those assumptions, the distribution of the  $t$ -statistic is a student's  $t$  distribution, which is almost the same as a standard normal distribution unless the sample size is very small.

A common rule of thumb is that a variable's contribution is not statistically significant if its coefficient's  $p$ -value is greater than 0.05, which indicates that there is a 1 in 20 or greater probability of obtaining a value that large in magnitude by pure chance if the true coefficient of that variable is 0 and the rest of the model specification is correct. This is essentially the same standard of insignificance as having a  $t$ -statistic that is less than 2 in magnitude.

It is not required to keep a variable whose  $p$ -value is less than 0.05 or remove one whose  $p$ -value is greater than 0.05, although you should generally avoid including marginally significant variables without other supporting logic or design considerations. Sometimes a group of variables forms a logical unit that should not be broken up. For example, a group of variables might be dummy variables that are used to identify mutually exclusive treatments in a designed experiment, or it might be seasons of the year in a time series forecasting model. In such cases, you generally do not pick and choose among them individually based on their  $p$ -values and  $t$ -statistics.

- **LOWER AND UPPER CONFIDENCE LIMITS:** Lower and upper confidence limits for a coefficient estimate are obtained by adding or subtracting the appropriate number of standard errors for that confidence level. These limits can be roughly interpreted as intervals within which there is a given probability that the true value lies within that range.

95% confidence limits, which are commonly reported by default, are roughly equal to the coefficient estimate plus or minus 2 standard errors. You may sometimes want to present intervals for other confidence levels, depending on the decision context. For example, a 50% confidence interval (a coin flip) is plus or minus two-thirds of a standard error.

## Model Summaries

Clicking the “Model Summaries” button will allow for a side-by-side comparison of model statistics for all models fitted to the same dependent variable.

The “Model Summaries” worksheet, which is located to the right of all analysis worksheets, is updated with every new regression model and provides an audit trail for all models that have been fitted in the lifetime of the Excel file, even those models whose output worksheets may have been subsequently deleted. It is recommended that you not delete model worksheets to maintain the entire audit trail.

Only models fitted to the same dependent variable are displayed side by side.

### **Instructions/Help**

Clicking the “Instructions/Help button” opens an abbreviated set of instructions on how to use the Program Evaluation Toolkit Calculator. The current version number of the tool is also displayed.