
PO12Q: Introduction to Quantitative Political Analysis II
Week 4 - Worksheet Solutions

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1. Plot the data in Table in a suitable scatter plot. Yes, on paper.

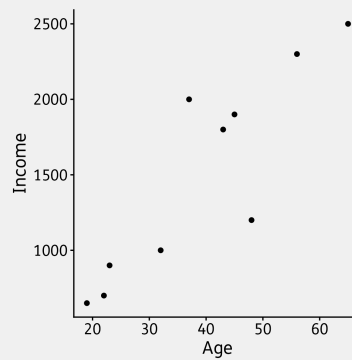


Figure 1: Scatterplot

2. Fit a line of best fit through the scatter plot (by eyeballing and a ruler).

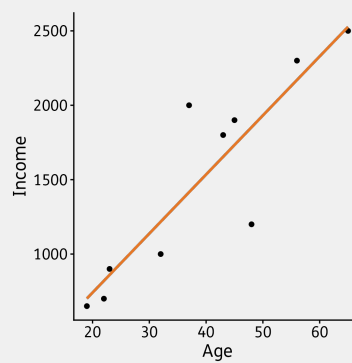


Figure 2: Regression Line

3. Assuming a regression model of the type $Y_i = \beta_0 + \beta_1 X_i + \epsilon_i$, calculate the estimators for β_0 and β_1 .

For intermediate calculations see [Excel Sheet](#).

$$\hat{\beta}_1 = \frac{83200}{2096} = 39.69465$$

$$\hat{\beta}_0 = 1495 - \hat{\beta}_1 \times 39 = -53.0916$$

4. Calculate the regression coefficients β_0 and β_1 using matrices.

Recall that

$$(\mathbf{X}'\mathbf{X})^{-1} = \frac{1}{n\sum x_i^2 - \sum x_i \sum x_i} \begin{bmatrix} \sum x_i^2 & -\sum x_i \\ -\sum x_i & n \end{bmatrix}$$

and that

$$(\mathbf{X}'\mathbf{Y}) = \begin{bmatrix} 1 & 1 & \dots & 1 \\ x_1 & x_2 & \dots & x_n \end{bmatrix} \times \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_i y_i \end{bmatrix}$$

Into this we plug the values from our Excel sheet:

$$\begin{aligned} (\mathbf{X}'\mathbf{X})^{-1} &= \frac{1}{20960} \begin{bmatrix} 17306 & -390 \\ -390 & 10 \end{bmatrix} \\ &= \begin{bmatrix} 0.8256679 & -0.01860687 \\ -0.01860687 & 0.0004770992 \end{bmatrix} \end{aligned}$$

$$(\mathbf{X}'\mathbf{Y}) = \begin{bmatrix} 14950 \\ 666250 \end{bmatrix}$$

Which leads us to

$$\begin{aligned} \hat{\beta} &= (\mathbf{X}'\mathbf{X})^{-1}(\mathbf{X}'\mathbf{Y}) = \begin{bmatrix} 0.8256679 & -0.01860687 \\ -0.01860687 & 0.0004770992 \end{bmatrix} \times \begin{bmatrix} 14950 \\ 666250 \end{bmatrix} \\ &= \begin{bmatrix} -53.092 \\ 39.6946 \end{bmatrix} \end{aligned}$$

5. Build the SRF and interpret the estimators of β_0 and β_1 .

$$\text{inc}\hat{\text{ome}}_i = -53.0916 + 39.69465 \text{ age}_i$$

- **Intercept:** At age zero, a person would earn -53.09 units of income on average
- **Slope:** For every additional year of age, a person's income would increase by 39.69 units on average