1. **Homoscedasticity**

✔ **Definition**

* The **variance of residuals (errors)** is **constant** across all levels of the independent variable(s).
* Simply: The spread of errors remains the **same throughout the data**.

✔ **Graphical pattern**

* When plotting **residuals vs. predicted values**, the points are **evenly spread around zero** without any cone or funnel shape.

✔ **Implications in regression**

* It is an **assumption of linear regression** and other parametric tests.
* If homoscedasticity holds:
  + Regression estimates remain **efficient and unbiased**.

✔ **Example scenario**

* Predicting **salary based on years of experience**, where variability in salary remains the same regardless of experience level.

**2. Heteroscedasticity**

✔ **Definition**

* The **variance of residuals is NOT constant**; it **changes with the value of the independent variable**.
* Simply: Spread of errors **increases or decreases systematically** with x.

✔ **Graphical pattern**

* Residual plot shows a **funnel, cone, or fan shape** (errors increase or decrease along x).

✔ **Implications in regression**

* It **violates linear regression assumptions**.
* Consequences include:
  + Coefficient estimates remain **unbiased** but are **no longer efficient**.

✔ **Example scenario**

* Predicting **expenditure based on income**, where higher income groups show wider spending variation.

**Which is best?**

✔ **Homoscedasticity is ideal** because:

* It meets regression assumptions.
* Ensures **valid standard errors**.

❌ **Heteroscedasticity is problematic** because:

* Violates assumptions.
* Leads to **incorrect inference** (Type I or II errors).
* Needs remedial measures before interpretation.

**Key points summary**

| **Aspect** | **Homoscedasticity** | **Heteroscedasticity** |
| --- | --- | --- |
| **Variance** | Constant | Changing |
| **Graph pattern** | Even spread | Cone/funnel |
| **Regression impact** | Valid assumptions | Violated assumptions |
| **Estimate efficiency** | Efficient | Inefficient |
| **Best for regression?** | ✅ Yes | ❌ No (needs correction) |