

# Regression Analysis: Basic Concepts

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## The simple linear model

Represents the dependent variable,  $y_i$ , as a linear function of one independent variable,  $x_i$ , subject to a random "disturbance" or "error",  $u_i$ .

$$y_i = \beta_0 + \beta_1 x_i + u_i$$

The error term  $u_i$  is assumed to have a mean value of zero, a constant variance, and to be uncorrelated with its own past values (i.e., it is "white noise").

The task of estimation is to determine regression coefficients  $\hat{\beta}_0$  and  $\hat{\beta}_1$ , estimates of the unknown parameters  $\beta_0$  and  $\beta_1$  respectively.

The estimated equation will have the form

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i$$

1

## OLS

The basic technique for determining the coefficients  $\hat{\beta}_0$  and  $\hat{\beta}_1$  is Ordinary Least Squares (OLS).

Values for the coefficients are chosen to minimize the sum of the squared estimated errors or *residual sum of squares* (SSR). The estimated error associated with each pair of data-values ( $x_i, y_i$ ) is defined as

$$\hat{u}_i = y_i - \hat{y}_i = y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i$$

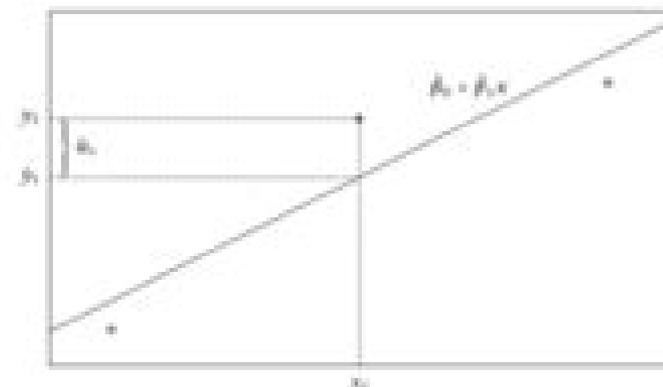
We use a different symbol for this estimated error ( $\hat{u}_i$ ) as opposed to the "true" disturbance or error term, ( $u_i$ ). These two coincide only if  $\hat{\beta}_0$  and  $\hat{\beta}_1$  happen to be exact estimates of the regression parameters  $\alpha$  and  $\beta$ . The estimated errors are also known as *residuals*.

The SSR may be written as

$$SSR = \sum \hat{u}_i^2 = \sum (y_i - \hat{y}_i)^2 = \sum (y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i)^2$$

2

## Picturing the residuals



The residual,  $\hat{u}_i$ , is the vertical distance between the actual value of the dependent variable,  $y_i$ , and the fitted value,  $\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i$ .

3

# Regression Analysis Basic Concepts

**Yicheng Fang**



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## **Table of Contents Regression Analysis Basic Concepts**

1. Understanding the eBook Regression Analysis Basic Concepts
  - The Rise of Digital Reading Regression Analysis Basic Concepts
  - Advantages of eBooks Over Traditional Books
2. Identifying Regression Analysis Basic Concepts
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Regression Analysis Basic Concepts
  - User-Friendly Interface
4. Exploring eBook Recommendations from Regression Analysis Basic Concepts
  - Personalized Recommendations
  - Regression Analysis Basic Concepts User Reviews and Ratings
  - Regression Analysis Basic Concepts and Bestseller Lists
5. Accessing Regression Analysis Basic Concepts Free and Paid eBooks
  - Regression Analysis Basic Concepts Public Domain eBooks
  - Regression Analysis Basic Concepts eBook Subscription Services
  - Regression Analysis Basic Concepts Budget-Friendly Options
6. Navigating Regression Analysis Basic Concepts eBook Formats

- ePub, PDF, MOBI, and More
  - Regression Analysis Basic Concepts Compatibility with Devices
  - Regression Analysis Basic Concepts Enhanced eBook Features
7. Enhancing Your Reading Experience
    - Adjustable Fonts and Text Sizes of Regression Analysis Basic Concepts
    - Highlighting and Note-Taking Regression Analysis Basic Concepts
    - Interactive Elements Regression Analysis Basic Concepts
  8. Staying Engaged with Regression Analysis Basic Concepts
    - Joining Online Reading Communities
    - Participating in Virtual Book Clubs
    - Following Authors and Publishers Regression Analysis Basic Concepts
  9. Balancing eBooks and Physical Books Regression Analysis Basic Concepts
    - Benefits of a Digital Library
    - Creating a Diverse Reading Collection Regression Analysis Basic Concepts
  10. Overcoming Reading Challenges
    - Dealing with Digital Eye Strain
    - Minimizing Distractions
    - Managing Screen Time
  11. Cultivating a Reading Routine Regression Analysis Basic Concepts
    - Setting Reading Goals Regression Analysis Basic Concepts
    - Carving Out Dedicated Reading Time
  12. Sourcing Reliable Information of Regression Analysis Basic Concepts
    - Fact-Checking eBook Content of Regression Analysis Basic Concepts
    - Distinguishing Credible Sources
  13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
  14. Embracing eBook Trends
    - Integration of Multimedia Elements
    - Interactive and Gamified eBooks

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