

ALLAMA IQBAL OPEN UNIVERSITY

Department of Statistics

SOLVED ASSIGNMENT NO. 2

Course Code: 1430
Course Title: Business Statistics
Assignment Number: 02 (Units 5–7)
Level: BA / B.Com / AD
Semester: Autumn 2026
Academic Year: 2026

[!] IMPORTANT NOTE

Assignments Last Date: 20-02-2027

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ALLAMA IQBAL OPEN UNIVERSITY, ISLAMABAD**Course: Business Statistics (1430) Semester: Autumn 2026****Level: BA / B.Com / AD Total Marks: 100 Pass Marks: 40 (BA) / 50 (AD)**

Q. 1 (a) How does hypothesis testing differ from confidence intervals?
 (b) From 1980 until 1985, the mean price/earnings (P/E) ratio of the approximately 1800 stocks was 14.35 and the standard deviation was 9.73. In a sample of 30 randomly chosen stocks, the mean P/E ratio in 1986 was 11.77. Does this sample present sufficient evidence to conclude that in 1986 the mean P/E ratio for stocks had changed from its earlier value at the 0.05 level of significance? **(10+10 = 20 Marks)**

Answer**(a) Differentiation Between Hypothesis Testing and Confidence Intervals:**

Feature	Hypothesis Testing	Confidence Interval
Primary Objective	Evaluates a specific claim or assertion about a population parameter against empirical sample evidence.	Estimates an unknown population parameter by providing a range of plausible values with a specified confidence level $(1 - \alpha)$.
Starting Point	Begins with a hypothesized null parameter value ($H_0 : \mu = \mu_0$).	Begins solely with sample statistics $(\bar{X}, S, n)$ without assuming a specific target value.
Output Type	Binary decision: Reject H_0 or Fail to Reject H_0 based on P -value or critical regions.	An interval $[L, U] = \bar{X} \pm E$ providing lower and upper bounds for parameter estimation.
Mathematical Equivalence	A two-tailed test at significance level α yields the same conclusion as a $(1 - \alpha)$ confidence interval.	If H_0 parameter value falls inside the $(1 - \alpha)$ interval, H_0 is not rejected; otherwise rejected.

(b) Hypothesis Test for Stock P/E Ratio: Given Parameters:

- Historical Population Mean (μ_0): 14.35
- Population Standard Deviation (σ): 9.73
- Sample Size (n): 30
- Sample Mean ($\bar{X}$): 11.77
- Significance Level (α): 0.05

Step-by-Step Test Execution:**1. Hypotheses:**

$$H_0 : \mu = 14.35 \quad (\text{Mean P/E ratio has not changed in 1986})$$

$$H_1 : \mu \neq 14.35 \quad (\text{Mean P/E ratio has changed in 1986})$$

(Two-tailed test).

2. **Standard Error of Mean ($\sigma_{\bar{X}}$):**

$$\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}} = \frac{9.73}{\sqrt{30}} = \frac{9.73}{5.477225} = 1.77645$$

3. **Test Statistic (Z_{calc}):**

$$Z_{\text{calc}} = \frac{\bar{X} - \mu_0}{\sigma_{\bar{X}}} = \frac{11.77 - 14.35}{1.77645} = \frac{-2.58}{1.77645} = -1.4523$$

4. **Critical Value (Z_{crit}):** For $\alpha = 0.05$ (two-tailed), $Z_{\text{crit}} = \pm 1.96$. Rejection region: Reject H_0 if $Z_{\text{calc}} < -1.96$ or $Z_{\text{calc}} > +1.96$.

5. **Decision & Conclusion:** Since $|Z_{\text{calc}}| = 1.4523 < 1.96$, Z_{calc} lies within the non-rejection region.

Decision: Fail to Reject H_0 .

Conclusion: At the 0.05 significance level, there is insufficient sample evidence to conclude that the mean P/E ratio for stocks in 1986 differed significantly from its historical value of 14.35.

Q. 2 (a) Write the procedures for tests for the difference between means when population variance is known and unknown.

(b) Connie Rodrigues, the Dean of Students at Midstate College, is wondering about grade distributions at the school. She has heard grumblings that the GPAs in the Business School are about 0.25 lower than those in the College of Arts and Sciences (A&S). A quick random sampling produced the following GPAs:

Business	2.86	2.77	3.18	2.80	3.14	2.87	3.19	3.24	2.91	3.00	2.83
A & S	3.35	3.32	3.36	3.63	3.41	3.37	3.45	3.43	3.44	3.17	3.26

Do these data indicate there is a factual basis for the grumblings? State and test appropriate hypotheses at $\alpha = 0.02$. (10+10 = 20 Marks)

Answer

(a) Procedures for Testing Difference Between Two Means: Case 1: Population Variances (σ_1^2, σ_2^2) Known (Z-Test):

1. Hypotheses: $H_0 : \mu_1 - \mu_2 = \Delta_0$ vs $H_1 : \mu_1 - \mu_2 \neq \Delta_0$.

2. Test Statistic:

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - \Delta_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

3. Compare calculated Z with standard normal critical values $Z_{\alpha/2}$.

Case 2: Population Variances Unknown but Assumed Equal ($\sigma_1^2 = \sigma_2^2 = \sigma^2$) (Pooled t-Test):

1. Calculate pooled sample variance S_p^2 :

$$S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

2. Test Statistic (t -distribution with $df = n_1 + n_2 - 2$):

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - \Delta_0}{\sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

3. Compare calculated t with Student's t critical values $t_{\alpha/2, df}$.

(b) Hypothesis Test for Business vs. A&S GPAs: 1. Sample Calculations:

• **Business School ($n_1 = 11$):**

$$\sum X_1 = 32.79 \implies \bar{X}_1 = \frac{32.79}{11} = 2.9791$$

$$\sum (X_1 - \bar{X}_1)^2 = 0.32029 \implies S_1^2 = \frac{0.32029}{10} = 0.03203 \quad (S_1 = 0.1790)$$

- **Arts & Sciences ($n_2 = 11$):**

$$\sum X_2 = 37.19 \implies \bar{X}_2 = \frac{37.19}{11} = 3.3809$$

$$\sum (X_2 - \bar{X}_2)^2 = 0.16989 \implies S_2^2 = \frac{0.16989}{10} = 0.01699 \quad (S_2 = 0.1303)$$

2. Step-by-Step Hypothesis Testing ($\alpha = 0.02$): The grumblings claim that Business GPAs are 0.25 lower than A&S GPAs ($\mu_1 - \mu_2 = -0.25$).

- Hypotheses:**

$$H_0 : \mu_1 - \mu_2 = -0.25 \quad (\text{GPA difference is exactly 0.25 as rumored})$$

$$H_1 : \mu_1 - \mu_2 \neq -0.25 \quad (\text{GPA difference differs significantly from 0.25})$$

- Pooled Sample Variance (S_p^2):**

$$S_p^2 = \frac{(11-1)(0.03203) + (11-1)(0.01699)}{11+11-2} = \frac{10(0.03203) + 10(0.01699)}{20} = \frac{0.4902}{20} = 0.02451$$

- Standard Error (SE):**

$$SE = \sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)} = \sqrt{0.02451 \times \left(\frac{1}{11} + \frac{1}{11} \right)} = \sqrt{0.02451 \times 0.181818} = \sqrt{0.0044563} = 0.066755$$

- Test Statistic (t_{calc}):** Observed difference $\bar{X}_1 - \bar{X}_2 = 2.9791 - 3.3809 = -0.4018$.

$$t_{\text{calc}} = \frac{(\bar{X}_1 - \bar{X}_2) - (-0.25)}{SE} = \frac{-0.4018 - (-0.25)}{0.066755} = \frac{-0.1518}{0.066755} = -2.274$$

- Critical Value & Decision ($df = 20, \alpha = 0.02$):** Two-tailed critical value $t_{0.01,20} = \pm 2.528$. Since $|t_{\text{calc}}| = 2.274 < 2.528$, t_{calc} falls inside the non-rejection region.

Decision: Fail to Reject H_0 .

Conclusion: At $\alpha = 0.02$, there is no statistically significant evidence to reject the assertion that Business GPAs are about 0.25 lower than A&S GPAs. The data is consistent with the grumblings.

Q. 3 (a) Explain the process for testing differences between means with dependent samples.
 (b) A credit-insurance organization has developed a new high-tech method of training new sales personnel. The company sampled 16 employees who were trained the original way and found average daily sales to be \$688 and the sample standard deviation was \$32.63. They also sampled 11 employees who were trained using the new method and found average daily sales to be \$706 and the sample standard deviation was \$24.84. At $\alpha = 0.05$, can the company conclude that average daily sales have increased under the new plan? **(10+10 = 20 Marks)**

Answer

(a) Process for Testing Differences Between Means with Dependent (Paired) Samples: Dependent samples occur when observations are naturally paired or matched (e.g., pre-test vs. post-test on the same subjects).

Step-by-Step Testing Process:

1. **Compute Differences (d_i):** For each paired pair i , calculate $d_i = X_{1i} - X_{2i}$.
2. **Calculate Mean ($\bar{d}$) and Standard Deviation (S_d) of Differences:**

$$\bar{d} = \frac{\sum d_i}{n}, \quad S_d = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n - 1}}$$

3. **Formulate Hypotheses:** $H_0 : \mu_d = 0$ vs $H_1 : \mu_d \neq 0$ (or $\mu_d > 0$).
4. **Compute Test Statistic (t -test):**

$$t = \frac{\bar{d} - \mu_{d0}}{S_d / \sqrt{n}}$$

5. **Decision Rule:** Compare t with critical $t_{\alpha, df}$ using $df = n - 1$.

(b) Hypothesis Test for Sales Training Methods (Independent Samples): Given Data:

- Original Training Group ($n_1 = 16$): $\bar{X}_1 = \$688$, $S_1 = \$32.63$
- New Training Group ($n_2 = 11$): $\bar{X}_2 = \$706$, $S_2 = \$24.84$
- Significance Level (α): 0.05

Step-by-Step Test Execution:

1. **Hypotheses:**

$$H_0 : \mu_2 - \mu_1 \leq 0 \quad (\text{New plan has not increased average daily sales})$$

$$H_1 : \mu_2 - \mu_1 > 0 \quad (\text{New plan has significantly increased average daily sales})$$

(Right-tailed test).

2. **Pooled Variance (S_p^2):**

$$S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} = \frac{(16 - 1)(32.63)^2 + (11 - 1)(24.84)^2}{16 + 11 - 2}$$

$$S_p^2 = \frac{15(1064.7169) + 10(617.0256)}{25} = \frac{15970.7535 + 6170.256}{25} = \frac{22141.0095}{25} = 885.64038$$

3. **Standard Error (SE):**

$$SE = \sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)} = \sqrt{885.64038 \times \left(\frac{1}{16} + \frac{1}{11} \right)} = \sqrt{885.64038 \times 0.153409} = \sqrt{135.8653} = 11.6561$$

4. **Test Statistic (t_{calc}):**

$$t_{\text{calc}} = \frac{\bar{X}_2 - \bar{X}_1}{SE} = \frac{706 - 688}{11.6561} = \frac{18}{11.6561} = \mathbf{1.5443}$$

5. **Critical Value & Decision ($df = 25, \alpha = 0.05$, **Right-Tailed**):** From Student's t -table, $t_{0.05, 25} = +1.708$. Since $t_{\text{calc}} = 1.5443 < 1.708$, t_{calc} does not fall into the rejection region.

Decision: Fail to Reject H_0 .

Conclusion: At the $\alpha = 0.05$ significance level, there is insufficient sample evidence to conclude that average daily sales have increased under the new training plan.

Q. 4 Cost accountants often estimate overhead based on the level of production. At the Standard Knitting Co., they have collected information on overhead expenses and units produced at different plants, and want to estimate a regression equation to predict future overhead:

Overhead (Y)	191	170	272	155	280	173	234	116	153	178
Units (X)	40	42	53	35	56	39	48	30	37	40

- (a) Develop the regression equation for the cost accountants.
 (b) Predict overhead when 50 units are produced.
 (c) Calculate the standard error of the estimate.

(10+5+5 = 20 Marks)

Answer

1. Full Calculation Table ($n = 10$):

Units (X)	Overhead (Y)	X^2	Y^2	XY
40	191	1600	36481	7640
42	170	1764	28900	7140
53	272	2809	73984	14416
35	155	1225	24025	5425
56	280	3136	78400	15680
39	173	1521	29929	6747
48	234	2304	54756	11232
30	116	900	13456	3480
37	153	1369	23409	5661
40	178	1600	31684	7120
$\sum X = 420$	$\sum Y = 2022$	$\sum X^2 = 18208$	$\sum Y^2 = 434924$	$\sum XY = 88764$

Sum of Squares Components:

- $\bar{X} = 420/10 = 42.0$, $\bar{Y} = 2022/10 = 202.2$
- $SS_{xx} = \sum X^2 - \frac{(\sum X)^2}{n} = 18208 - \frac{(420)^2}{10} = 18208 - 17640 = 568$
- $SS_{xy} = \sum XY - \frac{(\sum X)(\sum Y)}{n} = 88764 - \frac{420 \times 2022}{10} = 88764 - 84924 = 3840$
- $SS_{yy} = \sum Y^2 - \frac{(\sum Y)^2}{n} = 434924 - \frac{(2022)^2}{10} = 434924 - 408848.4 = 26075.6$

(a) Develop the Regression Equation ($\hat{Y} = a + bX$):

- Slope (b):

$$b = \frac{SS_{xy}}{SS_{xx}} = \frac{3840}{568} = 6.76056$$

- Intercept (a):

$$a = \bar{Y} - b\bar{X} = 202.2 - (6.76056 \times 42.0) = 202.2 - 283.94366 = -81.74366$$

- Final Regression Equation:

$$\hat{Y} = -81.7437 + 6.7606X$$

(b) **Predict Overhead when $X = 50$ units:**

$$\hat{Y}(50) = -81.74366 + 6.760563(50) = -81.74366 + 338.02815 = \text{\$256.28}$$

(c) **Calculate Standard Error of the Estimate (S_{yx}):**

$$SSE = SS_{yy} - b \times SS_{xy} = 26075.6 - (6.760563 \times 3840) = 26075.6 - 25960.562 = 115.038$$

$$S_{yx} = \sqrt{\frac{SSE}{n-2}} = \sqrt{\frac{115.038}{10-2}} = \sqrt{\frac{115.038}{8}} = \sqrt{14.37975} = \text{\$3.792}$$

Q. 5 (a) Differentiate between Laspeyres, Paasche and fixed-weight aggregates methods.
 (b) Write the main steps in the construction of wholesale price index numbers. **(10+10 = 20 Marks)**

Answer

(a) Differentiation Between Price Index Aggregate Methods:

Feature	Laspeyres Index (P_L)	Paasche Index (P_P)	Fixed-Weight Index (P_{FW})
Weighting Quantity	Uses Base Year quantities (q_0).	Uses Current Year quantities (q_n).	Uses Fixed Representative quantities (q_a).
Mathematical Formula	$P_L = \frac{\sum p_n q_0}{\sum p_0 q_0} \times 100$	$P_P = \frac{\sum p_n q_n}{\sum p_0 q_n} \times 100$	$P_{FW} = \frac{\sum p_n q_a}{\sum p_0 q_a} \times 100$
Systematic Bias	Tends to overstate price increases (upward bias).	Tends to understate price increases (downward bias).	Minimizes year-to-year bias fluctuations.
Operational Ease	Quantities fixed once; easy to update annually.	Requires re-collecting new quantity data every period.	Weights updated only during major census revisions.

(b) Main Steps in Construction of Wholesale Price Index (WPI) Numbers: Constructing a Wholesale Price Index involves a rigorous six-step statistical workflow:

1. Selection of Base Year:

- Choose a recent, economically stable year free from major disruptions (war, famine, hyperinflation, pandemic).
- The base year serves as the benchmark period where index = 100.

2. Selection of Commodity Basket:

- Select a representative sample of wholesale commodities categorized into major groups (Primary Articles, Fuel & Power, Manufactured Products).
- Items must be clearly defined in terms of standard grades and units.

3. Collection of Wholesale Price Quotations:

- Collect reliable wholesale price quotations regularly from major trade centers and wholesale markets across the country.

4. Selection and Assignment of Weights:

- Assign relative weights (W_i) to each commodity reflecting its relative share in total national wholesale transaction value.

5. Choice of Index Formula:

- Apply a weighted aggregate or weighted average of price relatives formula:

$$WPI = \frac{\sum \left(\frac{p_n}{p_0} \times 100 \right) \times W}{\sum W}$$

6. Computation and Regular Publication:

- Calculate and publish WPI monthly/weekly to monitor inflationary trends and guide macroeconomic policy.