

How to Perform Polynomial Regression in Excel: A Step-by-Step Guide

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Polynomial regression is a sophisticated statistical methodology employed to examine and quantify the intricate relationship between a **dependent variable** and one or more **independent variables**. Unlike standard linear models that assume a constant rate of change, this method is specifically designed for scenarios where the relationship is non-linear and is better characterized by a **polynomial function**. By elevating the **degree** of the independent variable, analysts can create a curved line of best fit that more accurately reflects the nuances of the data points. Within the **Microsoft Excel** environment, this process is streamlined through the use of built-in charting tools and trendline features, allowing for robust data analysis without the need for complex programming. To effectively perform this analysis, one must follow a systematic approach to ensure the resulting model is both statistically significant and practically useful.

Fundamentals of Statistical Modeling in Excel

In the realm of data science and business analytics, **regression analysis** serves as a foundational tool for predictive modeling and trend estimation. The primary objective is to understand how the typical value of the **response variable** changes when any one of the **explanatory variables** is varied while the other variables are held constant. While **linear regression** is the most frequently utilized technique, its application is strictly limited to relationships that can be represented by a straight line. When data exhibits curvature, such as in biological growth patterns or market saturation levels, a linear model will inevitably result in a poor fit, leading to inaccurate predictions and misleading conclusions.

To begin the process of **polynomial regression** in **Excel**, the first critical step is the accurate entry of data. Analysts should open a new spreadsheet and meticulously input their observations into two distinct columns, typically assigning the **independent variable** (X) to the first column and the **dependent variable** (Y) to the second. This organizational structure is essential for **Excel** to correctly interpret the data during the visualization phase. It is often recommended to label these columns clearly to maintain clarity throughout the analytical workflow, especially when dealing with large datasets or multiple regression iterations.

Once the data is successfully localized within the spreadsheet, the next phase involves the creation of a visual representation. By selecting the data range and navigating to the "Insert" tab, users can select the **scatter plot** option. This specific chart type is vital because it displays individual data points on a Cartesian plane, allowing the researcher to visually inspect the distribution. Before applying any mathematical models, a visual check of the **scatter plot** helps in determining whether a **quadratic**, **cubic**, or higher-order polynomial is appropriate for the data at hand. Choosing the smooth lines option during this step can further assist in identifying underlying patterns that might be obscured by noise.

After the chart is generated, the analytical transition from visualization to modeling occurs through

the "Add Trendline" feature. By right-clicking on any data point within the **scatter plot** and selecting this option, **Excel** opens a formatting pane that provides various regression types. Selecting "Polynomial" allows the user to specify the "Order" of the equation, which corresponds to the highest power of the variable. This flexibility is what enables **polynomial regression** to capture fluctuations that **linear regression** simply cannot, providing a more tailored mathematical description of the observed phenomena.

Advanced Configuration and Model Selection

Selecting the appropriate degree for a **polynomial regression** model is a delicate balance between accuracy and simplicity. In **Excel**, users can choose an order ranging from 2 to 6. A second-order polynomial creates a **parabolic** curve with one bend, while a third-order or **cubic function** can account for two distinct bends in the data. While it might be tempting to select the highest possible order to achieve a perfect fit, this often leads to **overfitting**. **Overfitting** occurs when the model describes the random noise in the data rather than the underlying relationship, which significantly reduces the model's predictive power for new, unseen data.

To evaluate the efficacy of the chosen model, **Excel** provides two essential options within the trendline settings: "Display Equation on Chart" and "Display R-squared value on chart." The **coefficient of determination**, commonly known as **R-squared**, is a statistical measure that represents the proportion of the variance for the **response variable** that's explained by the **explanatory variable**. An **R-squared** value closer to 1.0 indicates that the model fits the data extremely well, whereas a lower value suggests that the model may not be capturing the trend effectively or that the data is inherently volatile.

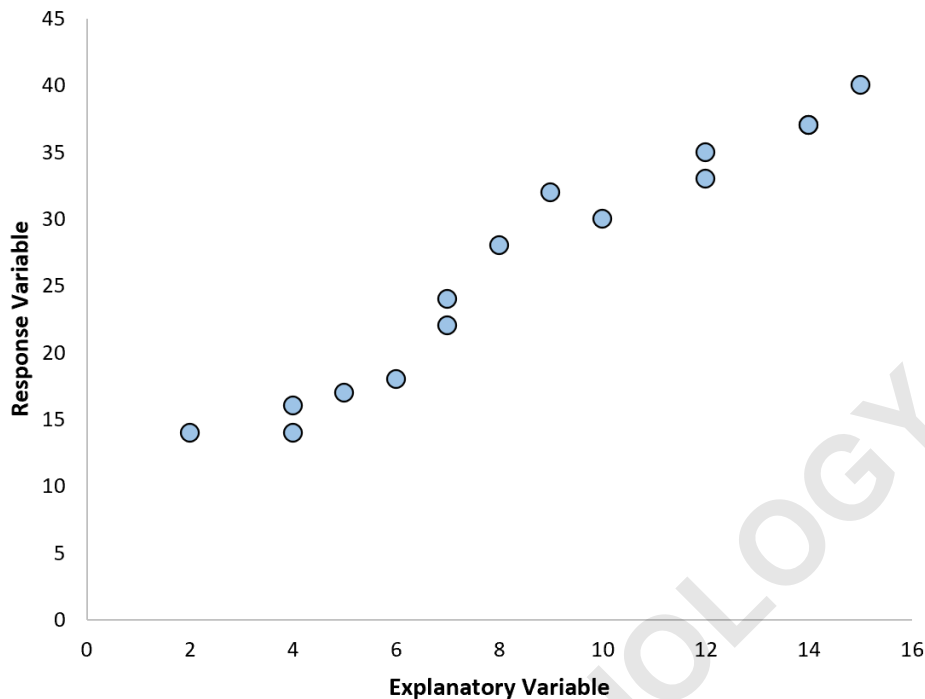
Upon finalizing these settings and clicking "Close," the polynomial trendline is superimposed onto the chart, accompanied by the regression equation and the **R-squared** value. This visual and mathematical output provides a comprehensive summary of the non-linear relationship. The equation itself is a powerful asset, as it allows for the manual calculation of predicted values for any given input. By systematically applying this method, researchers can move beyond simple observations to derive actionable insights and evidence-based forecasts from their **Excel** data.

Perform Polynomial Regression in Excel

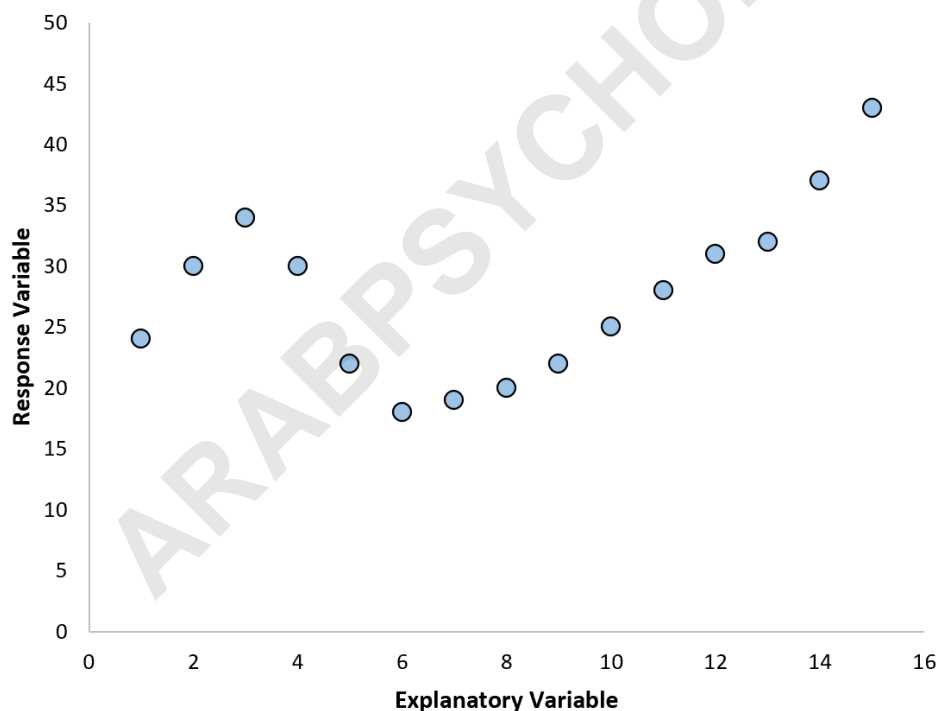
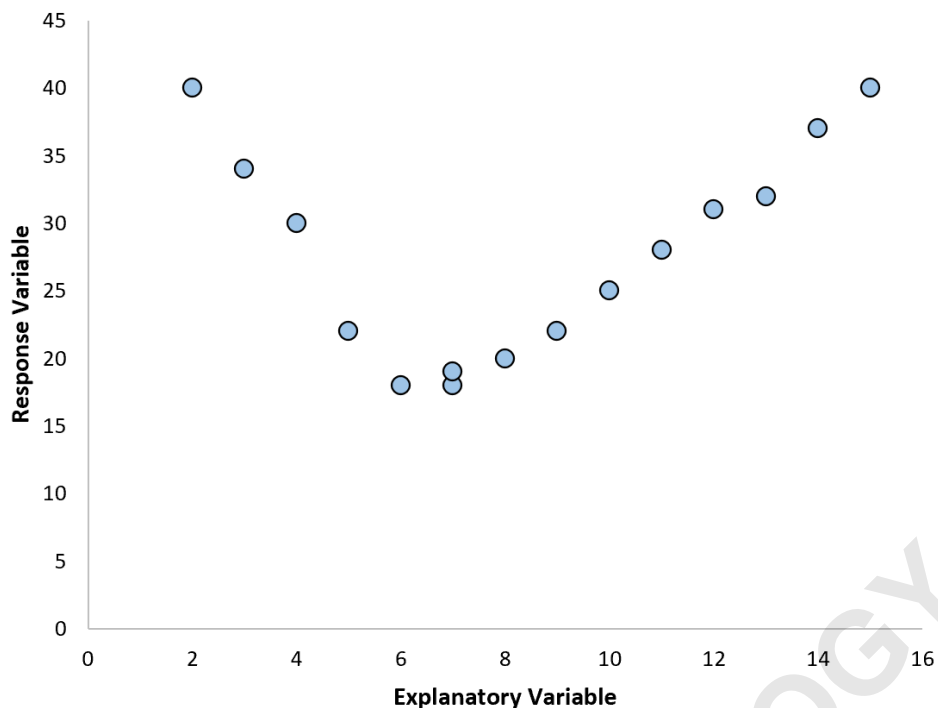
Regression analysis is a fundamental statistical tool utilized to quantify and define the specific relationship between one or more **explanatory variables** and a **response variable**. By establishing a mathematical framework, analysts can determine how changes in the input factors influence the output, which is crucial for forecasting and decision-making in diverse fields such as economics, science, and engineering.

The most frequently encountered methodology in this field is **simple linear regression**. This

approach is highly effective when the **explanatory variable** and the **response variable** share a direct, proportional relationship that can be mapped as a straight line. However, the simplicity of this model is also its limitation, as it cannot accommodate data that fluctuates or curves over time.



In many practical scenarios, the relationship between variables is inherently nonlinear, requiring a more flexible modeling approach. For instance, physical phenomena or market trends often display acceleration or deceleration that a straight line fails to capture. When a visualization of the data suggests a curve, a more complex model is required to ensure the integrity of the statistical analysis.



In these specific instances, it is highly advantageous to employ **polynomial regression**. This technique expands the mathematical horizons of the analysis by accounting for nonlinear interactions between variables through higher-order equations. By using this method, the researcher can achieve a much higher level of precision when modeling complex datasets.

This comprehensive guide provides a detailed walkthrough on how to successfully execute **polynomial regression** within **Excel**, ensuring that your data models are both accurate and visually compelling.

Practical Example: Implementing Polynomial Regression

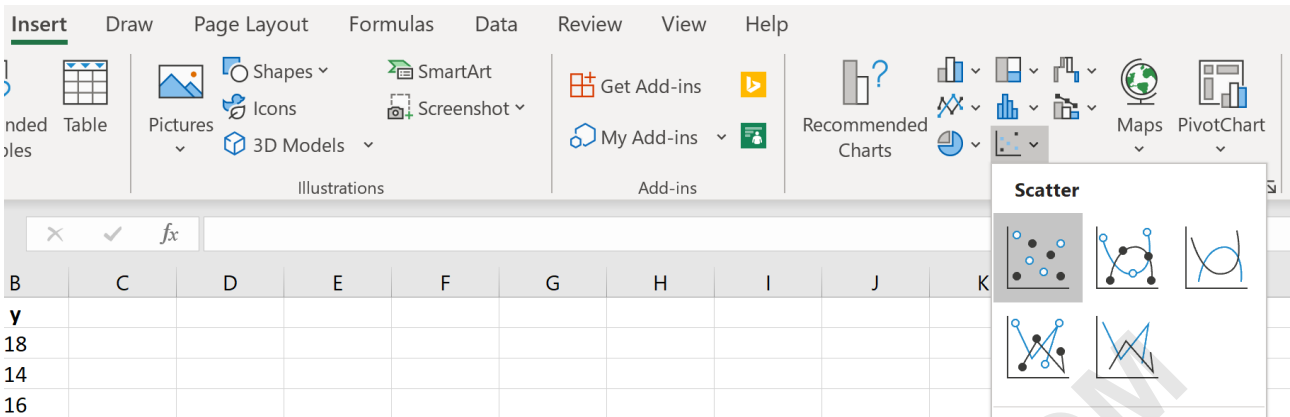
To illustrate the process effectively, let us examine a specific dataset within the **Excel** interface. Suppose we have documented a series of observations where the relationship between the input and output is not immediately obvious but appears to have multiple directional changes.

	A	B	C	D	E	F
1	x	y				
2	2	18				
3	4	14				
4	4	16				
5	5	17				
6	6	18				
7	7	23				
8	7	25				
9	8	28				
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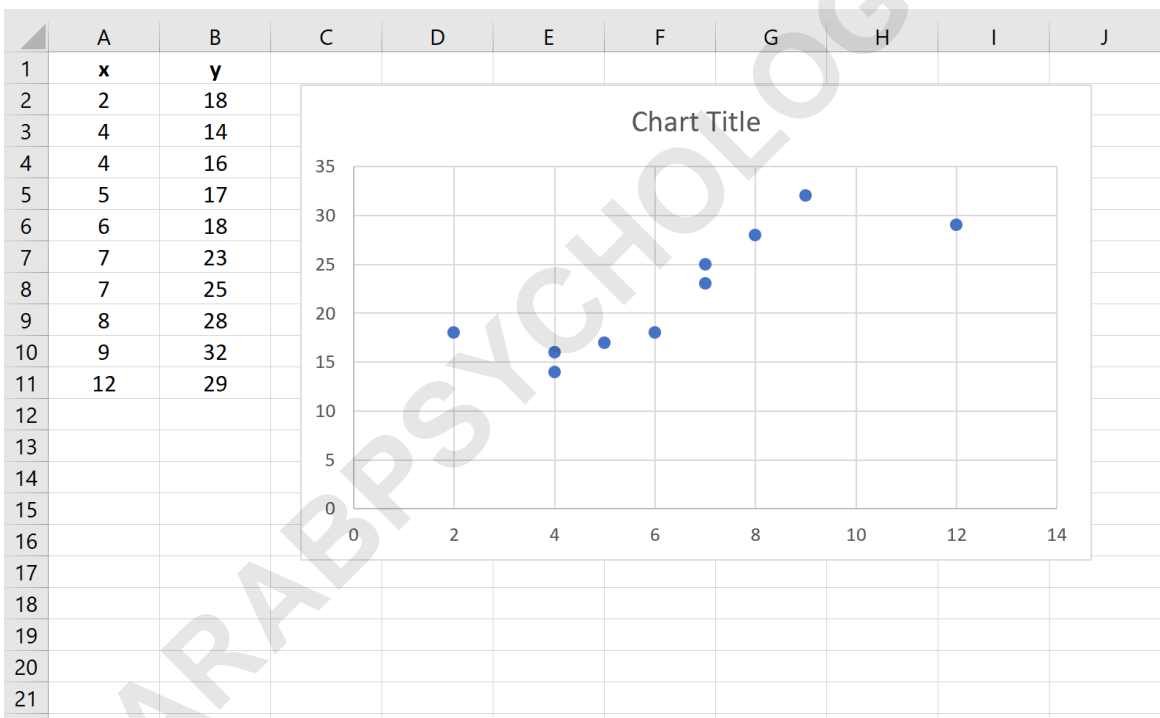
Follow the structured steps below to fit a precise **polynomial regression** equation to your unique dataset:

Step 1: Generating the Initial Scatterplot

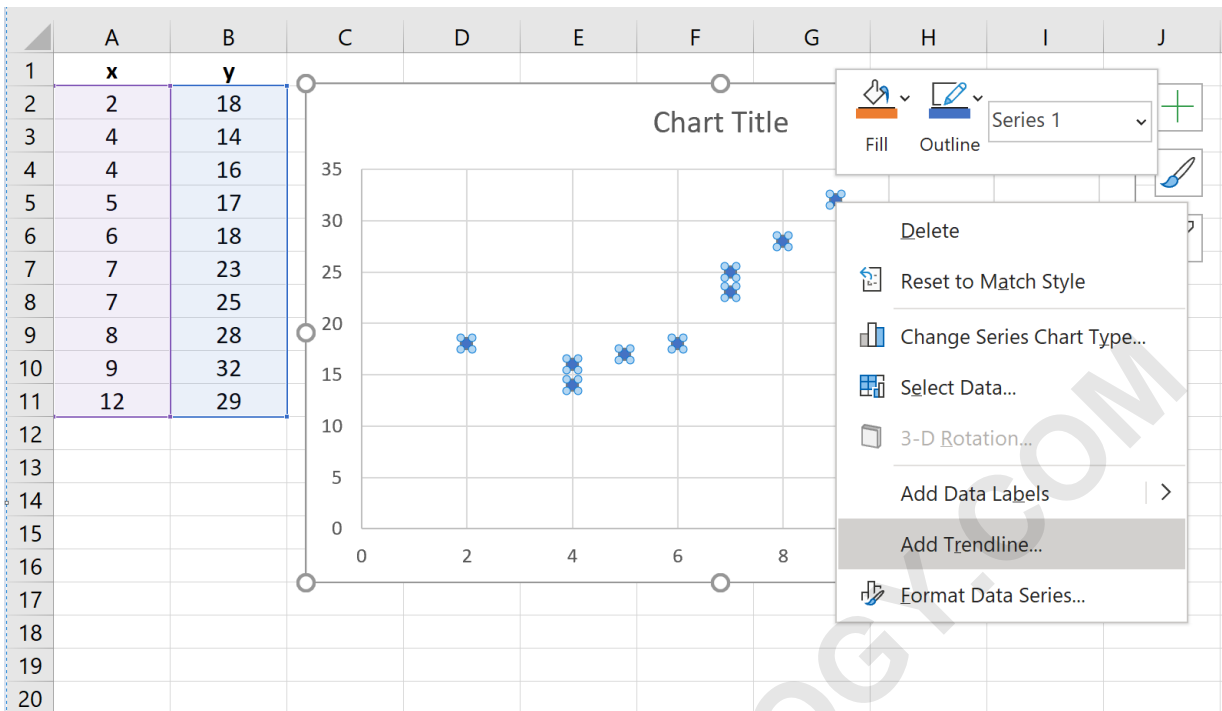
The foundation of any regression model is visual inspection. To begin, you must generate a **scatterplot** to identify the general trend of the data points. Navigate to the **Charts** group located within the **Insert** tab of the **Excel** ribbon. From there, select the **Scatter** icon and choose the standard **scatterplot** format to plot your X and Y coordinates.



Once selected, a **scatterplot** will be automatically generated on your worksheet, providing a clear view of how the **response variable** behaves in relation to the **explanatory variable**.

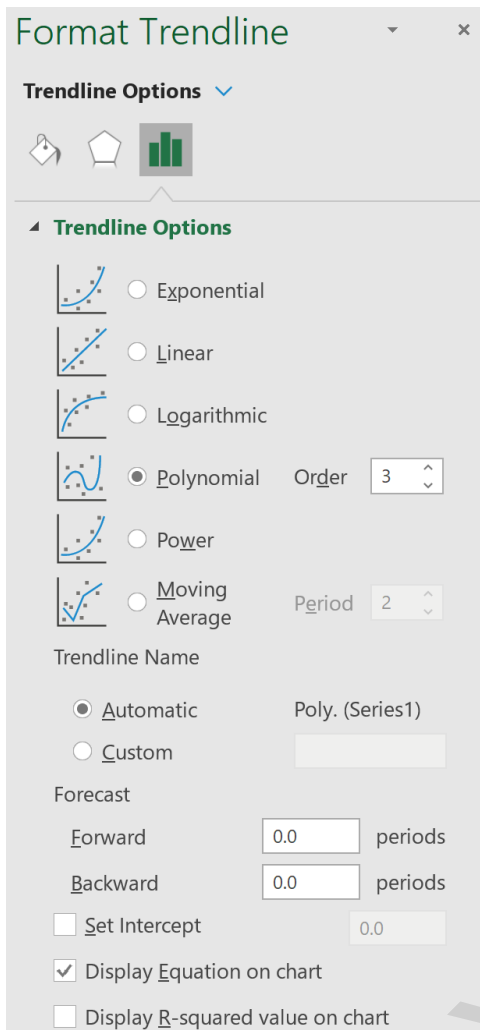


With the chart now visible, the next objective is to integrate a mathematical trendline. This is achieved by clicking on any individual data point within the plot to select the entire series. After selecting the points, right-click and choose the **Add Trendline...** option from the context menu to access advanced modeling settings.

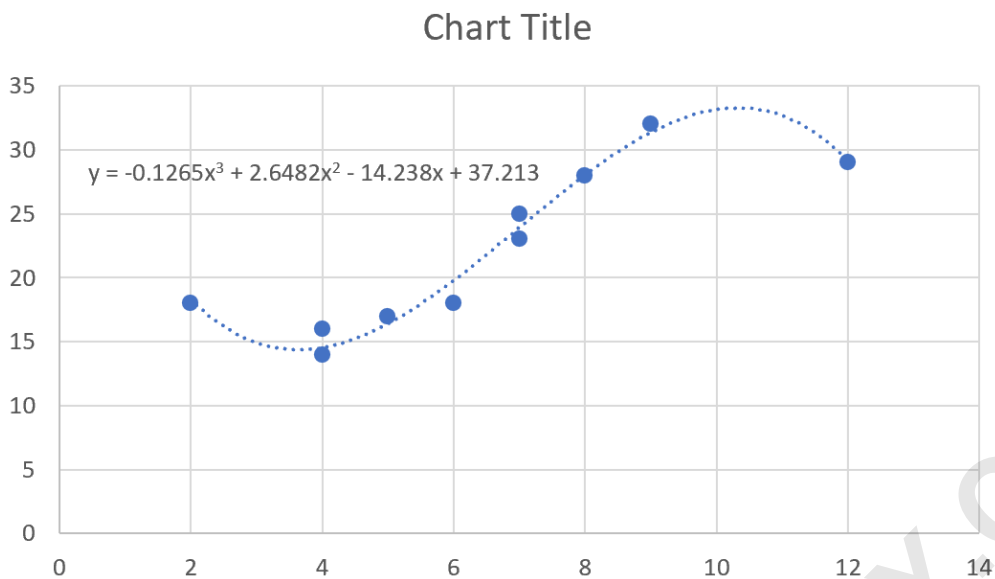


Step 2: Configuring the Polynomial Trendline

Upon selecting the trendline option, a configuration pane will appear on the right side of the **Excel** window. To model a non-linear relationship, select the **Polynomial** radio button. You will then need to define the **Order** of the polynomial. In this specific example, a **cubic function** (Order 3) is selected to match the two visible curves in the data. To ensure the model is transparent, also check the box labeled **Display Equation on chart**.



Following these adjustments, **Excel** will immediately render the **polynomial regression** line over your data points, providing a visual confirmation of the model's fit.



Step 3: Comprehensive Interpretation of the Model

The most critical part of the analysis is interpreting the resulting regression equation. For the dataset utilized in this example, the fitted **polynomial regression** equation is displayed as:

$$y = -0.1265x^3 + 2.6482x^2 - 14.238x + 37.213$$

This mathematical expression provides a roadmap for predicting the **response variable** based on specific values of the **explanatory variable**. For instance, if we wish to determine the expected value of y when x is equal to 4, we would substitute the value into the equation as follows:

$$y = -0.1265(4)^3 + 2.6482(4)^2 - 14.238(4) + 37.213$$

Performing the calculation yields an expected value of **14.5362**. This ability to derive precise estimates from non-linear data highlights the practical utility of **polynomial regression**. By mastering these steps in **Excel**, analysts can enhance their ability to interpret complex datasets and provide more accurate, data-driven insights.