08. Hypothesis Testing: Two Samples

Adapted From :

Probability & Statistics for Engineers & Scientists, 9th Ed.

Walpole/Myers/Myers/Ye (c)2010

Introduction to Business Statistics, 5e

Kvanli/Guynes/Pavur (c)2000

South-Western College Publishing

Statistics for Managers

Using Microsoft® Excel 4th Edition

Learning Objectives

After completing this session, you should be able to:

- Test hypotheses for the difference between two independent population means (standard deviations known or unknown)
- Test two means from related samples for the mean difference
- Complete a Z test for the difference between two proportions
- Use the F table to find critical F values
- Complete an F test for the difference between two variances

Two Sample Tests

Two Sample Tests

- Population Means, Independent Samples
- Population Means, Paired Observations
- Population Proportions
- Population Variances

Examples:

Population Means, Independent Samples	Population Means, Paired Observations	Population Proportions	Population Variances
Group 1 vs. independent Group 2	Same group before vs. after treatment	Proportion 1 vs. Proportion 2	Variance 1 vs. Variance 2

Difference Between Two Means

Population means, independent samples *

- σ_1 and σ_2 known
- $\sigma_1 = \sigma_2$ but unknown
- $\sigma1 \neq \sigma2$ and unknown

Goal: Test hypotheses or form a confidence interval for the difference between two population means, $\mu_1 - \mu_2$

The point estimate for the difference is

$$\bar{X}_1 - \bar{X}_2$$

Independent Samples

- Population means, independent samples *
  - σ_1 and σ_2 known
  - σ_1 and σ_2 unknown
  - $\sigma 1 \neq \sigma 2$ and unknown

- Different data sources
  - Unrelated
  - Independent
    - Sample selected from one population has no effect on the sample selected from the other population
- Use the difference between 2 sample means
- Use Z test or pooled variance t test

Difference Between Two Means

Population means, independent samples *

σ_1 and σ_2 known → Use a **Z** test statistic

σ_1 and σ_2 unknown → Use S to estimate unknown σ , use a **t** test statistic and pooled standard deviation

σ1 ≠ σ2 and unknown → Use S to estimate unknown σ , use a **t** test statistic and pooled standard deviation

σ_1 and σ_2 Known

Population means, independent samples

- σ_1 and σ_2 known *
- σ_1 and σ_2 unknown
- $\sigma1 \neq \sigma2$ and unknown

Assumptions:

- Samples are randomly and independently drawn
- population distributions are normal or both sample sizes are ≥ 30
- Population standard deviations are known

σ_1 and σ_2 Known

(continued)

Population means, independent samples

- σ_1 and σ_2 known *
- σ_1 and σ_2 unknown
- $\sigma 1 \neq \sigma 2$ and unknown

When σ_1 and σ_2 are known and both populations are normal or both sample sizes are at least 30, the test statistic is a Z-value…

…and the standard error of $\bar{X}_1 - \bar{X}_2$ is

$$\sigma_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_2^{\,2}}{n_2}}$$

σ_1 and σ_2 Known

(continued)

Population means, independent samples

- σ_1 and σ_2 known *
- σ_1 and σ_2 unknown
- σ1 ≠ σ2 and unknown

The test statistic for $\mu_1 - \mu_2$ is:

$$Z = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}}$$

Hypothesis Tests for Two Population Means

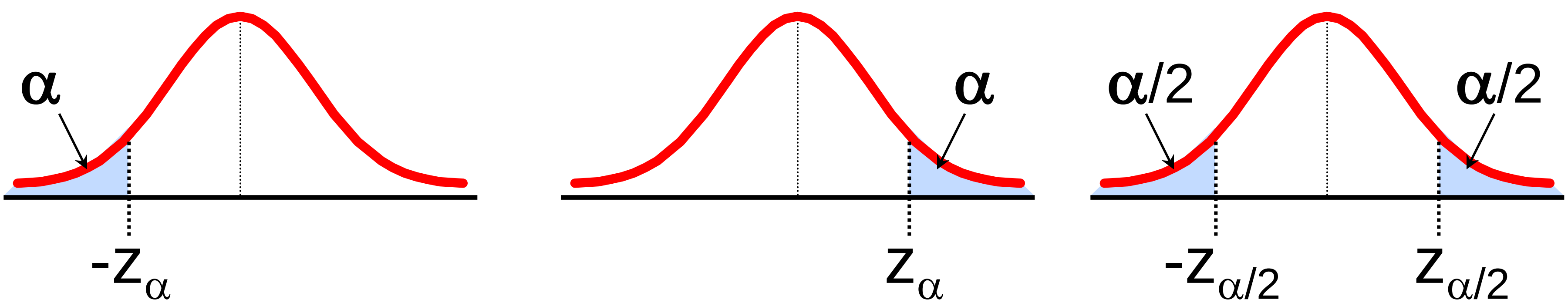
Two Population Means, Independent Samples

Lower tail test:	Upper tail test:	Two-tailed test:
$H_0: \mu_1 = \mu_2$ $H_1: \mu_1 < \mu_2$ i.e., $H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 < 0$	$H_0: \mu_1 = \mu_2$ $H_1: \mu_1 > \mu_2$ i.e., $H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 > 0$	$H_0: \mu_1 = \mu_2$ $H_1: \mu_1 \neq \mu_2$ i.e., $H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 \neq 0$

Hypothesis tests for $\mu_1 - \mu_2$

Two Population Means, Independent Samples

Lower tail test:	Upper tail test:	Two-tailed test:
$H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 < 0$	$H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 > 0$	$H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 \neq 0$



Reject H_0 if $Z < -Z_\alpha$

Reject H_0 if $Z > Z_\alpha$

Reject H_0 if $Z < -Z_{\alpha/2}$
or $Z > Z_{\alpha/2}$

σ_1 and σ_2 Unknown

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown *
- σ1 ≠ σ2 and unknown

Assumptions:

- Samples are randomly and independently drawn
- Populations are normally distributed
- Population variances are unknown but assumed equal

σ_1 and σ_2 Unknown

(continued)

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown *
- σ1 ≠ σ2 and unknown

Forming interval estimates:

- The population variances are assumed equal, so use the two sample standard deviations and pool them to estimate σ
- the test statistic is a t value with $(n_1 + n_2 – 2)$ degrees of freedom

σ_1 and σ_2 Unknown

(continued)

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown *
- σ1 ≠ σ2 and unknown

The pooled standard deviation is

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

σ_1 and σ_2 Unknown

(continued)

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown *
- σ1 ≠ σ2 and unknown

The test statistic for $\mu_1 - \mu_2$ is:

$$t = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where t has $(n_1 + n_2 - 2)$ d.f.,

and

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

$\sigma_1 \neq \sigma_2$ and Unknown

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown
- σ1 ≠ σ2 and unknown *

Assumptions:

- Samples are randomly and independently drawn
- Populations are normally distributed
- Population variances are unknown and unequal

$\sigma_1 \neq \sigma_2$ and Unknown

(continued)

Population means, independent samples

- σ_1 and σ_2 known
- σ_1 and σ_2 unknown
- $\sigma1 \neq \sigma2$ and unknown

- The statistics :

$$T' = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{S_1^2 / n_1 + S_2^2 / n_2}}$$

- has an approximate t distribution with approximate degrees of fredom :

$$\upsilon = \frac{\left(S_1^2 / n_1 + S_2^2 / n_2\right)^2}{(S_1^2 / n_1)^2 / (n_1 - 1) + (S_2^2 / n_2)^2 / (n_2 - 1)}$$

Pooled S_p t Test: Example

You are a financial analyst for a brokerage firm. Is there a difference in dividend yield between stocks listed on the NYSE & NASDAQ? You collect the following data:

	NYSE	NASDAQ
Number	**21**	**25**
Sample mean	**3.27**	**2.53**
Sample std dev	**1.30**	**1.16**

Assuming equal variances, is there a difference in average yield (α = **0.05**)?

Calculating the Test Statistic

The test statistic is:

$$t = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{\left(3.27 - 2.53\right) - 0}{\sqrt{1.5021\left(\frac{1}{21} + \frac{1}{25}\right)}} = \boxed{2.040}$$

$$S_p^2 = \frac{(n_1 - 1)S_1^{\,2} + (n_2 - 1)S_2^{\,2}}{(n_1 - 1) + (n_2 - 1)} = \frac{(21 - 1)1.30^2 + (25 - 1)1.16^2}{(21\text{-}1) + (25 - 1)} = 1.5021$$

Solution

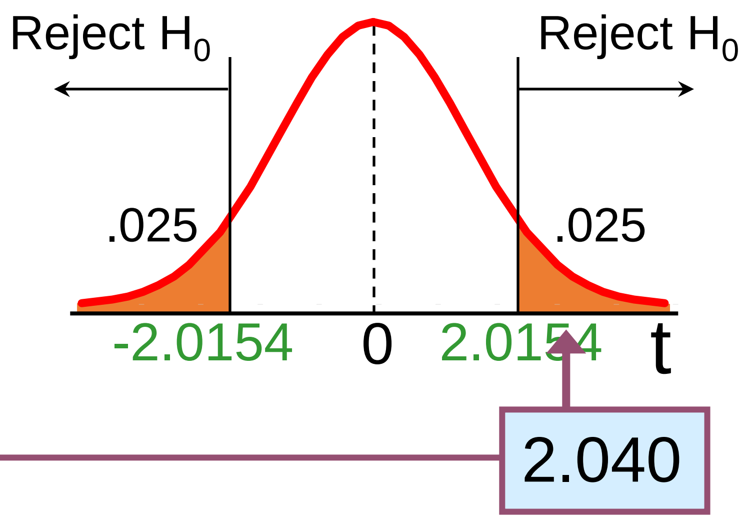
H_0: $\mu_1 - \mu_2 = 0$ i.e. ($\mu_1 = \mu_2$)

H_1: $\mu_1 - \mu_2 \neq 0$ i.e. ($\mu_1 \neq \mu_2$)

$\alpha = 0.05$

df = 21 + 25 - 2 = 44

Critical Values: t = ± 2.0154



Test Statistic:

$$t = \frac{3.27 - 2.53}{\sqrt{1.5021\left(\frac{1}{21} + \frac{1}{25}\right)}} = \boxed{2.040}$$

Decision:

Reject H_0 at $\alpha = 0.05$

Conclusion:

There is evidence of a difference in means.

Paired Observations

Related samples

Tests Means of 2 Related Populations

- Paired or matched samples
- Repeated measures (before/after)
- Use difference between paired values:

$$D = X_1 - X_2$$

- Eliminates Variation Among Subjects
- Assumptions:
  - Both Populations Are Normally Distributed
  - Or, if Not Normal, use large samples

Mean Difference

Related samples

The i^{th} paired difference is D_i , where

$$D_i = X_{1i} - X_{2i}$$

The point estimate for the population mean paired difference is $\bar{D}$:

$$\bar{D} = \frac{\sum_{i=1}^{n} D_i}{n}$$

n is the number of pairs in the paired sample

Sample Standard Deviation

Related samples

We can estimate the unknown population standard deviation with a sample standard deviation:

The sample standard deviation is

$$S_D = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{n-1}}$$

Mean Difference

(continued)

Paired samples

The test statistic for $\bar{D}$ is now a t statistic, with n-1 d.f.:

$$T = \frac{\bar{D} - \mu_D}{S_D / \sqrt{n}}$$

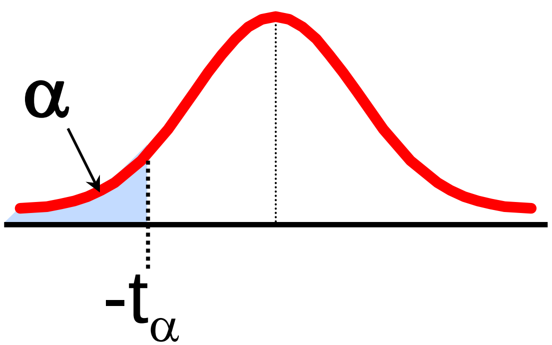
Where t has n - 1 d.f.

and S_D is: $S_D = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{n-1}}$

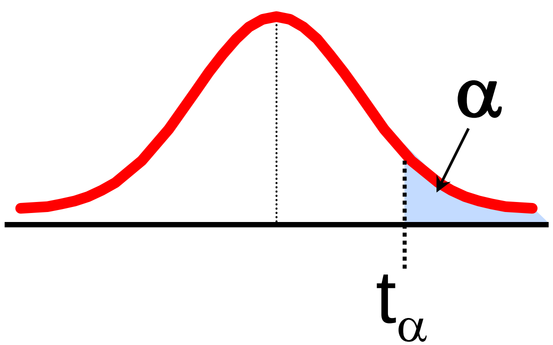
Hypothesis Testing for Mean Difference

Paired Samples

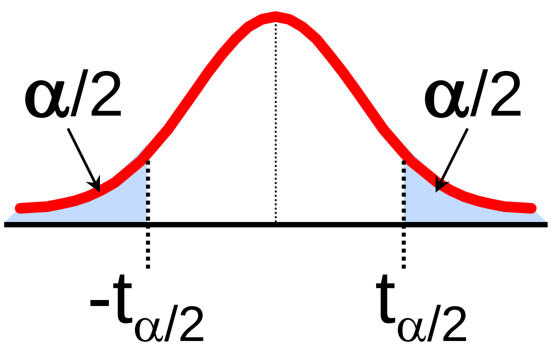
Lower tail test:	Upper tail test:	Two-tailed test:
$H_0: \mu_D = 0$ $H_1: \mu_D < 0$	$H_0: \mu_D = 0$ $H_1: \mu_D > 0$	$H_0: \mu_D = 0$ $H_1: \mu_D \neq 0$



Reject H_0 if $t < -t_\alpha$



Reject H_0 if $t > t_\alpha$



Reject H_0 if $t < -t_{\alpha/2}$
or $t > t_{\alpha/2}$

Where t has n - 1 d.f.

Paired Samples Example

- Assume you send your salespeople to a "customer service" training workshop. Is the training effective? You collect the following data:

Salesperson	Number of Complaints: Before (1)	After (2)	(2) - (1) Difference, D_i
C.B.	6	4	- 2
T.F.	20	6	-14
M.H.	3	2	- 1
R.K.	0	0	0
M.O.	4	0	- 4
			-21

$$\bar{D} = \frac{\sum D_i}{n}$$

$$= -4.2$$

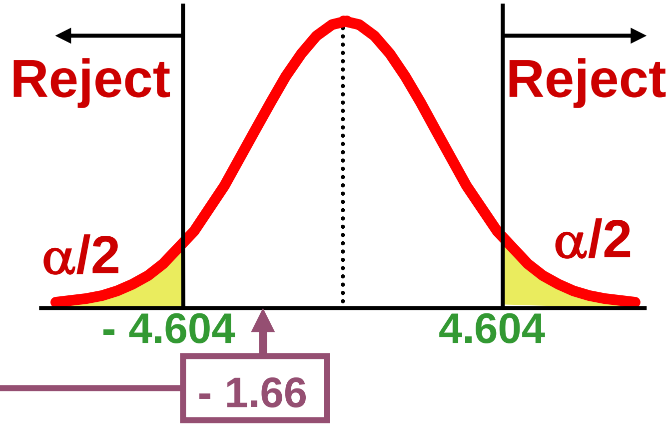
$$S_D = \sqrt{\frac{\sum (D_i - \bar{D})^2}{n-1}}$$

$$= 5.67$$

Paired Samples: Solution

- Has the training made a difference in the number of complaints (at the 0.01 level)?

H_0: $\mu_D = 0$
H_1: $\mu_D \neq 0$



$\alpha = .01$ $\quad \bar{D} = -4.2$

Critical Value = ± 4.604
d.f. = n - 1 = 4

Test Statistic:

$$t = \frac{\bar{D} - \mu_D}{S_D/\sqrt{n}} = \frac{-4.2 - 0}{5.67/\sqrt{5}} = \boxed{-1.66}$$

Decision: **Do not reject H_0**
(t stat is not in the reject region)

Conclusion: **There is not a significant change in the number of complaints.**

Two Population Proportions

Population proportions

Goal: test a hypothesis or form a confidence interval for the difference between two population proportions,

$$\boxed{p_1 - p_2}$$

Assumptions:

$n_1p_1 \geq 5$, $n_1(1-p_1) \geq 5$

$n_2p_2 \geq 5$, $n_2(1-p_2) \geq 5$

The point estimate for the difference is $\hat{p}_1 - \hat{p}_2$

Two Population Proportions

Population proportions

Since we begin by assuming the null hypothesis is true, we assume $p_1 = p_2$ and the pooled estimate p of proportion p is

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

where X_1 and X_2 are the numbers from samples 1 and 2 with the characteristic of interest

Two Population Proportions

(continued)

Population proportions

The test statistic for

$p_1 – p_2$ is a Z statistic:

$$Z = \frac{\left(\hat{P}_1 - \hat{P}_2\right) - \left(p_1 - p_2\right)}{\sqrt{p_1 q_1 / n_1 + p_2 q_2 / n_2}}$$

$$Z = \frac{\hat{P}_1 - \hat{P}_2}{\sqrt{pq(1/n_1 + 1/n_2)}}$$

where

$$\hat{p} = \frac{X_1 + X_2}{n_1 + n_2}, \quad \hat{p}_1 = \frac{X_1}{n_1}, \quad \hat{p}_2 = \frac{X_2}{n_2}$$

Hypothesis Tests for Two Population Proportions

Population proportions

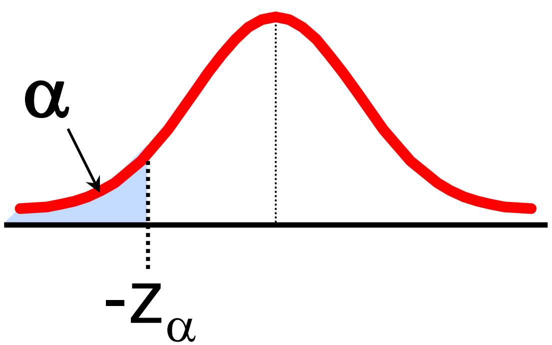
Lower tail test:	Upper tail test:	Two-tailed test:
H_0: $p_1 \geq p_2$ H_A: $p_1 < p_2$ i.e., H_0: $p_1 - p_2 \geq 0$ H_A: $p_1 - p_2 < 0$	H_0: $p_1 \leq p_2$ H_A: $p_1 > p_2$ i.e., H_0: $p_1 - p_2 \leq 0$ H_A: $p_1 - p_2 > 0$	H_0: $p_1 = p_2$ H_A: $p_1 \neq p_2$ i.e., H_0: $p_1 - p_2 = 0$ H_A: $p_1 - p_2 \neq 0$

Hypothesis Tests for Two Population Proportions

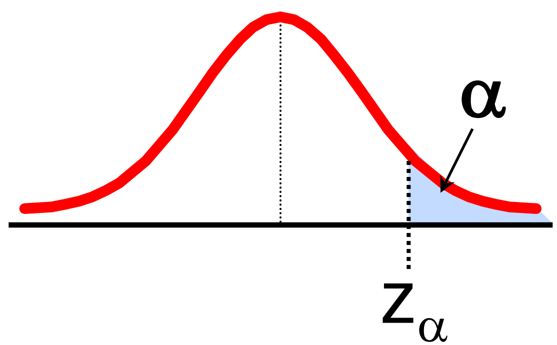
(continued)

Population proportions

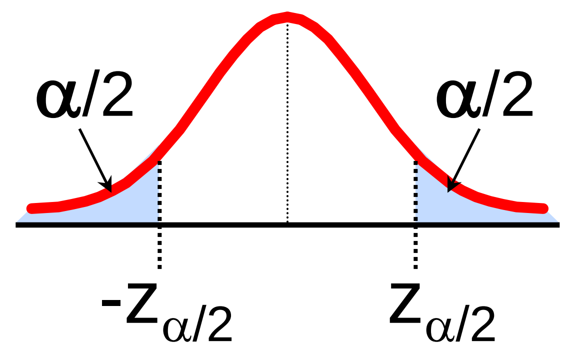
Lower tail test:	Upper tail test:	Two-tailed test:
$H_0: p_1 - p_2 = 0$ $H_A: p_1 - p_2 < 0$	$H_0: p_1 - p_2 = 0$ $H_A: p_1 - p_2 > 0$	$H_0: p_1 - p_2 = 0$ $H_A: p_1 - p_2 \neq 0$



Reject H_0 if $Z < -Z_\alpha$



Reject H_0 if $Z > Z_\alpha$



Reject H_0 if $Z < -Z_{\alpha/2}$ or $Z > Z_{\alpha/2}$

Example:
Two population Proportions

Is there a significant difference between the proportion of men and the proportion of women who will vote Yes on Proposition A?

- In a random sample, 36 of 72 men and 31 of 50 women indicated they would vote Yes
- Test at the .05 level of significance

Example: Two population Proportions *(continued)*

- The hypothesis test is:

H_0: $p_1 – p_2 = 0$ (the two proportions are equal)
H_A: $p_1 – p_2 \neq 0$ (there is a significant difference between proportions)

- The sample proportions are:
  - Men: $p_{s1} = 36/72 = .50$
  - Women: $p_{s2} = 31/50 = .62$
- The pooled estimate for the overall proportion is:

$$\hat{p} = \frac{X_1 + X_2}{n_1 + n_2} = \frac{36+31}{72+50} = \frac{67}{122} = .549$$

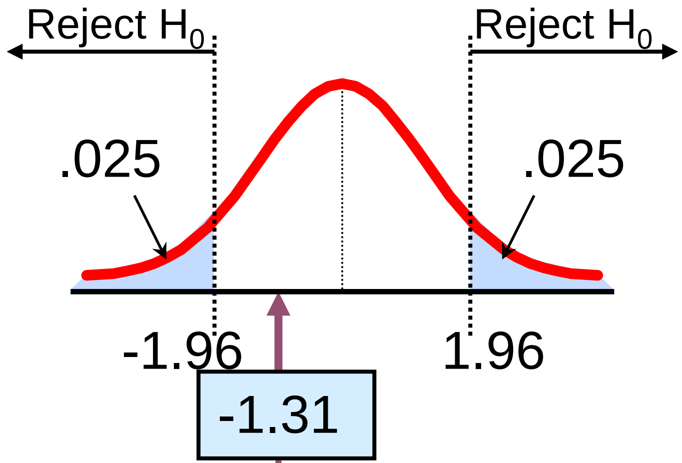
Example:
Two population Proportions

(continued)

The test statistic for $p_1 - p_2$ is:

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{(.50 - .62) - (0)}{\sqrt{.549\,(1 - .549)\left(\frac{1}{72} + \frac{1}{50}\right)}} = \boxed{-1.31}$$



Critical Values = ±1.96
For α = .05

Decision: Do not reject H_0

Conclusion: There is not significant evidence of a difference in proportions who will vote yes between men and women.

Hypothesis Tests for Variances

Tests for Two Population Variances *

F test statistic

$H_0: \sigma_1^2 = \sigma_2^2$
$H_1: \sigma_1^2 \neq \sigma_2^2$

Two tailed test

$H_0: \sigma_1^2 = \sigma_2^2$
$H_1: \sigma_1^2 < \sigma_2^2$

Lower tail test

$H_0: \sigma_1^2 = \sigma_2^2$
$H_1: \sigma_1^2 > \sigma_2^2$

Upper tail test

Hypothesis Tests for Variances *(continued)*

Tests for Two Population Variances

F test statistic *

The F test statistic is:

$$F = \frac{S_1^2}{S_2^2}$$

S_1^2 = Variance of Sample 1

$n_1 - 1$ = numerator degrees of freedom

S_2^2 = Variance of Sample 2

$n_2 - 1$ = denominator degrees of freedom

The F Distribution

- The F critical value is found from the F table
- The are two appropriate degrees of freedom: numerator and denominator

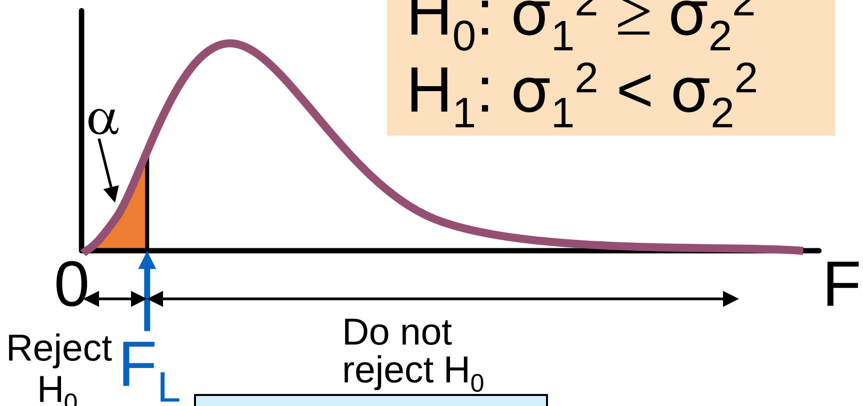
$$F = \frac{S_1^2}{S_2^2}$$

where $df_1 = n_1 - 1$; $df_2 = n_2 - 1$

- In the F table,
  - numerator degrees of freedom determine the column
  - denominator degrees of freedom determine the row

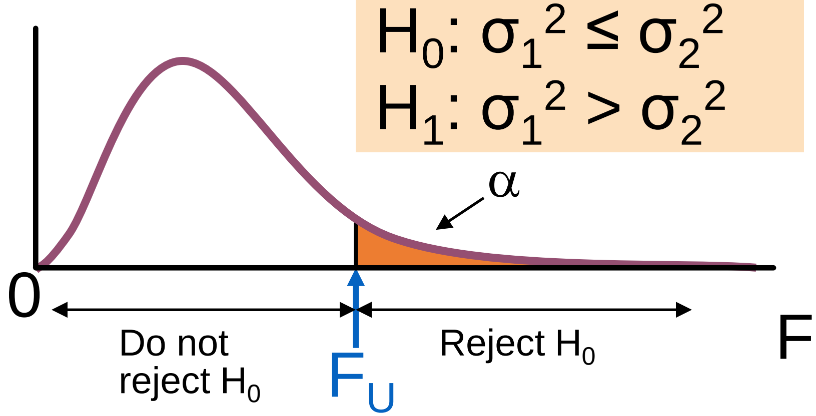
Finding the Rejection Region

H_0: $\sigma_1^2 \geq \sigma_2^2$
H_1: $\sigma_1^2 < \sigma_2^2$



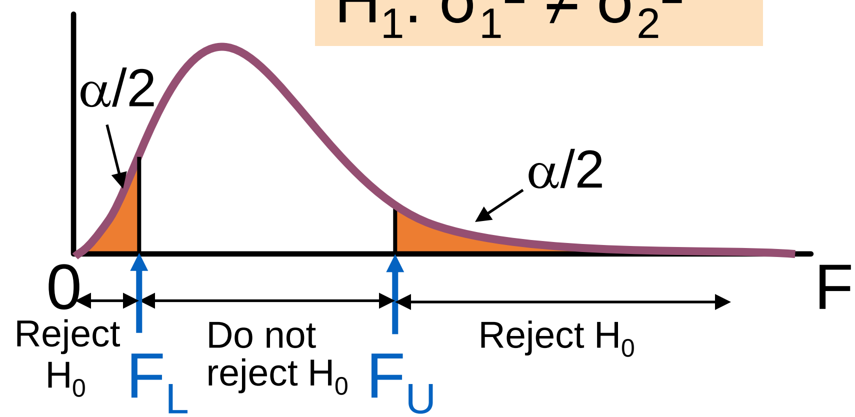
Reject H_0 if $F < F_L$

H_0: $\sigma_1^2 \leq \sigma_2^2$
H_1: $\sigma_1^2 > \sigma_2^2$



Reject H_0 if $F > F_U$

H_0: $\sigma_1^2 = \sigma_2^2$
H_1: $\sigma_1^2 \neq \sigma_2^2$



- rejection region for a two-tailed test is:

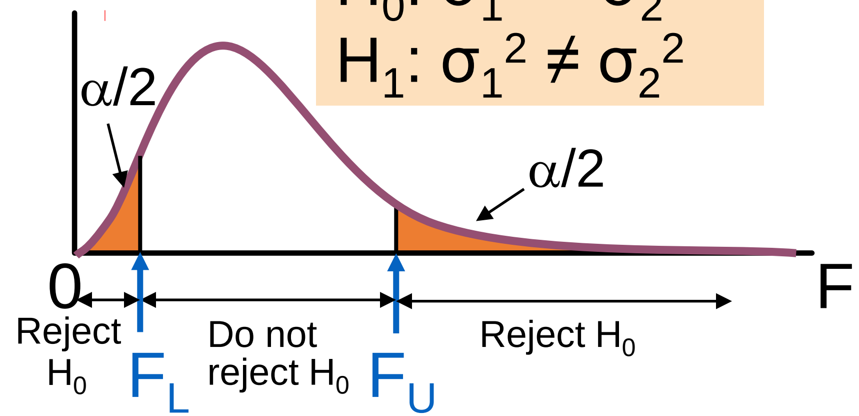
$$F = \frac{S_1^2}{S_2^2} > F_U$$

$$F = \frac{S_1^2}{S_2^2} < F_L$$

Finding the Rejection Region

(continued)

$H_0: \sigma_1^2 = \sigma_2^2$
$H_1: \sigma_1^2 \neq \sigma_2^2$



To find the critical F values:

1. Find F_U from the F table for $n_1 - 1$ numerator and $n_2 - 1$ denominator degrees of freedom

2. Find F_L using the formula: $\boxed{F_L = \dfrac{1}{F_{U^*}}}$

Where F_{U^*} is from the F table with $n_2 - 1$ numerator and $n_1 - 1$ denominator degrees of freedom (i.e., switch the d.f. from F_U)

F Test: An Example

You are a financial analyst for a brokerage firm. You want to compare dividend yields between stocks listed on the NYSE & NASDAQ. You collect the following data:

	NYSE	NASDAQ
Number	**21**	**25**
Mean	**3.27**	**2.53**
Std dev	**1.30**	**1.16**

Is there a difference in the variances between the NYSE & NASDAQ at the $\alpha = 0.1$ level?

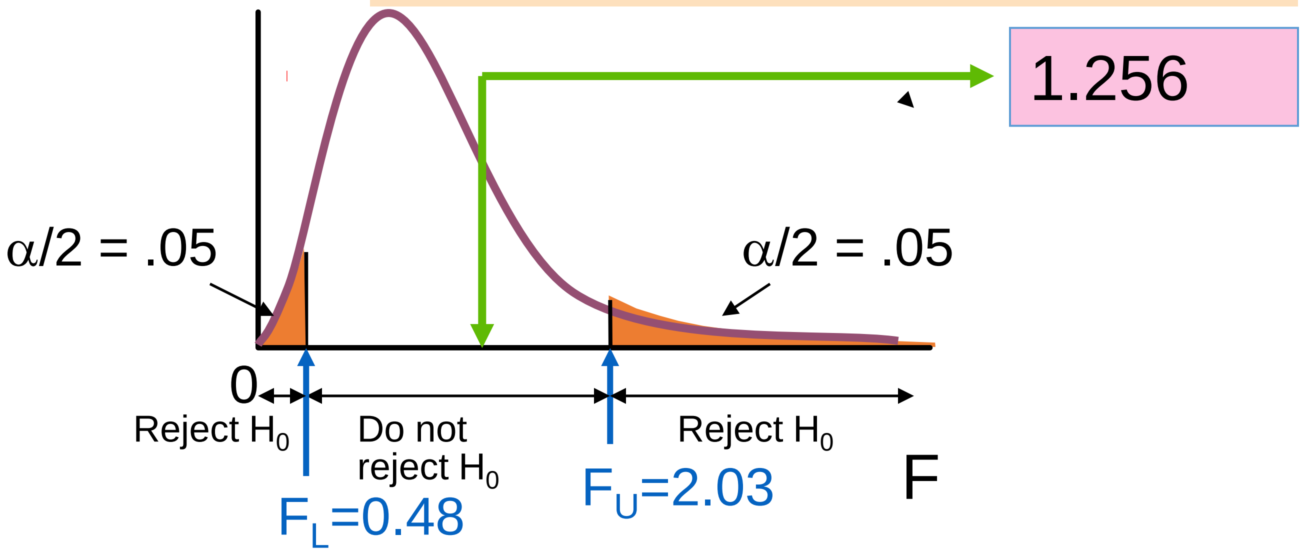
$$H_0: \sigma^2_1 - \sigma^2_2 = 0$$ (there is no difference between variances)

$$H_1: \sigma^2_1 - \sigma^2_2 \neq 0$$ (there is a difference between variances)

- The test statistic is: $F = \dfrac{S_1^2}{S_2^2} = \dfrac{1.30^2}{1.16^2} = 1.256$

$$F_U = F_{\alpha/2,\, n\,,\, d} = F_{.05,\, 20,\, 24} = 2.03$$

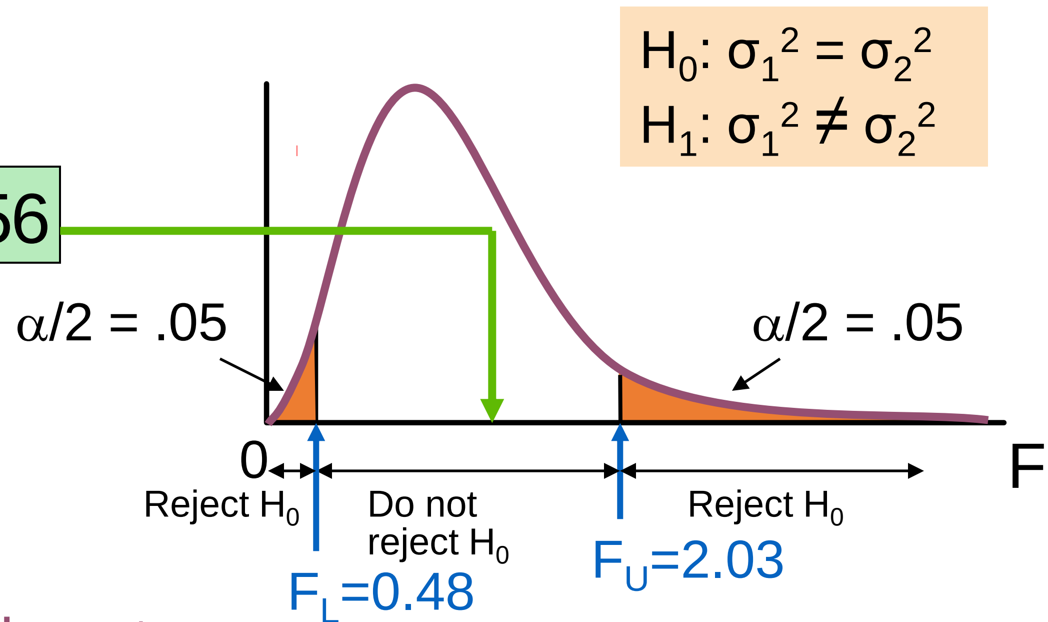
$$F_L = F_{(1-\alpha/2)\,,\, n\,,\, d} = 1/F_{\alpha/2,\, d\,,\, n} = 1/F_{.05,\, 24,\, 20} = 1/2.08 = .48$$



F Test: Example Solution *(continued)*

- The test statistic is:

$$F = \frac{S_1^2}{S_2^2} = \frac{1.30^2}{1.16^2} = \boxed{1.256}$$



- $F = 1.256$ is not in the rejection region, so we do not reject H_0
- Conclusion: There is not sufficient evidence of a difference in variances at $\alpha = 0.1$

$H_0: \sigma^2_2 - \sigma^2_1 = 0$ (there is no difference between variances)

$H_1: \sigma^2_2 - \sigma^2_1 \neq 0$ (there is a difference between variances)

- The test statistic is: $$F = \frac{S_2^2}{S_1^2} = \frac{1.16^2}{1.30^2} = 0.796$$

$F_U = F_{\alpha/2, n, d}$

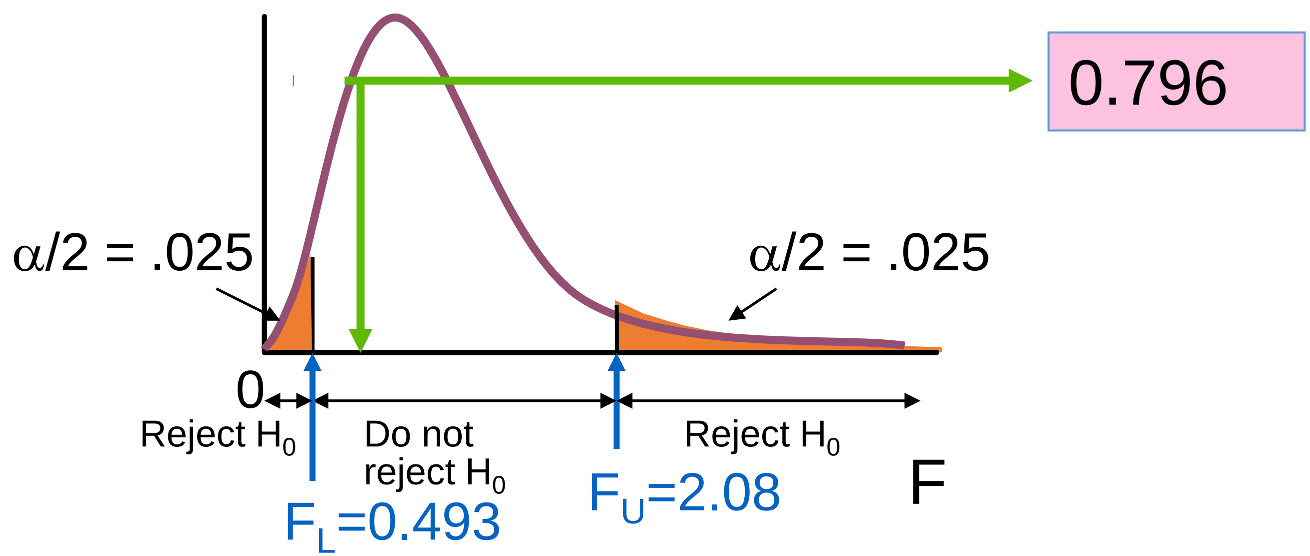
$= F_{.05, 24, 20}$

$= 2.08$

$F_L = F_{(1-\alpha/2), n, d}$

$= 1/F_{\alpha/2, d, n} = 1/F_{.05, 20 . 24}$

$= 1/2.03 = .493$



F Test: Example Solution

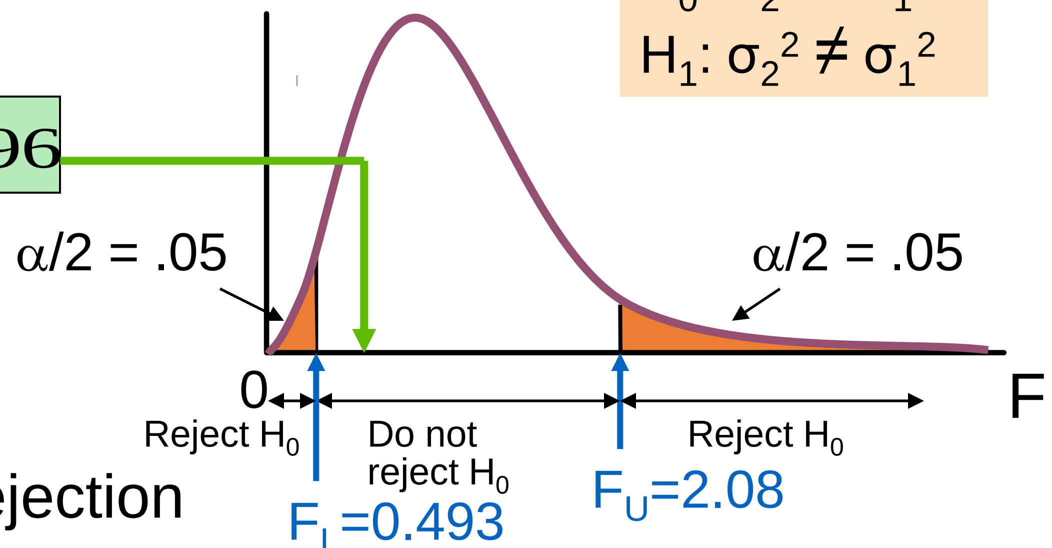
(continued)

H_0: $\sigma_2^2 = \sigma_1^2$

H_1: $\sigma_2^2 \neq \sigma_1^2$

- The test statistic is:

$$F = \frac{S_2^2}{S_1^2} = \frac{1.16^2}{1.30^2} = \boxed{0.796}$$



- F = 0.796 is not in the rejection region, so we do not reject H_0

- Conclusion: There is not sufficient evidence of a difference in variances at $\alpha = 0.1$

F Test: An Example

ANALYSIS OF VARIANCE UJI 1 ARAH

Seorang supervisor pengendalian mutu perusahaan otomotif sangat memperhatikan jumlah kerusakan yang terjadi pada setiap perakitan. Jika sebuah perakitan mempunyai varian kerusakan yang tinggi, maka perbaikan harus segera dilakukan. Supervisor tersebut telah mengumpulkan data dari 2 perakitan sebagai berikut :

	JUMLAH KERUSAKAN	
	Perakitan A	Perakitan B
Rata-rata	10	11
Varian	9	25
Ukuran sampel	20	16

Ujilah pada α 0,01 apakah varian perakitan B lebih besar daripada A ?

F Test: An Example

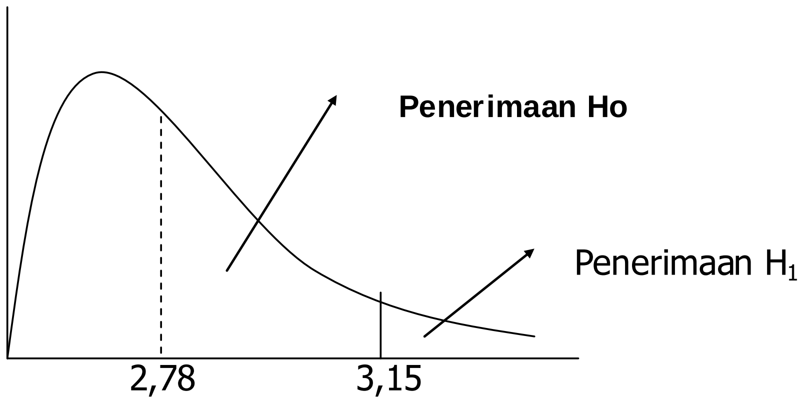
1. Menentukan Hipotesis :
   - Ho : $s_A^2 = s_B^2$; varian kerusakan B sama dgn varian A
   - H_1 : $s_B^2 > s_A^2$; varian kerusakan B > varian A

2. Critical Value uji 1 arah pada α 0,01 dengan numerator $n = n_B - 1 = 16 - 1 = 15$; $d = n_A - 1 = 20 - 1 = 19$ adalah $F_{\alpha,n,d} = 3,15$

3. Perhitungan F_s :
   $F_s = s_B^2 / s_A^2 = 25 / 9 = 2,78$

F Test: An Example

4.



5. Karena F_s berada didalam penerimaan Ho artinya varian kerusakan yang terjadi pada perakitan B tidak lebih besar dari perakitan A

F Test: An Example

Alternatif Lain :

1. Menentukan Hipotesis :
   - Ho : $s_A^2 = s_B^2$; varian kerusakan B tidak > varian A
   - H_1 : $s_A^2 < s_B^2$; varian kerusakan B > varian A

2. Critical Value uji 1 arah pada α 0,01 dengan numerator $n = n_A - 1 = 20 - 1 = 19$; $d = n_B - 1 = 16 - 1 = 15$ adalah :

$$F_{1-\alpha\,,\,n\,,\,d} \text{ (lower tail)} = \frac{1}{F_{\alpha\,,\,d\,,\,n}} = \frac{1}{3{,}15} = 0{,}32$$

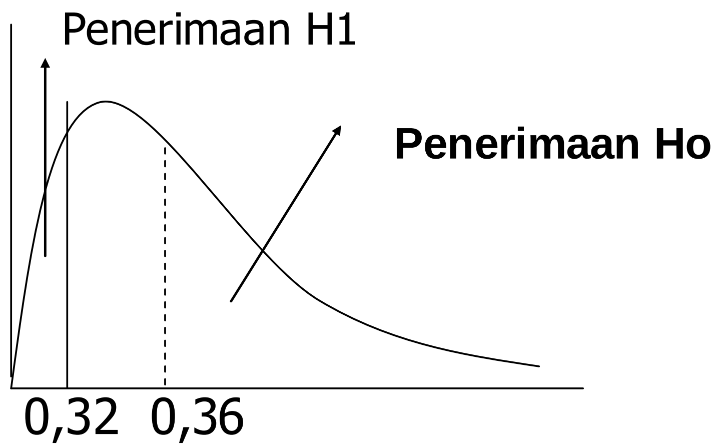
3. Perhitungan F_s :

$$F_s = s_A^2 / s_B^2 = 9 / 25 = 0{,}36$$

F Test: An Example

Alternatif Lain :

4.



5. Karena F_s berada didalam penerimaan Ho artinya varian kerusakan yang terjadi pada perakitan B tidak lebih besar dari perakitan A

Exercises

PROBLEM 1

In a recent survey, college students were asked the amount of time they spend watching television and surfing on the Internet. The researchers were interested in determining whether the time spent on both activities was equal. They collected the following data:

Person #	1	2	3	4	5	6	7	8
Internet	2	7	3	8	9	15	7	2
TV	4	15	5	3	4	4	4	8

Test the hypothesis at α = 0.05 !

PROBLEM 2

National Park rangers were surveyed as to whether they endorsed the idea of carrying firearms. Of the 260 ranges polled west of the Mississippi, 78% endorsed the idea. Of the 184 rangers polled east of the Mississippi, 64% endorsed the idea. Is there evidence that the level of support for carrying firearms is BIGGER in the West than it is in the East ?

PROBLEM 3

You are comparing the precision of two brands of stamping machines. From a random sample of 12 units of output from Brand A machine, you find that it produces with a standard deviation of 15.2. For the Brand B machine, in a sample of 20 units of output, you find a standard deviation of 10.1. Assume that the output of both machines follows a normal distribution, and the population variances are equal. Evaluate the null hypothesis of equal variances against the alternative hypothesis that Brand B machines produce with lower variance α 0.10.

Thank You

"We trust in GOD, all others must bring data"