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# POLS 418: Quantitative Methods

Problem Set 4

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Problem Set #4:

Hypothesis Testing using Cross-tabulation and Means Comparisons

**Introduction:**

The purpose of this analysis is to test a series of hypotheses based on data from the 2016 American National Election Study (ANES). This paper tests the following four claims: those who hold an advanced degree are more likely to believe in anthropogenic climate change; women have warmer feelings towards feminists than men; churchgoers favor using the death penalty more than those who do not attend church; and white people favor the construction of a border wall more than nonwhites. These hypotheses are tested with survey data from ANES. Two of the hypotheses are tested using a Chi square calculation and two are tested using a difference of means test. Each hypothesis includes a brief discussion on the findings of the test with corresponding tables and figures.

**Overview:**

* **Hypothesis 1 (tabular):**

*“In comparing individuals, those who hold an advanced educational degree be more likely to believe humans are causing climate change than those without an advanced degree.”*

* **Hypothesis 2 (difference of means T-Test):**

*“In comparing individuals, women will have warmer feelings towards feminists than men.”*

* **Hypothesis 3 (tabular):**

*“In comparing individuals, those who attend church will be more likely to favor using the death penalty than those who do not.”*

* **Hypothesis 4 (difference of means T-Test):**

*“In comparing individuals, those who are identity as white will be more likely to favor building a wall on the Mexican border than those who are do not identity as white.”*

**Hypothesis 1 (tabular):**

*“In comparing individuals, those who hold an advanced educational degree will be more likely to believe humans are causing climate change than those without an advanced degree.”*

***Methodology***

A Chi square test of significance was used to see if those who hold an advanced degree are more likely than those who do not, to support the belief that humans are causing climate change.[[1]](#footnote-0) The purpose of this test is to determine the extent of the relationship between our two categorical variables—education status and beliefs about the causes of climate change.[[2]](#footnote-1), [[3]](#footnote-2)

***Findings***

Based on the Chi square statistic and the p-value, we reject the null hypothesis and accept the alternative hypothesis that there *is* a true difference in the population between those who hold advanced degrees and those who do not in, in their belief in anthropogenic climate change. In addition to being statistically significant, there is a substantive difference between the two compared groups. In this test the Chi square score was 48.41, indicating a large difference in beliefs between the two groups. Finally, the *p-*value was .000, meaning that there is a less than .0001% chance that we would observe in the unobserved population these findings by chance. These findings show strong support for the alternative hypothesis.

Table 1. Crosstab of Views on Climate Change and Education Status

|  |  |  |  |
| --- | --- | --- | --- |
| Views on the causes of  climate change | Advanced degree  (Yes) | Advanced degree  (No) | Total |
| Mostly by human activity | 36.84% | 50.77% | 39.19% |
|  | (1,297) | (363) | (1,660) |
|  |  |  |  |
| Mostly by natural causes | 18.40% | 14.41% | 17.73% |
|  | (648) | (103) | (751) |
|  |  |  |  |
| Human activity and natural causes | 44.76% | 34.83% | 43.08% |
|  | (1,576) | (249) | (1,825) |
|  |  |  |  |
| Total | 100.00% | 100.00% | 100.00% |
|  | (3,521) | (715) | (4,236) |

*chi2= 48.41; p-value = <.0001*

Figure. 1 Causes of Climate Change Survey by Advanced and Non-advanced degree holders.

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**Hypothesis 2 (difference of means T-Test):**

*“In comparing individuals, women will have warmer feelings towards feminists than men.”*

**Methodology**

A difference of means test was used to test the hypothesis that women have warmer feelings towards feminists than men. The purpose of this test is to determine the extent of the relationship between our categorical variable (gender) and (interval level variable) score on a feminist thermometer.[[4]](#footnote-3),[[5]](#footnote-4)

***Findings***

Based on the test’s p-value, confidence intervals, and t-statistic, we reject the null hypothesis and accept the alternative hypothesis that these sample differences reflect the true mean scores for men and women in the unobserved population and thus are not a product of random sampling error.[[6]](#footnote-5) While the difference is statistically significant, the size of the difference is small and not substantively important. The mean score on the feminist thermometer for men and women was roughly 52.0 and 60.0 respectively, leaving an 8.0 difference between the two groups. A reported p-value of .000 suggests that a random sample would produce a sample mean of 52.0 and 60.0 for men and women respectively, less than .1% of the time by chance. There is a 95% degree of confidence that a random sample will produce mean scores between roughly 50.0 - 53.0 points for men and 59.0 – 61.0 points for women. The fact that these intervals do not overlap provides additional support of a true difference in scores.[[7]](#footnote-6),[[8]](#footnote-7) Finally, the value of the *t*-statistic—valued at -9.6 supports a rejection of the null hypothesis.

Table 2. Difference of Means Test Comparing Men and Women on Feminist Thermometer

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Group | Obs | Mean | Std. Err. | Std. Dev. | [95% Conf. | Interval] |
| Male | 1,664 | 51.69 | .62 | 25.43 | 50.47 | 52.92 |
| Female | 1,874 | 59.96 | .59 | 25.87 | 58.79 | 61.13 |
| Combined | 3,538 | 56.07 | .43 | 25.99 | 55.21 | 56.93 |
| Difference between groups |  | -8.26 | .86 |  | -9.96 | -6.57 |

*t-statistic = 9.6, p value = <.0001*

Figure 4. Mean Score Comparison on Border Wall Opinion

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**Hypothesis 3 (tabular):**

*“In comparing individuals, those who attend church will be more likely to favor using the death penalty than those who do not.”*

***Methodology***

A Chi square test of significance was used to determine if churchgoers are more likely than non-churchgoers to support the death penalty.[[9]](#footnote-8) The purpose of this test is to determine the extent of the relationship between our two categorical variables—church attendance (yes or no) and support for the death penalty.[[10]](#footnote-9),[[11]](#footnote-10)

***Findings***

Based on the values of the Chi square statistic and *p-*Value, a Chi square test of significance shows that there is strong support for accepting the null hypothesis that there is *no* meaningful difference between churchgoers and non-churchgoers in their support for the death penalty. The critical value for *p* is .005, meaning that if the *p*-value is greater than .005, the null hypothesis should be accepted. In this test, the p value (.654) is considerably higher than the .005 threshold. The low Chi square score is consistent with the reported *p*-value. In light of these findings, we reject the alternative hypothesis and accept the null hypothesis.

Table 3. Chi Square Calculation for View on Death Penalty

|  |  |  |  |
| --- | --- | --- | --- |
| View on death penalty | Attend Church  (Yes) | Attend Church  (No) | Total |
| Strongly Favor | 54.09% | 52.78% | 53.56% |
|  | (1,349) | (884) | (2,233) |
|  |  |  |  |
| Favor | 15.68% | 15.40% | 15.57% |
|  | (391) | (258) | (649) |
|  |  |  |  |
| Oppose | 12.83% | 14.09% | 13.34% |
|  | (320) | (236) | (556) |
|  |  |  |  |
| Strongly Oppose | 17.40% | 17.73% | 17.53% |
|  | (434) | (297) | (731) |
|  |  |  |  |
| Total | 100.00% | 100.00% | 100.00% |
|  | (2,494) | (1,675) | (4,169) |

*chi2= 1.6240; p-value = 0.654*

Figure 3. Views on Death Penalty

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**Hypothesis 4 (difference of means T-Test):**

*“In comparing individuals, those who identify as white will be more likely to favor building a wall on the Mexican border than those who are do not identity as white.”*

**Methodology**

A difference of means test was used to test the hypothesis that whites are more likely than non-whites to support a border wall with Mexico.[[12]](#footnote-11) The purpose of this test is to determine the extent of the relationship between our categorical variable (race) and (interval level variable) level of support for a border wall.[[13]](#footnote-12),[[14]](#footnote-13)

***Findings***

A p-value of .000 suggests that a random sample would produce a sample mean of 4.0 and 5.0 for whites and nonwhites respectively, less than .1% of the time by chance, which supports the alternative hypothesis that there *is* a true difference between the two groups in population. The confidence intervals show a 95% degree of confidence that a random sample will produce mean scores between 4.07 – 4.24 points for whites and 4.94 – 5.18 points for non-whites.[[15]](#footnote-14),[[16]](#footnote-15) Finally, a -11.3 *t-*statistic reinforces support for the alternative hypothesis.[[17]](#footnote-16) Based on the p-value, the confidence intervals, and the t-statistic, we reject the null hypothesis and accept the alternative hypothesis that these sample differences reflect the true mean scores for whites and nonwhites in the unobserved population and thus are not a product of random sampling error.[[18]](#footnote-17) However, while the difference is statistically significant, it is not substantive.

Table 3. Difference of Means Test Comparing White and Nonwhites on Border Wall Opinion

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Group | Obs | Mean | Std. Err. | Std. Dev. | [95% Conf. | Interval] |
| White | 3,027 | 4.16 | .04 | 2.40 | 4.07 | 4.24 |
| Non-white | 1,191 | 5.06 | .06 | 2.16 | 4.94 | 5.18 |
|  |  |  |  |  |  |  |
| Combined | 4,218 | 4.41 | .03 | 2.37 | 4.34 | 4.48 |
| Diff. between groups |  | -.90 | .08 |  | -1.06 | -.74 |

*t-statistic = -11.3, p-value= .000*

Figure 4. Mean Score Comparison on Border Wall OpinionA screenshot of a cell phone

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Bibliography

“2016 American National Election Study.” ANES. <https://electionstudies.org/data-center/2016-time-series-study/>

Howard, Christopher. *Thinking like a political scientist: a practical guide to research methods*. University of Chicago Press, 2017.

Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018.

Pollock III, Philip H., and Barry C. Edwards. *The essentials of political analysis*. Cq Press, 2019.

Appendix A

**Figure 8. Code for Problem Set 4**

. tab education

. generate Adv\_Deg = 0

. replace Adv\_Deg = 1 if education>=14

. tab Climate\_Change

. replace Climate\_Change = . if Climate\_Change <=-8

. tab Climate\_Change

. tabulate Climate\_Change Adv\_Deg

. tabulate Climate\_Change Adv\_Deg, column

. tabulate Climate\_Change Adv\_Deg, chi2 column

. tab gender

. tab V162096

. replace V162096 = . if V162096<0

. replace V162096 = . if V162096>100

. ttest V162096, by(gender)

. tab attend\_church

. replace attend\_church = . if attend\_church<0

. tab death\_penalty

. replace death\_penalty = . if death\_penalty<0

. tabulate death\_penalty attend\_church, chi2 column

. tab race

. generate White = .

. replace White = 1 if race==1

. replace White = 2 if race>=2

. ttest build\_wall, by(White)

. graph bar (mean) build\_wall, over(White)

. graph bar (mean) build\_wall, over(White) ytitle(Mean on Border Wall Opinion)

. graph bar (mean) V162096, over(gender) ytitle(Mean on Feminist Thermometer)

. graph bar, over(Climate\_Change) ytitle(Views on Causes of Climate Change) by(Adv\_Deg)

. graph bar, over(death\_penalty) ytitle(Views on Causes of Climate Change) by(, title(Views on Death Penalty)) by(attend\_church)

1. A survey question asked to report the view on the causes of climate change. Three beliefs on the causes of climate were available: “mostly by human activity,” “mostly by natural causes,” and “about equally from both human and natural causes.” [↑](#footnote-ref-0)
2. Pollock III, Philip H., and Barry C. Edwards. *The essentials of political analysis*. Cq Press, 2019: 113, 273, 275 [↑](#footnote-ref-1)
3. For this analysis, a Chi square test revealed how much the “observed” values of our dependent variable (belief in anthropogenic climate change) “diverged” from its expected values. The farther the Chi square statistic is from “0” the more support there will be for rejecting the null hypothesis.More important is the p value, which tells us how likely we would observe these differences in the unobserved population by chance. The lower the *p-*value the greater confidence that a true relationship exists in the unobserved population. See Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018: 139 and [↑](#footnote-ref-2)
4. Feeling thermometer between 0-100. [↑](#footnote-ref-3)
5. Three critical values used to test our hypothesis: the p-value, the confidence intervals, and the t-statistic. The p-value tells us how likely we would observe the differences in mean scores between men and women in the unobserved population by chance. The confidence intervals tells us with a 95% degree of confidence that the true mean score on the feminist thermometer in the unobserved population will fall within a certain range. We will find support for the alternative hypothesis if the confidence intervals for both men and women do not overlap. Finally, the t-statistic tells us how far the observed mean is from the population mean; the higher the absolute value, the more support there will be for the rejecting the null hypothesis. See Howard, Christopher. *Thinking like a political scientist: a practical guide to research methods*. University of Chicago Press, 2017: 181 and Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018: 119 [↑](#footnote-ref-4)
6. Ibid, 120 [↑](#footnote-ref-5)
7. Ibid, 121 [↑](#footnote-ref-6)
8. Additionally, there is a 95% confidence that the difference between the mean scores among men and women in a random sample will roughly fall between -10.0 and -7.0. Because this bound does not include zero, the null hypothesis can be rejected. [↑](#footnote-ref-7)
9. A survey question asked to report the view on the causes of climate change. Three beliefs on the causes of climate were available: “mostly by human activity,” “mostly by natural causes,” and “about equally from both human and natural causes.” [↑](#footnote-ref-8)
10. Pollock III, Philip H., and Barry C. Edwards. *The essentials of political analysis*. Cq Press, 2019: 113 [↑](#footnote-ref-9)
11. For this analysis, a Chi square test revealed how much the “observed” values of our dependent variable (support for the death penalty) “diverged” from its expected values. The farther the Chi square statistic is from “0” the more support there will be for rejecting the null hypothesis. More important is the p value, which tells us how likely we would observe these differences in the unobserved population by chance. The lower the *p-*value the greater confidence that a true relationship exists in the unobserved population. From Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018: 139 and Pollock III, Philip H., and Barry C. Edwards. *The essentials of political analysis*. Cq Press, 2019: 273, 275 and Howard, Christopher. *Thinking like a political scientist: a practical guide to research methods*. University of Chicago Press, 2017: 181 [↑](#footnote-ref-10)
12. A survey question asked respondents to rate the favorability of a border wall with Mexico on a 7.0-point scale with 1 indicating strong support and 7 indicating strong opposition. The mean scores for whites and nonwhites were roughly 4.0 and 5.0 respectively, leaving the difference between the two groups approximately 1.0 point. [↑](#footnote-ref-11)
13. Feeling thermometer between 0-100. [↑](#footnote-ref-12)
14. For this analysis, there are three critical values used to test our hypothesis: the p-value, the confidence intervals, and the t-statistic. The p-value tells us how likely we would observe the differences in mean scores between whites and nonwhites in the unobserved population by chance. The confidence intervals tells us with a 95% degree of confidence that the true mean score on the border wall survey in the unobserved population will fall within a certain range. We will find support for the alternative hypothesis if the confidence intervals for both whites and nonwhites do not overlap. Finally, the t-statistic tells us how far the observed mean is from the population mean; the higher the absolute value, the more support there will be for the rejecting the null hypothesis. See Howard, Christopher. *Thinking like a political scientist: a practical guide to research methods*. University of Chicago Press, 2017: 181 and Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018: 119. [↑](#footnote-ref-13)
15. Additionally, you can say with 95% confidence that the difference between the mean scores among men and women in a random sample will roughly fall between -10.0 and -7.0. Because this bound does not include zero, the null hypothesis can be rejected. A value of zero would otherwise indicate no true difference between men and women. Since zero falls outside of -10 and -7, the null hypothesis that there is no meaningful difference can be rejected. See Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018: 121 [↑](#footnote-ref-14)
16. These intervals also do not overlap further indicating that there is a true difference in mean scores [↑](#footnote-ref-15)
17. Although given the results of the test, the original phrasing of the hypothesis could be misleading. A more precise claim is that whites are more indifferent about the construction of a border wall than nonwhites. Whites have a mean score of roughly 4.0, indicating “neither oppose nor support.” [↑](#footnote-ref-16)
18. Pollock III, Philip H., and Barry C. Edwards. *A Stata® companion to political analysis*. CQ Press, 2018:120 [↑](#footnote-ref-17)