Perform Power Regression in Excel (Step-by-Step)

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Power regression is a highly specialized form of non-linear regression used extensively when the relationship between variables exhibits a characteristic exponential or curved trend, rather than the simple linearity assumed by ordinary least squares. This statistical modeling technique is indispensable in fields like physics, biology, and economics, where numerous natural and social phenomena adhere to **power laws**.

The fundamental mathematical representation of the power regression model is given by the equation:

y = axb

Understanding the role of each element in this equation is critical for successful analysis:

y: Represents the response variable (also known as the **dependent variable**), the outcome we are attempting to predict or explain.
x: Represents the predictor variable (the **independent variable**), which drives the response.
a, b: These are the regression coefficients. The coefficient *a* (the scaling factor) and *b* (the exponent or power) collectively define the exact shape of the curve and quantify the strength of the non-linear relationship between *x* and *y*.

Since the power model is inherently non-linear, it cannot be solved directly using Excel's standard linear least squares methods. To overcome this computational hurdle, we must employ a critical initial step: applying a logarithmic transformation to convert the equation into a solvable linear form.

The following comprehensive, step-by-step tutorial details the entire process--from initial data preparation and linearization to utilizing Excel's powerful analytical tools and deriving the final predictive equation.

Step 1: Constructing the Sample Data Set

To begin our power regression analysis, the first necessity is a clean, well-structured sample dataset. For this demonstration, we will create a simple array of observations that clearly represents two variables: the independent variable (x), which serves as the input, and the dependent variable (y), which is the observed outcome.

Carefully enter the chosen values for 'x' and 'y' into adjacent columns within your Excel worksheet. It is essential to ensure this data foundation is accurate, as any subsequent analysis relies entirely on the integrity of these initial measurements. Proper organization now will prevent complications in later steps involving data range selection.

	A	B	C	D	E	F	G
1	x	y					
2	1	1					
3	2	8					
4	3	5					
5	4	7					
6	5	6					
7	6	20					
8	7	15					
9	8	19					
10	9	23					
11	10	37					
12	11	33					
13	12	38					
14	13	49					
15	14	50					
16	15	56					
17	16	52					
18	17	70					
19	18	89					
20	19	97					
21	20	115					
22							
23							
24							
25							

Step 2: Linearizing the Data Through Transformation

As established earlier, the power relationship (*y* = *axb*) is non-linear, meaning we cannot directly use Excel's built-in **linear regression** tools. To make the model accessible to standard statistical software, we must perform a key mathematical manipulation: applying the natural logarithm (ln) to both the predictor (x) and the response (y) variables.

This logarithmic transformation is powerful because it converts the multiplicative power function into an additive linear equation. The original equation, *y* = *axb*, becomes **ln(y) = ln(a) + b * ln(x)**. This new structure perfectly mirrors the standard linear form, *Y* = *A* + *B*X*, where the transformed variables and coefficients are identified as: *Y* = *ln(y)*, *A* = *ln(a)*, *B* = *b*, and *X* = *ln(x)*.

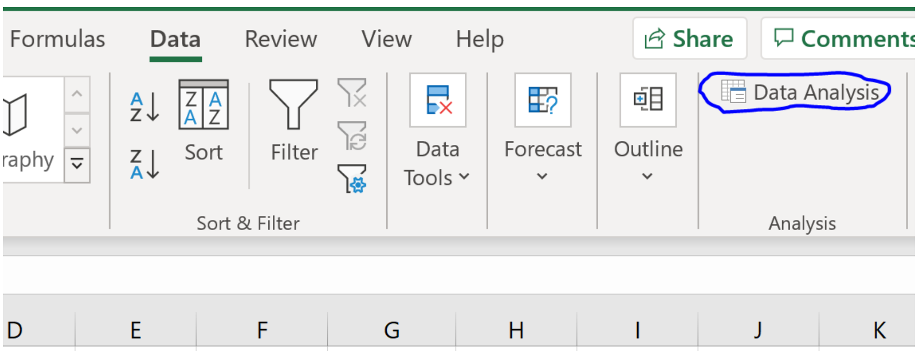
In your Excel sheet, create two new columns titled "ln(x)" and "ln(y)". Use the built-in Excel function **=LN(number)** to calculate the natural log of every corresponding original x and y value. These newly calculated, transformed values will serve as the crucial input variables for running the regression analysis in the next step.

	A	B	C	D	E	F	G	H
1	x	y		ln(x)	ln(y)			
2	1	1		=LN(A2)	0			
3	2	8		0.69	2.08			
4	3	5		1.10	1.61			
5	4	7		1.39	1.95			
6	5	6		1.61	1.79			
7	6	20		1.79	3.00			
8	7	15		1.95	2.71			
9	8	19		2.08	2.94			
10	9	23		2.20	3.14			
11	10	37		2.30	3.61			
12	11	33		2.40	3.50			
13	12	38		2.48	3.64			
14	13	49		2.56	3.89			
15	14	50		2.64	3.91			
16	15	56		2.71	4.03			
17	16	52		2.77	3.95			
18	17	70		2.83	4.25			
19	18	89		2.89	4.49			
20	19	97		2.94	4.57			
21	20	115		3.00	4.74			
22								
23								
24								
25								

Step 3: Fitting the Regression Model in Excel

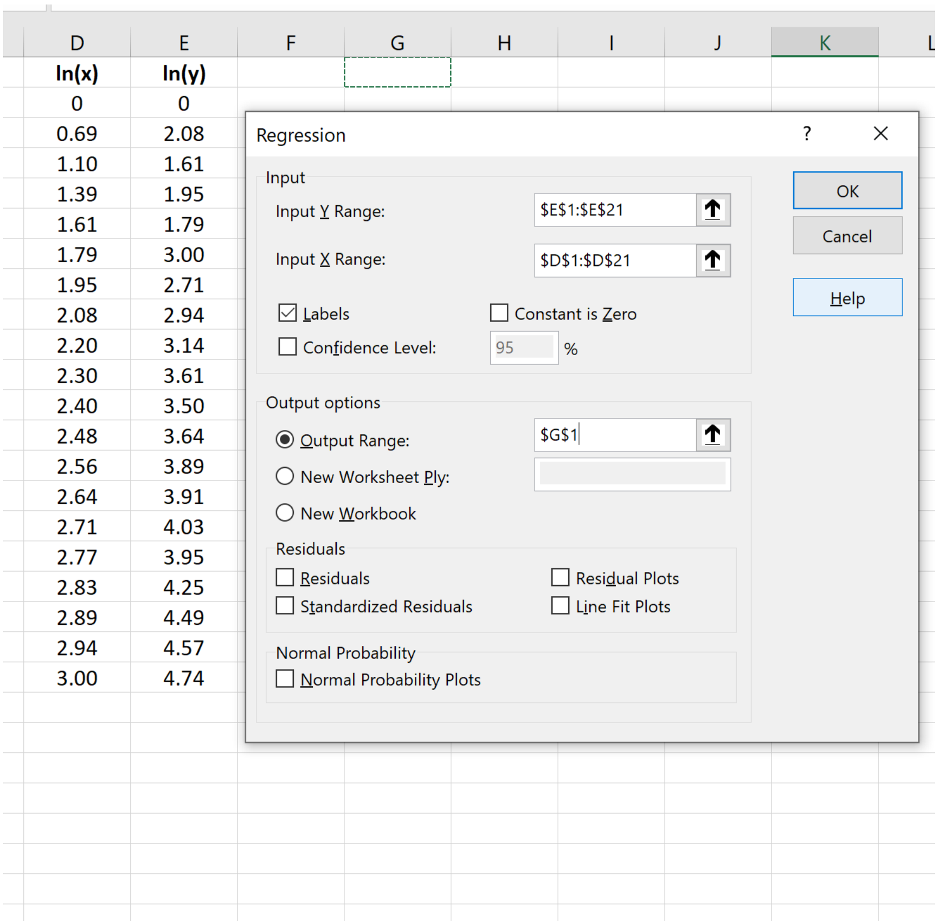
With the data successfully linearized, we are now prepared to fit the regression model using the powerful analytical capabilities within Excel. This process requires the activation of the **Data Analysis ToolPak** add-in, which provides the necessary statistical procedures.

To locate the tool, navigate to the **Data** tab on the main ribbon. Look for the **Analyze** section on the far right, and click the **Data Analysis** option. If this option is not visible, you must first install the Data Analysis ToolPak add-in via Excel's options menu.



In the Data Analysis dialogue box, select **Regression** from the list of available tools. It is absolutely crucial at this stage to use the transformed variables, not the original data. The inputs should be defined as follows:

Input Y Range: Select the entire column containing the **ln(y)** values (the transformed dependent variable).
Input X Range: Select the entire column containing the **ln(x)** values (the transformed independent variable).



After confirming the correct ranges, click **OK**. Excel will generate a comprehensive regression output table, typically populating a new worksheet or a specified output range.

Step 4: Interpreting the Regression Output and Model Coefficients

The output table provides extensive statistical details regarding the linear model fitted to the logarithmically transformed data. Our primary goal here is twofold: confirming the overall reliability of the model and extracting the necessary coefficient values to reconstruct the original power equation.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.966375
R Square	0.933881
Adjusted R	0.930208
Standard E	0.318685
Observatio	20

ANOVA

	df	SS	MS	F	Significance F
Regression	1	25.82038	25.82038	254.2367	4.61887E-12
Residual	18	1.828087	0.10156		
Total	19	27.64847			

	Coefficients	tandard Errc	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Jpper 95.0%
Intercept	0.153334	0.203322	0.754143	0.460516	-0.273829448	0.580497	-0.27383	0.580497
ln(x)	1.434391	0.08996	15.9448	4.62E-12	1.245392243	1.623389	1.245392	1.623389

First, assess the model's overall significance by examining the ANOVA table. The calculated **F-statistic** (254.2367) is large, and the corresponding p-value (4.61887e-12) is extremely small. This highly significant result confirms that the linear regression equation is statistically valid and effectively models the relationship between the transformed variables ln(x) and ln(y).

Next, we extract the coefficient values from the bottom section of the output table. These values correspond directly to the components of our linearized equation:

ln(y) = Intercept + (Coefficient of ln(x)) * ln(x)

By inserting the calculated values from the output, we finalize the linearized model equation:

ln(y) = 0.15333 + 1.43439 * ln(x)

Step 5: Deriving the Final Non-Linear Power Equation

The final, and most critical, step in power regression is reversing the logarithmic transformation to return the equation to its original, non-linear power form: **y = axb**. This is accomplished by applying the exponential function (e, or Euler's number) to both sides of the linearized equation we derived in Step 4.

We begin with the linearized result and apply the exponential function:

Start: **ln(y) = 0.15333 + 1.43439 * ln(x)**
Apply e: **y = e(0.15333 + 1.43439 * ln(x))**

Using the rules of exponents (eA+B = eA * eB) and logarithms (eb*ln(x) = xb), we can isolate and calculate the original regression coefficients, *a* and *b*:

The exponent *b* is simply the coefficient of ln(x): **b = 1.43439**
The scaling factor *a* is the exponential of the intercept (eIntercept): **a = e0.15333** ≈ **1.1657**

The final fitted non-linear regression equation, which relates the original variables *x* and *y*, is therefore:

y = 1.1657x1.43439

Step 6: Utilizing the Predictive Model

The successful derivation of the power equation provides a powerful predictive model ready for practical application. We can now accurately forecast the expected value of the response variable (y) for any given input value of the predictor variable (x), assuming the observed power relationship remains consistent outside the sample range.

For instance, if we need to predict the value of *y* when the input *x* is equal to 12, we substitute 12 into our final derived equation:

y = 1.1657 * (12)1.43439

Executing this calculation yields a predicted value of approximately **41.167**. This result clearly demonstrates the utility and validity of using Excel's transformation and linear regression capabilities to effectively solve complex, non-linear regression problems.

Bonus Tip: For quick cross-validation of your coefficients, consider using an online power regression calculator. While manual calculation provides depth of understanding, a calculator can rapidly verify the derived scaling factor (a) and exponent (b) for your dataset.

Additional Resources and Further Reading