From: Hayden Smith
To: Professor Neal Devins
Date: July 17, 2023
Subject: Senior Status Judges

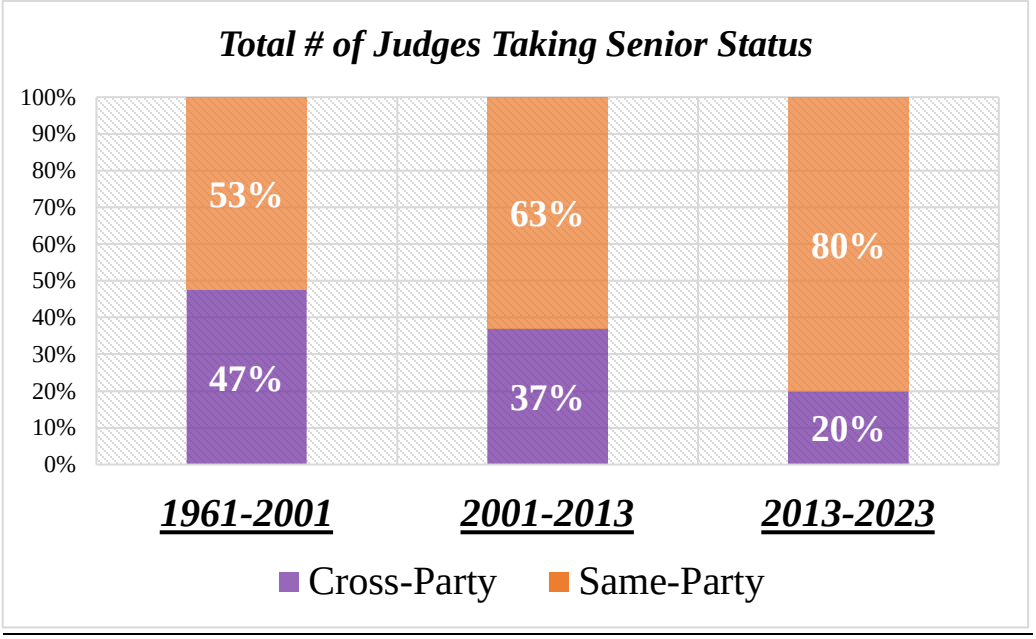
**Statistical Significance Calculations**

**Procedure:**

1. Formulated a Research Hypothesis
    - There *is* a relationship between judges' ideology and the administration under which they choose to take senior status.
        - There is a statistically significant difference in judges taking senior status during opposite-party presidencies before the nuclear option compared to the post-nuclear period today.
        - We hypothesize that there *is* a relationship between a judge's decision to take senior status and the ideology of the president when the judge takes status.
2. Formulated a Null Hypothesis
    - There is *no* relationship between judges' ideology and the administration under which they choose to take senior status.
3. Selected a Probability of Error Level
    - Type I Error (Alpha): $p < 0.05$ (5% probability of making a Type I error)
        - Accepting our null hypothesis that there is no relationship between ideology and senior status decisions during opposite-party presidencies
    - Type II Error (Beta): Rejecting our research hypothesis and finding that a relationship does exist
4. Selected and computed the test for statistical significance
    - I considered creating a Chi Table and a T-test to evaluate statistical significance since our hypothesis is that fewer judges take senior status during an opposite-party presidency after the nuclear period compared to before. Although I believe our data already corroborates this claim sufficiently. A Chi Table would help us if our hypothesis identified a nominal relationship and not a qualitative prediction that one "group," in this case opposite-party judges, take senior status less frequently. The "two-tailed" t-test identifies alpha on the tail ends of the curve when distributed over a mean of zero with a standard deviation of one (+ / - one from the mean).
    - I decided to use a Chi-Table and conduct two separate tests on the relationship identified in our hypothesis between 1961-2001 and 2013-2023 and 2013-2023.

| Time Period | Total # of Judges Taking Senior Status[i] | Cross-Party | Same-Party |
|---|---|---|---|
| *1961-2001*[ii] | **217** | **103** (47%) | **114** (53%) |
| *2001-2013*[iii] | **73** | **27** (47%) | **46** (63%) |

| | | | |
|---|---|---|---|
| *2013-2023*[iv] | **70** | **14** (20%) | **56** (80%) |




| Cross-Party? | Time Periods (Observed Frequency Periods) | | | |
|---|---|---|---|---|
| | 1961-2001 | 2001-2013 | 2013-2023 | Total |
| Yes | 103 | 27 | 14 | **144** |
| No | 114 | 46 | 56 | **216** |
| **Total** | **217** | **73** | **70** | **360** |

## (1) FIRST TEST: 1961 to 2001 *and* 2013 to 2023

Observed Frequency:

- **N = 287**
- If there was no relationship between the time period and political ideology, then we would expect the total number of cross-party judges since 1961 (40% or 144/360) to be greater than or equal to the number of same-party judges (60% or 216/360), which it is not. Moving on from my initial smell test, we can calculate the time period differential by expected frequency.

| Cross-Party? | Time (Observed Frequency) | | |
|---|---|---|---|
| | 1961-2001 | 2013-2023 | Total |
| Yes | 103 | 14 | **117** |
| No | 114 | 56 | **170** |
| **Total** | **217** | **70** | **287** |

Expected Frequency:

- The following table shows the distribution of Expected Frequencies in blue. Expected Frequency is the cell frequencies we would expect if we accepted our null hypothesis that there is *no* relationship between time period and political ideology.

| **Cross-Party?** | **Time (Expected Frequency)** | | |
|---|---|---|---|
| | **1961-2001** | **2013-2023** | **Total** |
| Yes | 88.5 | 28.5 | **117** |
| No | 128.5 | 41.5 | **170** |
| **Total** | **217** | **70** | **287** |

Chi-Square Calculation:

- To calculate the Chi-Square, I compared the Observed Frequencies with the Expected Frequencies. Calculations below.

**Chi-Square Formulas and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | **Total** |
|---|---|---|---|
| (88.5 - 103) | $(88.5 - 103)^2$ | $[(88.5 - 103)^2] / 88.5$ | 2.389 |
| (128.5 - 114) | $(128.5 - 114)^2$ | $[(128.5 - 114)^2] / 128.5$ | 1.644 |
| (28.5 - 14) | $(28.0 - 14)^2$ | $[(28.0 - 14)^2] / 28.0$ | 7.405 |
| (41.5 - 56) | $(42.0 - 56)^2$ | $[(42.0 - 56)^2] / 42.0$ | 5.096 |

**Chi-Square Calculations and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | Total |
|---|---|---|---|
| -14.5366 | 211.3123 | 2.3887 | 2.3887 |
| 14.5366 | 211.3123 | 1.6440 | 1.6440 |
| 14.5366 | 211.3123 | 7.4050 | 7.4050 |
| -14.5366 | 211.3123 | 5.0964 | 5.0964 |
| | | | **16.5340** |

- Value of Chi-Square is calculated by totaling the table above: **16.534**

Calculated the Degrees of Freedom:

- Degree of Freedom determines the contingency for which the value of the Chi Square was computed. It is the product of the number of rows in the table minus the number of columns.[v]
- Formula (Chi Table with two rows and two columns): **df = (2 - 1) x (2 - 1) = 1**
- Selected our degree of freedom: **1**

Selected the Alpha:

- I selected 0.5 for our Alpha (5% probability of making a Type I error)
  - **P < 0.05**

- Calculated the probability of exceeding the critical value using a Chi-Square Table (see below).

Created a Contingency Table:

- If the value of Chi-Square is large, then the size of the contingency table also needs to be large to reach statistical significance. The tighter the level of alpha (α), the larger the Chi-Square value needs to be, in order to reach statistical significance.[vi]
- The tighter the level of alpha is, then the stricter the requirement for statistical significance becomes. Since our Chi Value is **16.982**, and because 5% type I error is typically standard for a binary relationship test, I created a tight alpha on the tail end of the distribution.

| | **Significance Level (α)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Degree of Freedom (df)** | 0.99 | 0.975 | 0.95 | 0.9 | 0.1 | 0.05 | 0.025 | 0.01 |
| **1** | 0.000 | 0.001 | 0.004 | 0.016 | 2.706 | 3.841 | 5.024 | 6.635 |
| **2** | 0.020 | 0.051 | 0.103 | 0.211 | 4.605 | 5.991 | 7.378 | 9.210 |
| **3** | 0.115 | 0.216 | 0.352 | 0.584 | 6.251 | 7.815 | 9.348 | 11.345 |
| **4** | 0.297 | 0.484 | 0.711 | 1.064 | 7.779 | 9.488 | 11.143 | 13.277 |
| **5** | 0.554 | 0.831 | 1.145 | 1.610 | 9.236 | 11.070 | 12.833 | 15.086 |
| **6** | 0.872 | 1.237 | 1.635 | 2.204 | 10.645 | 12.592 | 14.449 | 16.812 |
| **7** | 1.239 | 1.690 | 2.167 | 2.833 | 12.017 | 14.067 | 16.013 | 18.475 |
| **8** | 1.646 | 2.180 | 2.733 | 3.490 | 13.362 | 15.507 | 17.535 | 20.090 |
| **9** | 2.088 | 2.700 | 3.325 | 4.168 | 14.684 | 16.919 | 19.023 | 21.666 |
| **10** | 2.558 | 3.247 | 3.940 | 4.865 | 15.987 | 18.307 | 20.483 | 23.209 |

5. Interpreted the Results for Test One
    - The value of the Chi-Square (16.534) exceeds the value in the table for p = .05 and df = 1 (Chi Square = 3.84). We reject our null hypothesis (with a 5% probability of error) and accept the research hypothesis that there is a relationship between judges' ideology and the administration under which they choose to take senior status.
    - Since our Chi Value of **16.534** exceeds **3.841** in the table where the level of alpha and degrees of freedom meet, we can assume "that the observed relationship between the two variables exists (at the specified level of probability of error, or alpha), and reject the null hypothesis." [vii] Therefore, there ***is*** a relationship between judges' ideology and the administration under which they choose to take senior status when comparing 1961- 2001 and 2013-2023 time periods.

## (2) SECOND TEST: 2001 to 2013 *and* 2013 to 2023

Observed Frequency:

- **N = 143**
- If there was no relationship between the time period and political ideology, then we would expect the total number of cross-party judges (40% or 144/360) since 1961 to be greater than or equal to the number of same-party judges (60% or 216/360), which it is not. Now we calculate the time period differential by expected frequency.

| **Cross-Party?** | **Time (Observed Frequency)** | | |
|---|---|---|---|
| | **2001-2013** | **2013-2023** | **Total** |
| Yes | 27 | 14 | **41** |
| No | 46 | 56 | **102** |
| **Total** | **73** | **70** | **143** |

Expected Frequency:

- The following table shows the distribution of Expected Frequencies in blue. Expected Frequency is the cell frequencies we would expect if we accepted our null hypothesis that there is *no* relationship between time period and political ideology.

| **Cross-Party?** | **Time (Expected Frequency)** | | |
|---|---|---|---|
| | **2001-2013** | **2013-2023** | **Total** |
| Yes | 20.9 | 20.1 | **41** |
| No | 52.1 | 49.9 | **102** |
| **Total** | **73** | **70** | **143** |

Chi-Square Calculation:

- To calculate the Chi-Square, I compared the Observed Frequencies with the Expected Frequencies.

**Chi-Square Formulas and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | **Total** |
|---|---|---|---|
| (20.9 - 27) | (20.9 - 27)2 | $[(20.9 - 27)^2] / 20.9$ | 1.760 |
| (52.1 - 46) | (52.1 - 46)2 | $[(52.1 - 46)^2] / 52.1$ | 0.708 |
| (20.1 - 14) | (20.1 - 14)2 | $[(20.1 - 14)^2] / 20.1$ | 1.836 |
| (49.9 - 56) | (49.9 - 56)2 | $[(49.9 - 56)^2] / 49.9$ | 0.738 |

**Chi-Square Calculations and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | Total |
|---|---|---|---|
| -6.0699 | 36.8441 | 1.7603 | 1.7603 |
| 6.0699 | 36.8441 | 0.7076 | 0.7076 |

| | | | |
|---|---|---|---|
| 6.0699 | 36.8441 | 1.8358 | 1.8358 |
| -6.0699 | 36.8441 | 0.7379 | 0.7379 |
| | | | **5.042** |

- Value of Chi-Square is calculated by totaling the values above: **5.042**

Calculated the Degrees of Freedom:

- Degree of Freedom determines the contingency for which the value of the Chi Square was computed. It is the product of the number of rows in the table minus the number of columns.
- Formula (Chi Table with two rows and two columns): **df = (2 - 1) x (2 - 1) = 1**
- Selected our degree of freedom: **1**

Selected the Alpha Mirroring Test One (above):

- I selected 0.5 for our Alpha (5% probability of making a Type I error)
  - **P < 0.05**
- Calculated the probability of exceeding the critical value using a Chi-Square Table (see below).

Created a Contingency Table:

- If the value of Chi-Square is large, then the size of the contingency table also needs to be large to reach statistical significance. The tighter the level of alpha (α), the larger the Chi-Square value needs to be, in order to reach statistical significance.

| | **Significance Level (α)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Degree of Freedom (df)** | 0.99 | 0.975 | 0.95 | 0.9 | 0.1 | 0.05 | 0.025 | 0.01 |
| **1** | 0.000 | 0.001 | 0.004 | 0.016 | 2.706 | 3.841 | 5.024 | 6.635 |
| **2** | 0.020 | 0.051 | 0.103 | 0.211 | 4.605 | 5.991 | 7.378 | 9.210 |
| **3** | 0.115 | 0.216 | 0.352 | 0.584 | 6.251 | 7.815 | 9.348 | 11.345 |
| **4** | 0.297 | 0.484 | 0.711 | 1.064 | 7.779 | 9.488 | 11.143 | 13.277 |
| **5** | 0.554 | 0.831 | 1.145 | 1.610 | 9.236 | 11.070 | 12.833 | 15.086 |
| **6** | 0.872 | 1.237 | 1.635 | 2.204 | 10.645 | 12.592 | 14.449 | 16.812 |
| **7** | 1.239 | 1.690 | 2.167 | 2.833 | 12.017 | 14.067 | 16.013 | 18.475 |
| **8** | 1.646 | 2.180 | 2.733 | 3.490 | 13.362 | 15.507 | 17.535 | 20.090 |
| **9** | 2.088 | 2.700 | 3.325 | 4.168 | 14.684 | 16.919 | 19.023 | 21.666 |
| **10** | 2.558 | 3.247 | 3.940 | 4.865 | 15.987 | 18.307 | 20.483 | 23.209 |

## 6. Interpreted the Results for Test Two

- The value of the Chi-Square (5.042) exceeds the value in the table for p =.05 and df = 1 (Chi Square = 3.84). We reject our null hypothesis (with a 5% probability of error) and accept the research hypothesis that there is a relationship between judges' ideology and the administration under which they choose to take senior status.
- Using the table above, our Chi Value of **5.042** exceeds 3.841. However, we may want to select a significance level of 0.025 for comparing the 2001 to 2013 and 2013 to 2023 time periods because the sample size is smaller. For the purposes of comparing all three time periods though, we will need to stay consistent in what significance level we apply. Considering this, P < 0.05 is still the best choice for alpha.
- Since our Chi Value of **5.042** exceeds **3.841** in the table where the level of alpha and degrees of freedom meet, we can assume "that the observed relationship between the two variables exists (at the specified level of probability of error, or alpha), and reject the null hypothesis." Therefore, there ***is*** a relationship between judges' ideology and the administration under which they choose to take senior status when comparing 1961-2001 and 2013-2023 time periods.

## (3) THIRD TEST: 1961 to 2001 *and* 2001 to 2013

Observed Frequency:

- **N = 290**
- If there was no relationship between the time period and political ideology, then we would expect the total number of cross-party judges (40% or 144/360) since 1961 to be greater than or equal to the number of same-party judges (60% or 216/360), which it is not. Now we calculate the time period differential by expected frequency.

| **Cross-Party?** | **Time (Observed Frequency)** | | |
|---|---|---|---|
| | **1961-2001** | **2001-2013** | **Total** |
| Yes | 103 | 27 | **130** |
| No | 114 | 46 | **160** |
| **Total** | **217** | **73** | **290** |

Expected Frequency:

- The following table shows the distribution of Expected Frequencies in blue. Expected Frequency is the cell frequencies we would expect if we accepted our null hypothesis that there is *no* relationship between time period and political ideology.

| **Cross-Party?** | **Time (Expected Frequency)** | | |
|---|---|---|---|
| | **1961-2001** | **2001-2013** | **Total** |
| Yes | 97.3 | 32.7 | **130** |

| | | | |
|---|---|---|---|
| No | 119.7 | 40.3 | **160** |
| **Total** | **217** | **73** | **290** |

Chi-Square Calculation:

- To calculate the Chi-Square, I compared the Observed Frequencies with the Expected Frequencies.

**Chi-Square Formulas and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | **Total** |
|---|---|---|---|
| (97.3 - 103) | $(97.3 - 103)^2$ | $[(97.3 - 103)^2] / 97.3$ | 0.337 |
| (119.7 - 114) | $(119.7 - 114)^2$ | $[(119.7 - 114)^2] / 119.7$ | 0.274 |
| (32.7 - 27) | $(32.7 - 27)^2$ | $[(32.7 - 27)^2] / 32.7$ | 1.001 |
| (40.3 - 46) | $(40.3 - 46)^2$ | $[(40.3 - 46)^2] / 40.3$ | 0.814 |

**Chi-Square Calculations and Total**

| $f_e - f_o$ | $(f_e - f_o)^2$ | $[(f_e - f_o)^2] / f_e$ | Total |
|---|---|---|---|
| -5.7241 | 32.7658 | 0.3368 | 0.3368 |
| 5.7241 | 32.7658 | 0.2737 | 0.2737 |
| 5.7241 | 32.7658 | 1.0013 | 1.0013 |
| -5.7241 | 32.7658 | 0.8135 | 0.8135 |
| | | | **2.425** |

- Value of Chi-Square is calculated by totaling the values above: **2.425**

Calculated the Degrees of Freedom:

- Degree of Freedom determines the contingency for which the value of the Chi Square was computed. It is the product of the number of rows in the table minus the number of columns.
- Formula (Chi Table with two rows and two columns): **df = (2 - 1) x (2 - 1) = 1**
- Selected our degree of freedom: **1**

Selected the Alpha Mirroring Test One (above):

- I selected 0.5 for our Alpha (5% probability of making a Type I error)
  - **P < 0.05**
- Calculated the probability of exceeding the critical value using a Chi-Square Table (see below).

Created a Contingency Table:

- If the value of Chi-Square is large, then the size of the contingency table also needs to be large to reach statistical significance. The tighter the level of alpha (α), the larger the Chi-Square value needs to be, in order to reach statistical significance.

| | **Significance Level (α)** |
|---|---|

| Degree of Freedom (df) | 0.99 | 0.975 | 0.95 | 0.9 | 0.1 | 0.05 | 0.025 | 0.01 |
|---|---|---|---|---|---|---|---|---|
| **1** | 0.000 | 0.001 | 0.004 | 0.016 | 2.706 | 3.841 | 5.024 | 6.635 |
| **2** | 0.020 | 0.051 | 0.103 | 0.211 | 4.605 | 5.991 | 7.378 | 9.210 |
| **3** | 0.115 | 0.216 | 0.352 | 0.584 | 6.251 | 7.815 | 9.348 | 11.345 |
| **4** | 0.297 | 0.484 | 0.711 | 1.064 | 7.779 | 9.488 | 11.143 | 13.277 |
| **5** | 0.554 | 0.831 | 1.145 | 1.610 | 9.236 | 11.070 | 12.833 | 15.086 |
| **6** | 0.872 | 1.237 | 1.635 | 2.204 | 10.645 | 12.592 | 14.449 | 16.812 |
| **7** | 1.239 | 1.690 | 2.167 | 2.833 | 12.017 | 14.067 | 16.013 | 18.475 |
| **8** | 1.646 | 2.180 | 2.733 | 3.490 | 13.362 | 15.507 | 17.535 | 20.090 |
| **9** | 2.088 | 2.700 | 3.325 | 4.168 | 14.684 | 16.919 | 19.023 | 21.666 |
| **10** | 2.558 | 3.247 | 3.940 | 4.865 | 15.987 | 18.307 | 20.483 | 23.209 |

7. Interpreted the Results for Test Two
    - The value of the Chi-Square (**2.425**) does **not** exceed the value in the table for p =.05 and df = 1 (Chi Square = 3.841). We accept our null hypothesis (with a 5% probability of error) and reject the research hypothesis that there is a relationship between judges' ideology and the administration under which they choose to take senior status.
    - Using the table above, our Chi Value of **2.425** does **NOT** exceed 3.841. However, we may want to select a significance level of 0.025 for comparing the 2001 to 2013 and 2013 to 2023 time periods because the sample size is smaller. For the purposes of comparing all three time periods though, we will need to stay consistent in the significance level that we apply. Considering this, $P < 0.05$ is still the best choice for alpha.
    - Since our Chi Value of **2.425** exceeds **3.841** in the table where the level of alpha and degrees of freedom meet, we can assume "that the observed relationship between the two variables exists (at the specified level of probability of error, or alpha), and reject the null hypothesis." Therefore, there ***is*** **NOT** a relationship between judges' ideology and the administration under which they choose to take senior status when comparing 1961-2001 and 2013-2023 time periods.

**---Findings from the three tests---**

- Because the Chi value of 16.534 exceeds the critical value of the Chi-Square distribution with *d* degrees of freedom for the periods between 1961-2001 and 2013-2023, there is a statistically significant relationship between judges taking senior status and political ideology before 2001 when compared to the pre-nuclear period.

- Because the Chi value of 5.042 exceeds the critical value of the Chi-Square distribution with *d* degrees of freedom for the periods between 2001-2013 and 2013-2023, there is a statistically significant relationship between judges taking senior status and political ideology shortly before the nuclear option. However, while the relationship between 2001-2013 and 2013-2023 appears less statistically significant than 1961-2001, the difference in a forty-year timeframe compared to ten and twelve-year timeframes, respectively, highlights the ideological significance of judges taking senior status after the nuclear option in 2013.

- Because the Chi value of 2.425 does not exceed the critical value of the Chi-Square distribution with *d* degrees of freedom for the periods between 1961-2001 and 2001-2013, there is not a statistically significant relationship between judges taking senior status and political ideology before 2001 when compared to post-2001.

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[i] This data excludes transitional periods in party control of the White House. In order to use Professor Hellyer's data, I needed to mirror it exactly. "Transitional periods in party control of White House" means the period between Election Day and Inauguration Day when party control of the White House is changing. Removing transitional judges from the data resulted in minor numerical differences from my previous work.

[ii] Data on senior status from January 20, 1961 to January 19, 2001 taken from the Federal Judicial Center's *Biographical Directory of Article III Federal Judges, 1789-present*, available at https://www.fjc.gov/history/judges (downloaded July 17, 2023).

[iii] Data on senior status from January 20, 1961 to January 19, 2001 taken from the Federal Judicial Center's *Biographical Directory of Article III Federal Judges, 1789-present*, available at https://www.fjc.gov/history/judges (downloaded July 17, 2023).

[iv] Data on senior status from November 21, 2013 to July 15, 2023 taken from the Federal Judicial Center's *Biographical Directory of Article III Federal Judges, 1789-present*, available at https://www.fjc.gov/history/judges (downloaded July 17, 2023).

[v] https://home.csulb.edu/~msaintg/ppa696/696stsig.htm

[vi] *supra* note VI.

[vii] https://meera.seas.umich.edu/power-analysis-statistical-significance-effect-size.html