Handout for Lecture 14

Hypothesis Testing & p-values

ECON 340: Economic Research Methods — Instructor: Div Bhagia

Hypothesis Testing

1. Set up null hypothesis and alternative hypothesis

$$\begin{aligned} \text{Null Hypothesis:} \quad & H_0 : \mu = \mu_0 \\ \text{Alternative Hypothesis:} \quad & H_1 : \mu \neq \mu_0 \end{aligned}$$

2. Construct test statistic Z if true population variance is known, else use T-statistic.

$$z_0 = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \quad \text{and} \quad t_0 = \frac{\bar{x} - \mu_0}{S/\sqrt{n}}$$

3. Under the null if $\bar{X} \sim N(\mu_0, \sigma^2/n)$, then $Z \sim N(0,1)$ and $T \sim t_{n-1}$. In case of known population variance, reject the null if $|z_0| > z_{\alpha/2}$. In the case of unknown population variance, reject the null if $|t_0| > t_{n-1,\alpha/2}$.

Note: When $n \geq 100$ you can reject the null if $|t_0| > z_{\alpha/2}$ as in large sample t distribution looks like the standard normal.

Question 1: A car manufacturer wants to estimate the mean CO2 emissions of a new model of car. A sample of 196 cars is randomly selected and their CO2 emissions are measured. The sample mean and standard deviation are 120 g/km and 20 g/km, respectively. The car manufacturer had initially claimed that the average CO2 emissions of this model would be 115 g/km. Test the manufacturer's claim at a 5% level of significance.

p-Value:

p-Value is the probability of obtaining an outcome even more surprising under the null hypothesis than the one you got.

- Known variance: $p = 2Pr(Z > |z_0|)$
- Unknown variance, $n < 100$: $p = 2Pr(T > |t_0|)$
- Unknown variance, $n \geq 100$: $p = 2Pr(T > |t_0|) = 2Pr(Z > |t_0|)$

Question 2: Find the p-value associated with your test statistic in the previous question.