

# Hypothesis Testing

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Managerial Statistics - ECON 730

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## Objectives

- After this lecture you should be able to conduct Hypothesis Tests
- Topics:
  - What is Hypothesis Testing
  - Null and Alternative Hypotheses
  - Type I and Type II Error
  - Confidence Level, Significance Level, and Power
  - p-values

## Case Background

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# Three Cases

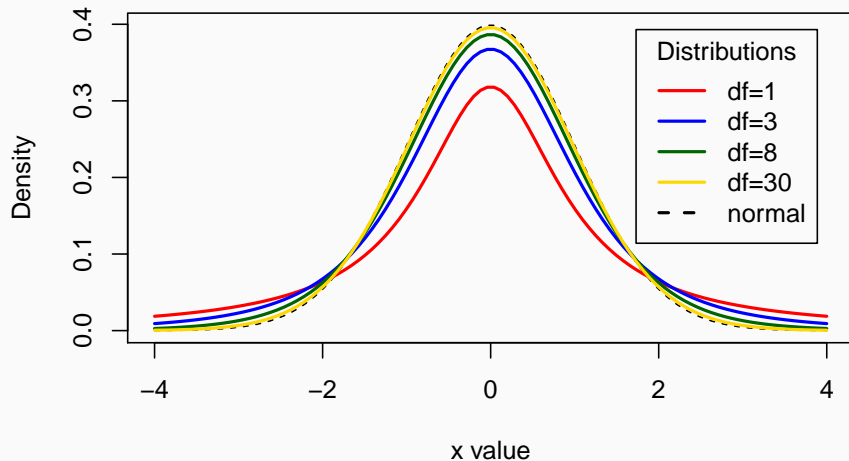
- Test Marketing
- Gender Gap
- Asset Return

# Hypothesis Testing

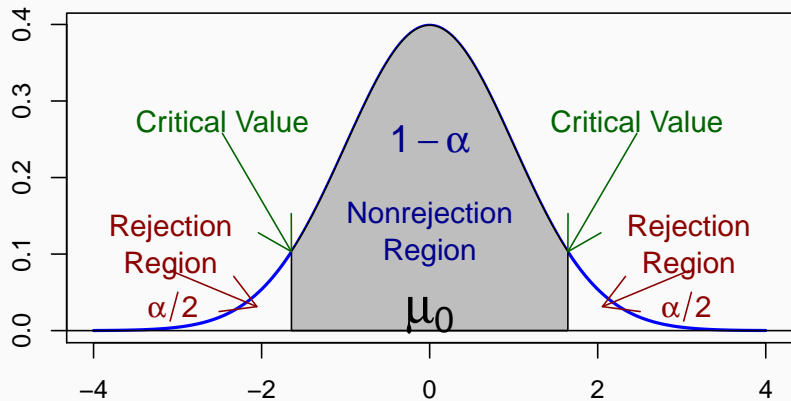
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# Student's t distributions with various degrees of freedom

## Comparison of t Distributions



## The Two-tailed Test Rejection Region



# Type 1 and Type 2 Error, and Power in Hypothesis Testing

- **Type 1 error:** *Rejecting* the null hypothesis ( $H_0$ ) when  $H_0$  is *true*
  - Significance level ( $\alpha$ ) is the probability of making Type 1 error
  - This value is usually set to 0.05
- **Type 2 error:** *Failing to reject* the null hypothesis ( $H_0$ ) when  $H_0$  is *false*
  - The value  $\beta$  is the probability of making Type 2 error
- **The Power of a test:** the probability of correctly rejecting  $H_0$  when it is false ( $1 - \beta$ )



# The wrights and wrongs of a hypothesis test

- $H_0$  is true
  - Fail to reject  $H_0$ 
    - Correct Conclusion
    - Probability =  $1 - \alpha$  which is called the Confidence Level
  - Reject  $H_0$ 
    - Incorrect Conclusion ~ Type 1 error
    - Probability =  $\alpha$  which is called the Significance Level
- $H_0$  is false
  - Fail to reject  $H_0$ 
    - Incorrect Conclusion ~ Type 2 error
    - Probability =  $\beta$
  - Reject  $H_0$ 
    - Correct Conclusion
    - Probability =  $1 - \beta$  which is called the Power of the Test

- p-value:
  - Assume that  $H_0$  is true, then
  - the p-value is it is the probability of getting a statistic as or more in favor of the alternative hypothesis  $H_A$
- Low p-values indicate that if  $H_0$  is true, we have observed an improbable event
- **NOTE:** Failing to reject  $H_0$  does not mean we have gathered evidence in favor of it (i.e., absence of evidence does not imply evidence of absence)

## Case 1: Test Markiting

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## Case Bankground

- The Pineapple Computer Company is deciding whether or not to introduce a new color option in their flagship laptop computer.
- Adding a new color will only be Profitable if average sales greater than 275 units per week.
- Data: Sales data collected over 36 weeks.

# Hypothesis Test

- $H_0$ : Average sales is less than 275 per week
- $H_\alpha$ : Average sales is greater than 275 per week

## Load the Data

```
test.market <- read.csv("data/PCC_TestMarket.csv")
```

## Conduct the Test

```
t.test(test.market$sales,  
       mu = 275, alternative = "greater", conf.level = 0.95)
```

One Sample t-test

data: test.market\$sales

t = 1.7575, df = 35, p-value = 0.04379

alternative hypothesis: true mean is greater than 275

95 percent confidence interval:

275.601      Inf

sample estimates:

mean of x

290.5495

## Graph the Test

