PSC 202
SYRACUSE UNIVERSITY

INTRODUCTION TO POLITICAL ANALYSIS

HYPOTHESIS TESTING WHEN USING SAMPLES, HYPOTHESIS TESTING WITH ONE CONFOUNDER

TODAY

- Hypothesis testing with a sample
- Hypothesis testing with one confounder

TODAY

- Hypothesis testing with a sample
- Hypothesis testing with one confounder

IDEA

- We start out thinking H_0 is true
  - No relationship between X and Y in population
- We ask: If H_0 is true, how likely is it that a random sample would produce an effect as large (or larger) than the one we have observed in our sample?
  - If less than 5% ($p<0.05$): we reject H_0
  - If more than 5% ($p>0.05$): we don't reject H_0

NOW

- How exactly do we do this hypothesis testing?
  - How do we compute a p-value, etc.?

IN OUR CASE

Job Approval Ratings of President Biden, by Subgroup

	Approve	Disapprove	N
	%	%	
All U.S. adults	56	39	2,937
Gender			
Men	49	45	1,643
Women	62	34	1,294

- H_0: No difference between men and women in population
- The survey does find a difference of 13 percentage points
  - 62 for women vs. 49 for men
  - Instead of 13 percentage points, we use 0.13

IN OUR CASE

Job Approval Ratings of President Biden, by Subgroup

	Approve %	Disapprove %	N
All U.S. adults	56	39	2,937
Gender			
Men	49	45	1,643
Women	62	34	1,294

- Question: If there is no difference between men and women in the population, what is the probability of getting a *sample* where they are at least 13 points different from each other?
  - Specifically: is it lower than 5%?

IN OUR CASE

Job Approval Ratings of President Biden, by Subgroup

	Approve	Disapprove	N
	%	%	
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Gender			
Men	49	45	1,643
Women	62	34	1,294

- Equivalent: If we reject H_0 based on this survey, what is probability of committing Type I error?
  - And is it lower than 5%?

TEST STATISTIC

- **Test statistic t:**

$$t = \frac{H_A - H_0}{\text{Standard Error of Difference}}$$

- **H_A: observed difference between samples (here: 0.13)**
- **H_0: difference between samples if H_0 is true (0.00)**
- **Standard Error of Difference between the two samples (here 0.018)**
  - **I calculated this for you**

TEST STATISTIC

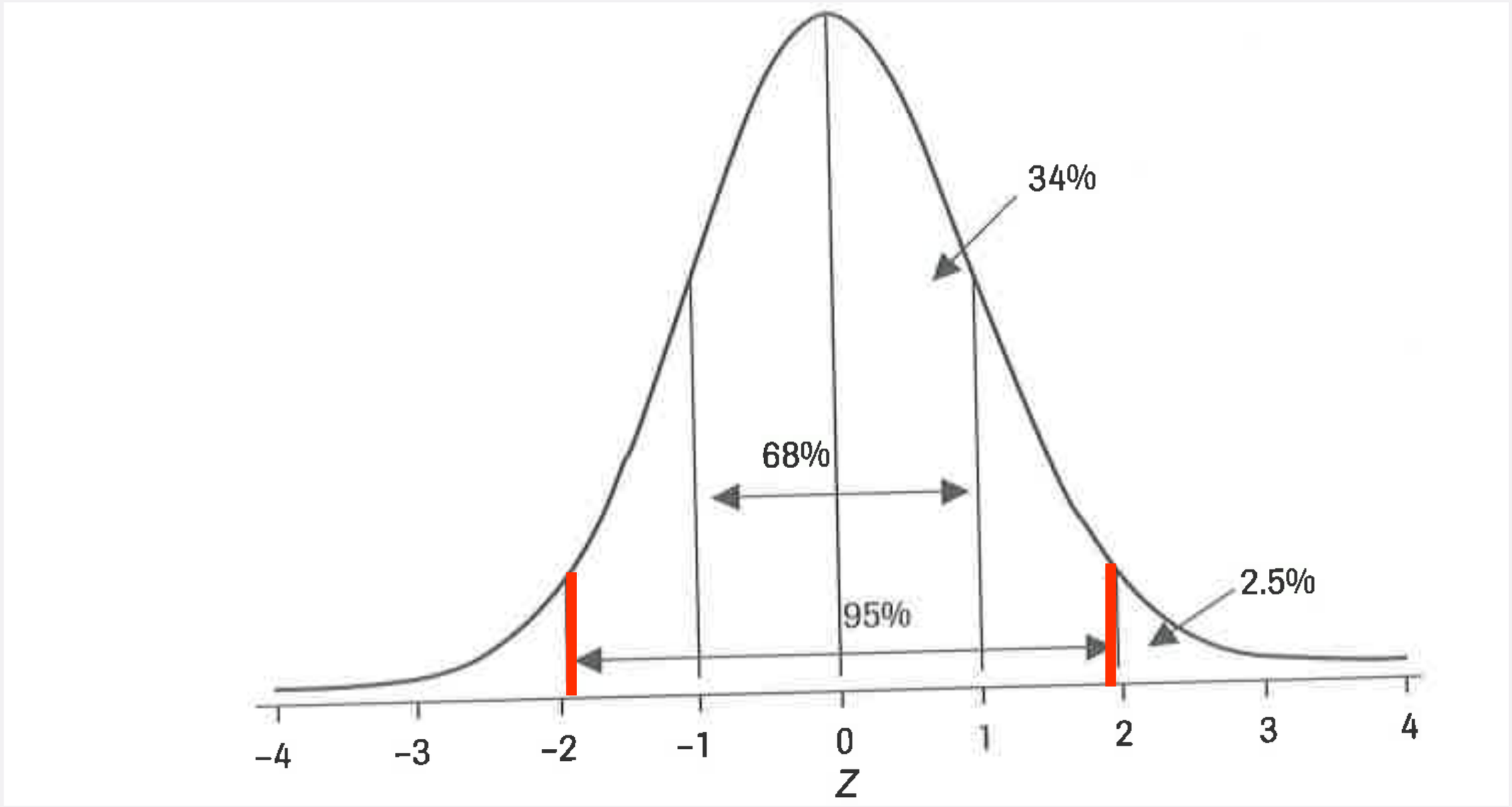
- H_A: 0.13
- H_0: 0
- Standard Error of Difference: 0.018

$$t = \frac{H_A - H_0}{\text{Standard Error of Difference}}$$

$$t = \frac{0.13 - 0.00}{0.018} = 7.22$$

- **This is called the "t-statistic" or "t-ratio"**

NORMAL DISTRIBUTION

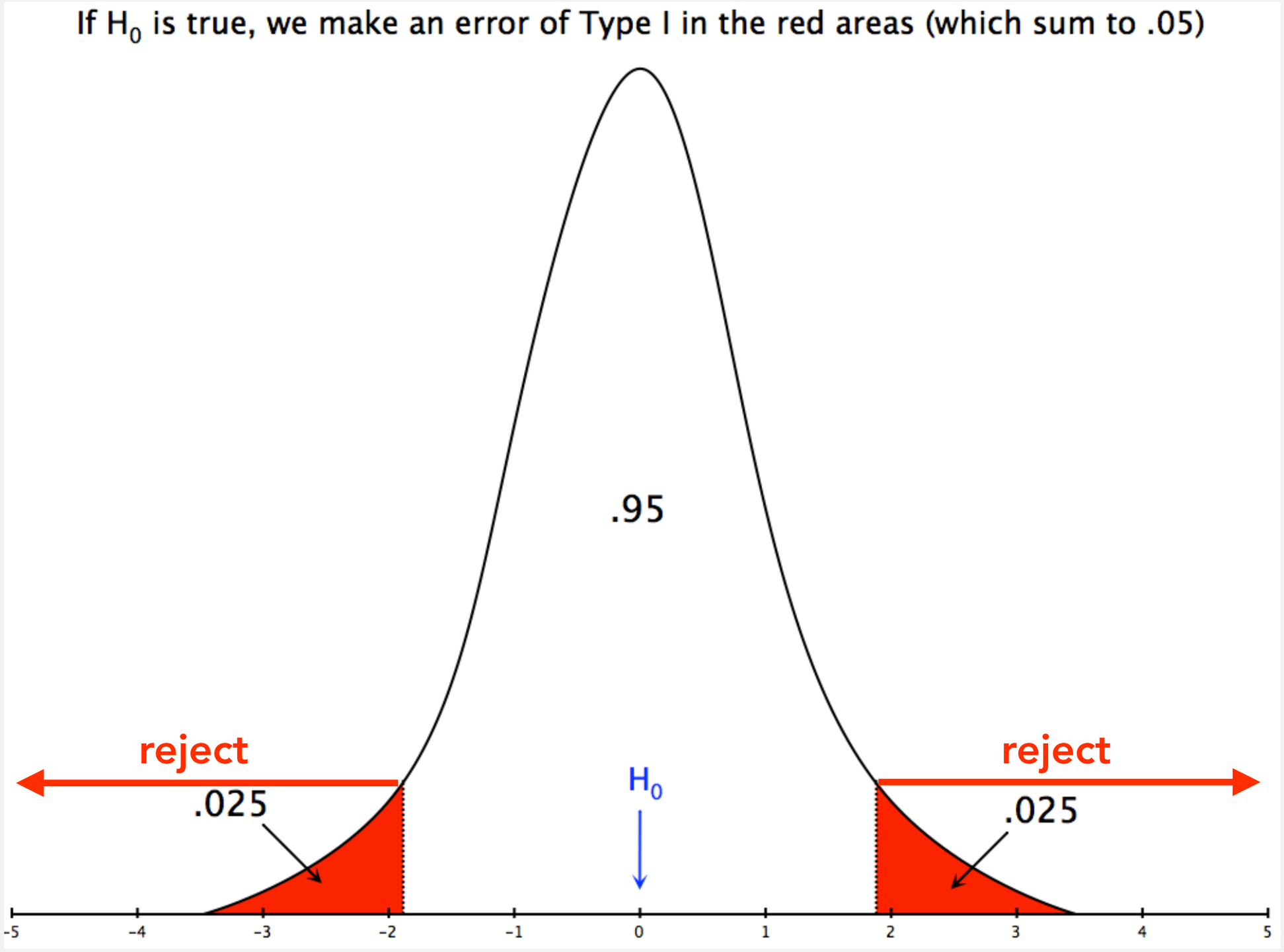


- Remember: 95% between scores of -1.96 and 1.96
- 5% of scores outside of those scores
- T-statistic is (basically) normally distributed

SIGNIFICANCE TEST

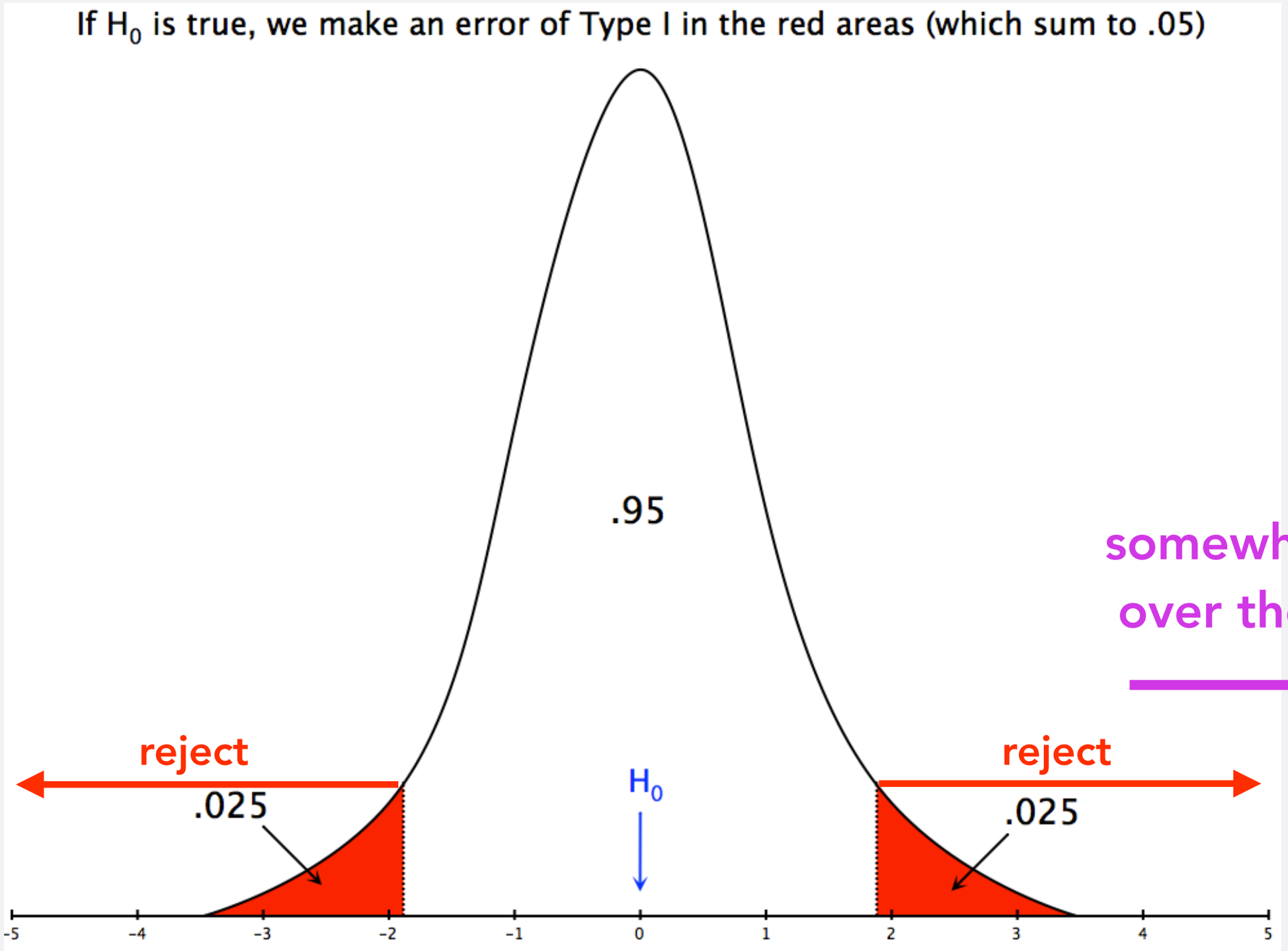
- We reject H_0 (no difference between men and women) if t-value is such that it is unlikely that we commit a Type I error
  - 5% chance (or less) that we falsely reject H_0
  - So if the null hypothesis is true (no effect in population), chance of seeing the effect we see in our sample is 5% or less

SIGNIFICANCE TEST



- We reject H_0 if t<-1.96 or t>1.96

SIGNIFICANCE TEST



- **t-score: 7.22**

SIGNIFICANCE TEST

Job Approval Ratings of President Biden, by Subgroup

	Approve	Disapprove	N
	%	%	
All U.S. adults	56	39	2,937
Gender			
Men	49	45	1,643
Women	62	34	1,294

- If there is no difference between men and women in population, chance that we find 13 percentage points difference in samples is less than 5 percent

SIGNIFICANCE TEST

Job Approval Ratings of President Biden, by Subgroup

	Approve	Disapprove	N
	%	%	
All U.S. adults	56	39	2,937
Gender			
Men	49	45	1,643
Women	62	34	1,294

- So we reject the null hypothesis that there is no difference between men and women in approval of Biden
- In favor of the alternative hypothesis that he has higher support among women

ANOTHER EXAMPLE

- From the class survey:
- How would you say the economy is doing?
  - Bad or very bad: 49%
  - Neither, good, very good: 51%

PARTISANSHIP AND ECONOMY

	Democrat	Republican	Total
Bad Or Very Bad	43% (32)	74% (14)	49% (46)
Neither, Good, Or Very Good	57% (42)	26% (5)	51% (47)
Total	100% (74)	100% (19)	100% (93)

- Difference: 31% (0.31)

CROSS-TABULATION

- Difference between Democrats and Republicans is 0.31 (31%)
  - Standard error of difference: 0.26

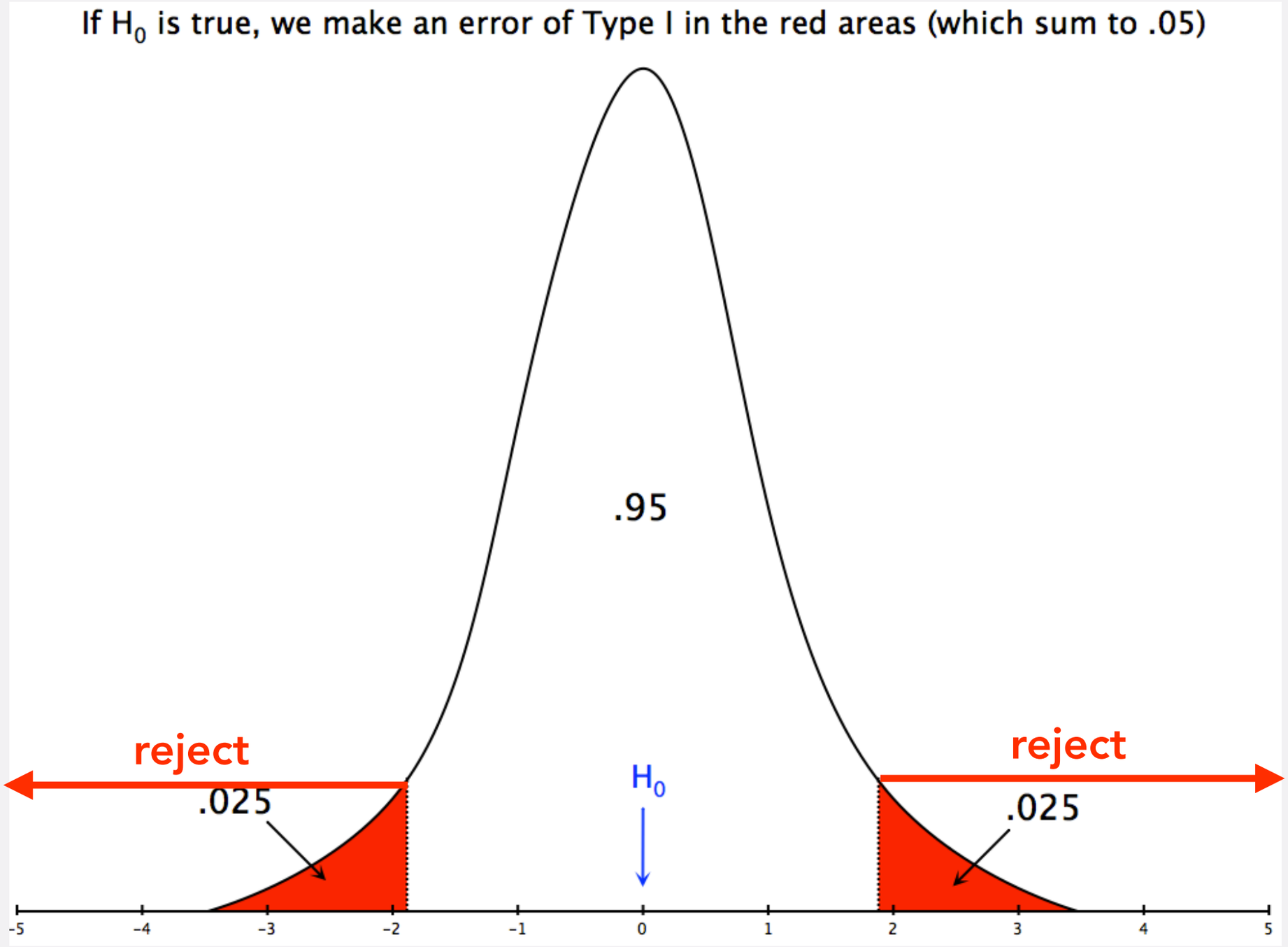
$$\frac{H_A - H_0}{\text{Standard Error of Difference}}$$

$$= \frac{0.31 - 0.0}{0.26}$$

$$= 1.19$$

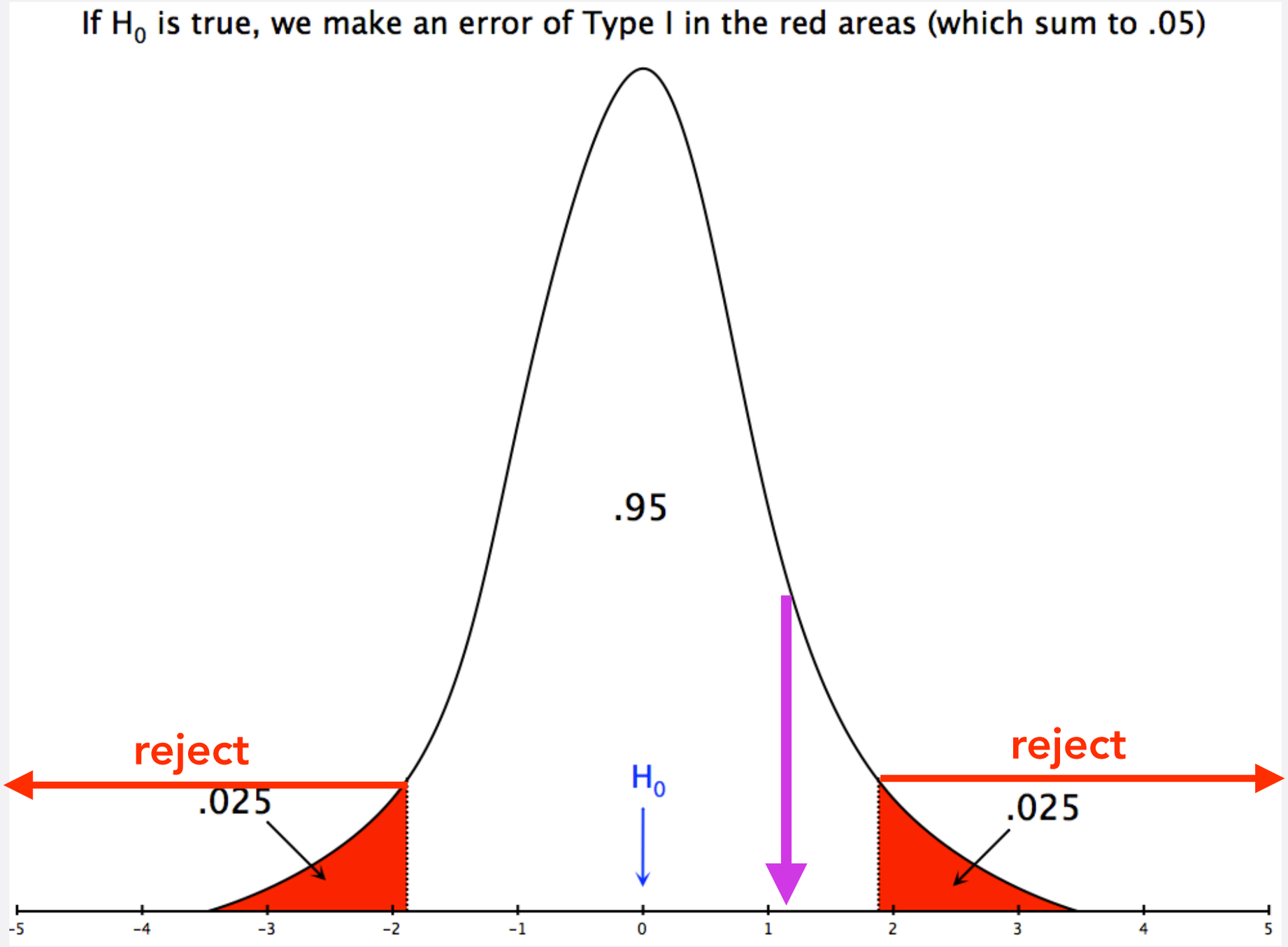
- Is this t-statistic large enough to reject H_0?

SIGNIFICANCE TEST



- We reject H_0 if t<-1.96 or t>1.96
- We had: t=1.19

SIGNIFICANCE TEST



- We reject H_0 if t<-1.96 or t>1.96
- We had: t=1.19

REJECT H_0?

- We reject H_0 if $t < -1.96$ or $t > 1.96$
- We had $t = 1.19$
- So we cannot reject H_0 that there is no difference between Democrats and Republicans in perceptions of economy
- It is quite likely that we see a difference as large as we observed in our sample if there is no difference in the population
  - Chance of that happening is larger than 5%

REJECT H_0?

- We found a very large difference between Republicans and Democrats
  - 74 vs. 43 percent!
- But: We have a relatively small sample, especially for Republicans
  - Makes it quite likely that, if H_0 is true, we get a sample with lots of Republicans thinking that the economy is bad

BIVARIATE RELATIONSHIPS

Dependent Variable	Independent Variable: Nominal/Ordinal	Independent Variable: Interval
Nominal/Ordinal	Cross-Tabulation	Not In This Class…
Interval	Mean Comparison	Correlation Coefficient, Linear Regression

BIVARIATE RELATIONSHIPS

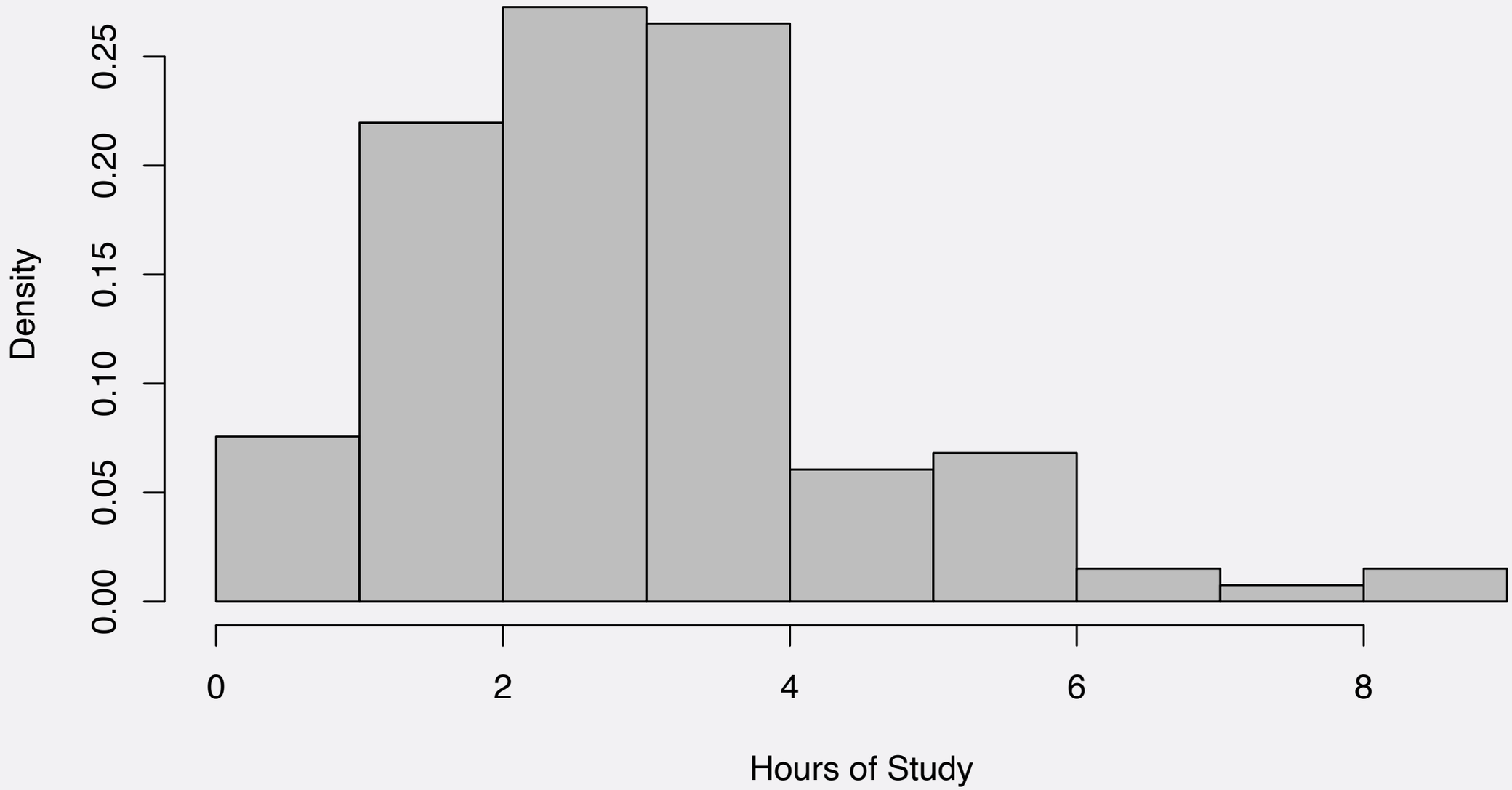
Dependent Variable	Independent Variable: Nominal/Ordinal	Independent Variable: Interval
Nominal/Ordinal	Cross-Tabulation	Not In This Class…
Interval	Mean Comparison	Correlation Coefficient, Linear Regression

CROSS-TABULATION

- Very similar approach as for mean comparisons

EXAMPLE

- On a typical day, how many hours do you spend studying/ revising/preparing for your classes, not counting time in class itself?



GENDER AND STUDYING

Gender	Mean Hours	Frequency	Standard Error
Female	3.29	79	0.17
Male	2.86	50	0.20
Difference	0.43	129	0.26

- Do men really study less than women?

TEST STATISTIC

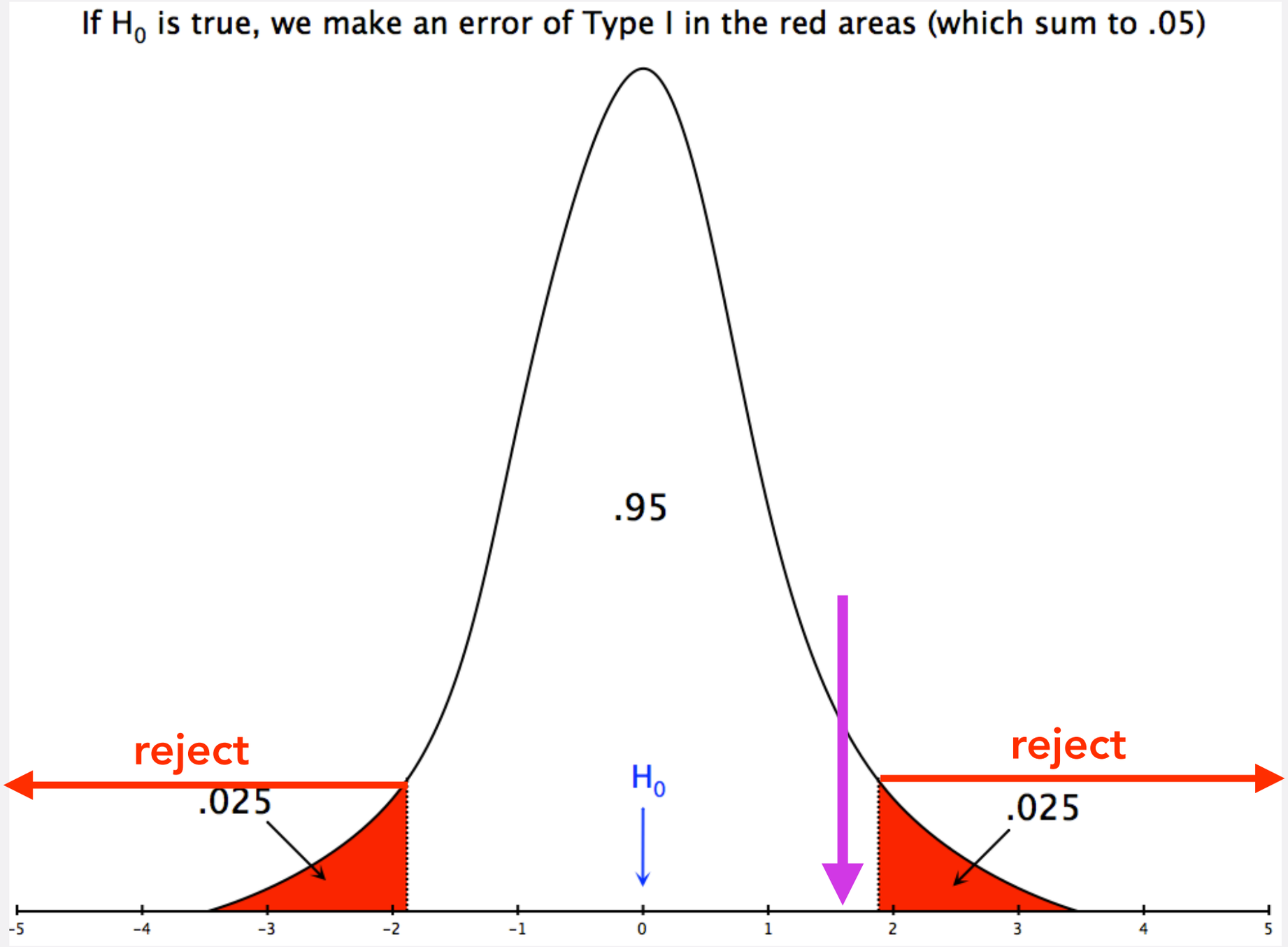
- H_A: 0.43
- H_0: 0
- Standard Error of Difference: 0.26

$$t = \frac{H_A - H_0}{\text{Standard Error}}$$

$$= \frac{0.43 - 0.0}{0.26}$$

$$= 1.65$$

SIGNIFICANCE TEST



- t-score: 1.65

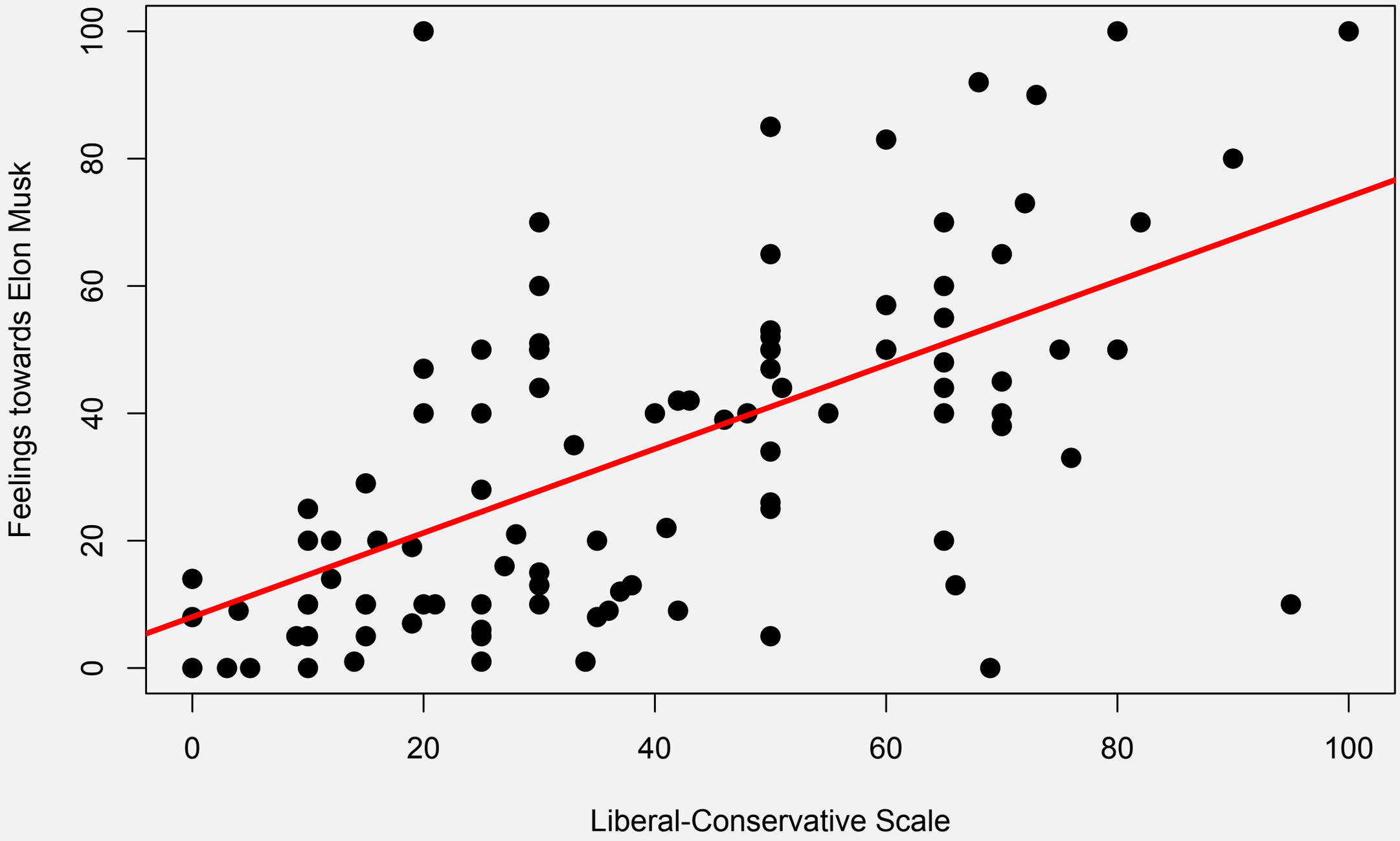
SIGNIFICANCE TEST

- We cannot reject H_0
- If there is no difference in study time between men and women in population of students, it is quite likely that we see a difference of 0.43 hours (or larger) in a sample of 129 students just by chance
- The probability of this happening is larger than 5%

BIVARIATE RELATIONSHIPS

Dependent Variable	Independent Variable: Nominal/Ordinal	Independent Variable: Interval
Nominal/Ordinal	Cross-Tabulation	Not In This Class…
Interval	Mean Comparison	Correlation Coefficient, Linear Regression

ELON MUSK



- Thermometer Score = 8 + 0.66 * Lib/Cons

REJECT H_0?

- Can we reject H_0 that there is no relationship between lib/cons and feelings towards Musk?

FORMULA

$$t = \frac{H_A - H_0}{\text{Standard Error}}$$

- H_A: 0.66
- H_0: 0
- Here, the relevant standard error is the SE of the linear regression coefficient

REGRESSION TABLE

```
> m <- lm(therm_6 ~ libcons_1, data = data)
> summary(m)

Call:
lm(formula = therm_6 ~ libcons_1, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-60.709 -12.931  -1.674  10.784  78.770

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  8.03561    4.01577   2.001    0.048 *
libcons_1    0.65972    0.08552   7.714 8.08e-12 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21.13 on 103 degrees of freedom
  (27 observations deleted due to missingness)
Multiple R-squared:  0.3662, Adjusted R-squared:   0.36
F-statistic: 59.51 on 1 and 103 DF,  p-value: 8.076e-12
```

REJECT H_0?

$$t = \frac{H_A - H_0}{\text{Standard Error}}$$

$$= \frac{0.66 - 0}{0.086}$$

$$= 7.67$$

SIGNIFICANCE TEST

- If how liberal/conservative people are has no effect on evaluations of Musk in population, it is quite unlikely that we would see such a large effect just by chance
  - The probability of this happening is much smaller than 5%
- So we are feel comfortable to reject H_0 and instead conclude that there is a relation between ideology and feelings towards Musk

RECAP

- We are now able to…
  - …tell whether there is covariation between X and Y in a sample
  - …tell whether our evidence (from a sample) is strong enough to conclude with reasonable certainty that the covariation is also present in the population

NEXT STEP

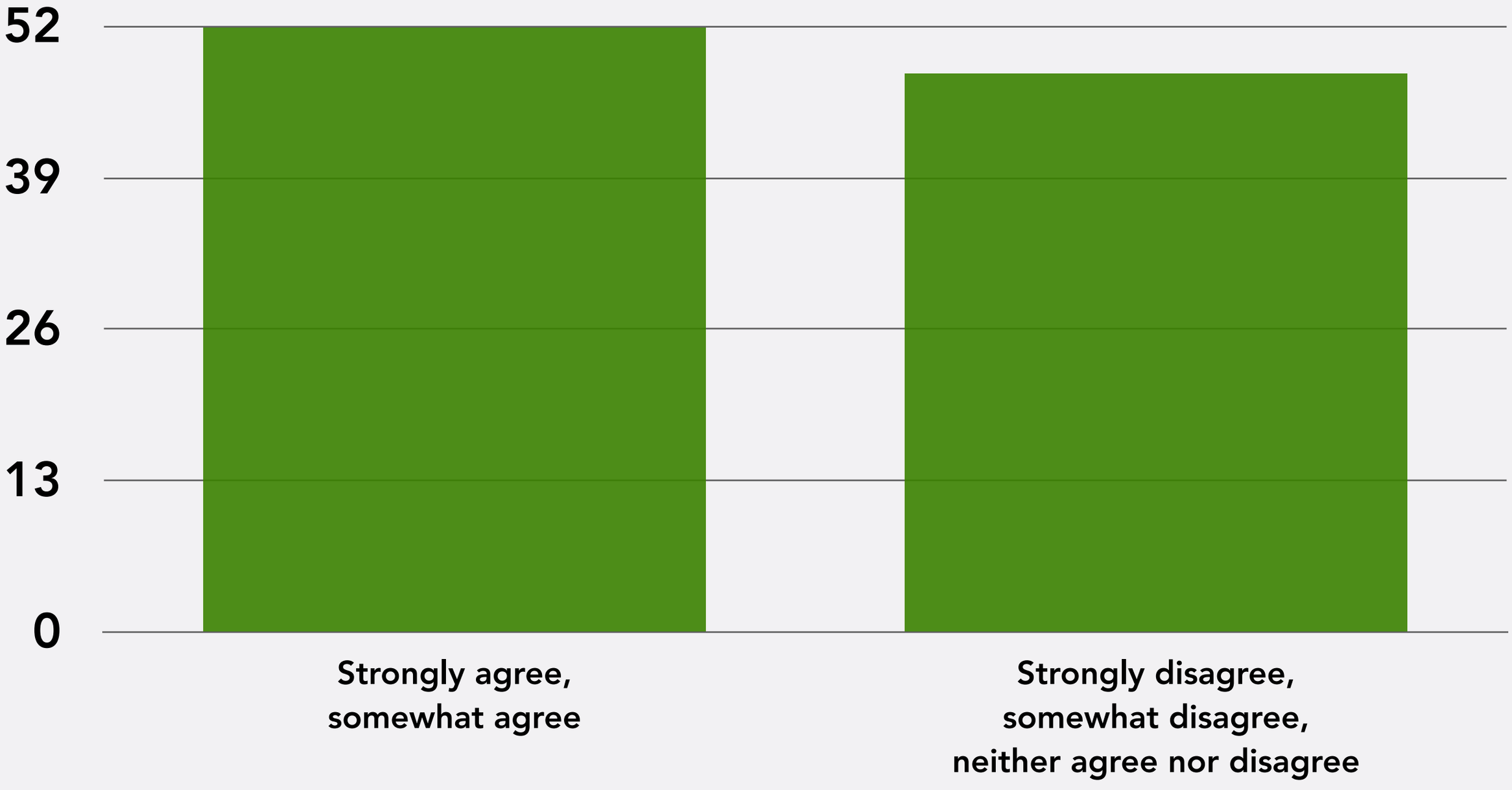
- Is there a credible causal mechanism that connects X to Y?
- Can we rule out the possibility that Y could cause X?
- Is there covariation between X and Y?
- Have we controlled for all confounding variables (Z) that might make the association between X and Y spurious?

TODAY

- Hypothesis testing with a sample
- Hypothesis testing with one confounder

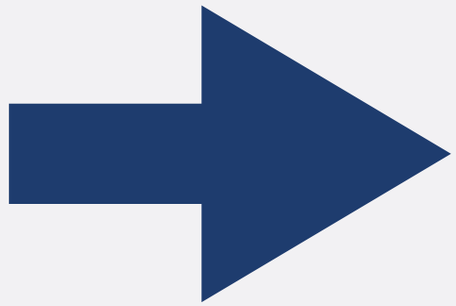
SURVEY

- **How much do you agree with the following statement: The federal government should mandate that everyone has to be vaccinated against Covid-19 (unless they have a medical or religious exemption).**



BIVARIATE RELATIONSHIP

?



Support for vaccine mandate

- What explains why some of you think there should be a vaccine mandate, while others disagree?

PARTISANSHIP & VACCINES

	Democrats	Not Democrats	Total
Mandate	69% (51)	30% (17)	52% (68)
No Mandate	31% (23)	70% (40)	48% (63)
Total	100% (74)	100% (57)	100% (131)

BIVARIATE RELATIONSHIP

Partisanship → Support for vaccine mandate

- Zero-order effect: Democrats are 39 percentage points more likely to support a vaccine mandate than Non-Democrats

CAUSALITY

- Want to know *causal* effect of partisanship on support for vaccine mandate:
- Attitude of person if Democrat - Attitude of same person if not Democrat
- Fundamental problem of causal inference: We can't observe alternate reality in which you identify with the other party!

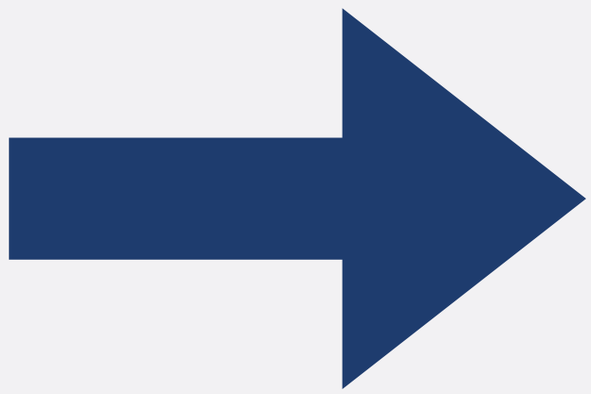
CAUSALITY

- Also: Whether people identify as Democrats or not depends on certain factors
  - e.g. gender, age
- These other factors might *also* determine people's attitudes towards vaccine mandates

CONFOUNDER?

Gender (Z)

Partisanship (X)



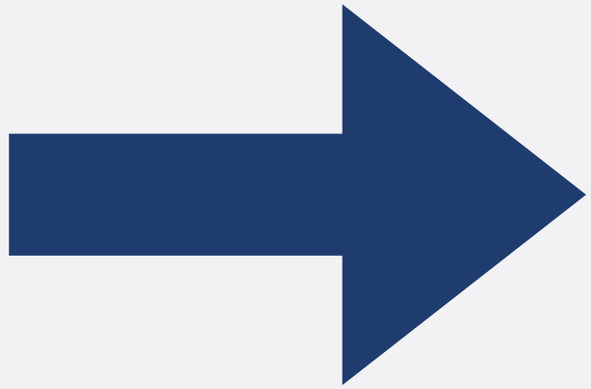
Vaccine Mandate (Y)

MAYBE THIS IS GOING ON?

Gender (Z)

W more likely to be Democrats than M

Partisanship (X)



Vaccine Mandate (Y)

MAYBE THIS IS GOING ON?

Gender (Z)

W more likely to be Democrats than M

W more supportive of vaccine mandate than M

Partisanship (X) → **Vaccine Mandate (Y)**

Partisanship by itself has no effect on vaccine mandate attitude

MAYBE THIS IS GOING ON?

Gender (Z)

W more likely to be Democrats than M

W more supportive of vaccine mandate than M

Partisanship (X) → **Vaccine Mandate (Y)**

- How can we find out if this is what's going on?

CONTROLLED COMPARISON TABLE

Vaccine Mandate		Female			Male		
		Dem	Non-Dem	Total	Dem	Non-Dem	Total
Mandate							
No Mandate							
Total							

CONTROLLED COMPARISON TABLE

Vaccine Mandate	Female			Male		
	Dem	Non-Dem	Total	Dem	Non-Dem	Total
Mandate	71% (40)	35% (8)	61% (48)			
No Mandate	29% (16)	65% (15)	39% (31)			
Total	100% (56)	100% (23)	100% (79)			

CONTROLLED COMPARISON TABLE

Vaccine Mandate	Female			Male		
	Dem	Non-Dem	Total	Dem	Non-Dem	Total
Mandate	71% (40)	35% (8)	61% (48)			
No Mandate	29% (16)	65% (15)	39% (31)			
Total	100% (56)	100% (23)	100% (79)			

36%

PARTISANSHIP & VACCINATION

- Among women, Democrats are more likely to support a vaccine mandate than Non-Democrats
- Democratic women 36 percentage points more likely to support

TERMINOLOGY

- Controlled effect: relationship between an independent variable (X) and a dependent variable (Y) within one value of another independent variable (Z)
  - e.g. relation between partisanship (X) and vaccine mandate support (Y) among women (one value of Z)

CONTROLLED COMPARISON TABLE

Vaccine Mandate	Female			Male		
	Dem	Non-Dem	Total	Dem	Non-Dem	Total
Mandate	71% (40)	35% (8)	61% (48)	59% (10)	28% (9)	39% (19)
No Mandate	29% (16)	65% (15)	39% (31)	41% (7)	72% (23)	61% (30)
Total	100% (56)	100% (23)	100% (79)	100% (17)	100% (32)	100% (49)

36%

CONTROLLED COMPARISON TABLE

Vaccine Mandate	Female			Male		
	Dem	Non-Dem	Total	Dem	Non-Dem	Total
	36%			31%		
Mandate	71% (40)	35% (8)	61% (48)	59% (10)	28% (9)	39% (19)
No Mandate	29% (16)	65% (15)	39% (31)	41% (7)	72% (23)	61% (30)
Total	100% (56)	100% (23)	100% (79)	100% (17)	100% (32)	100% (49)

PARTISANSHIP & VACCINES

- Among men, Democrats are more likely to support a vaccine mandate than Non-Democrats
  - Democratic men 31 percentage points more likely to support

PARTISANSHIP & VOTING

- So even if we take gender into account, partisanship *still* has effect on support for vaccine mandate
- Among both men and women, Democrats are more likely to support it