qwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmrtyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnmqwertyuiopasdfghjklzxcvbnm

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| Green house gas emissions  Variation by State  4/10/2016  Daljeet Maken |

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Green house gas emissions: Variation by State

# Introduction

The questions of interest in this study is whether the Green House Gas emission GHG varies by state and whether there is any difference among the mean scores of GHG measures.

For the test type main effect, the null hypothesis is that the mean GHG emission for all the states are the same:

The alternative hypothesis is that at least one of the state’s GHG score is different:

# Methods

This study was conducted at the Penn State University with the data from CAIT. CAIT’s Historic data allows for easy analysis and visualization of the latest available international greenhouse gas emissions data. It includes information for 186 countries, 50 U.S. states, 6 gases, multiple economic sectors, and 160 years - carbon dioxide emissions for 1850-2012 and multi-sector greenhouse gas emission for 1990-2012. For our analysis we have only used the State data and total emissions.

This is therefore an observational study with the factors as State (Fixed: since we have data for all 52 states). The independent variable is the total GHG emission. We will also evaluate if Population of the state can be used as a covariate for this analysis.

# Analysis

## Exploratory Data Analysis / One-way Anova

The first step is to plot some of the states against the total GHG emissions.



Let’s perform a simple One-Way Anova and get the 4-way graph:



We see that residuals show some fanning effect and the normality plot line is curved. So we try the Box-Cox transformation:



We get a λ = 0.13 and therefore add a new column GHG\_trans with:

GHG\_trans = GHG^0.13

We run the Anova again and get the following plot:



It is clear that the variance distribution has improved significantly and the normality plot line is less curved than before.

The ANOVA results are:

Analysis of Variance

Source DF Adj SS Adj MS F-Value P-Value

State 50 75.3833 1.50767 3600.45 0.000

Error 1312 0.5494 0.00042

Total 1362 75.9327

This clearly indicates that we can safely reject the null hypothesis and conclude that the means of GHG emissions are different for states. The comparison with tukey test is in the appendix.

## Covariate Analysis

We will also like to analyze the possibility of using the population as a covariate. This requires that we first perform various steps to determine whether ANCOVA is suitable in the given scenario. The steps are:

**Step 1: Are all regression slopes = 0**

We carry out this step for some of the states to see the trend of data. The relevant results are below with the significant figures highlighted.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| State = Alaska | | | | | | |
| **Analysis of Variance** | | | | | | |
| **Source** | | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | | 1 | 3.39017 | 3.39017 | 0.29 | 0.5963 |
| **Error** | | 20 | 233.98464 | 11.69923 |  |  |
| **Corrected Total** | | 21 | 237.37481 |  |  |  |

|  |
| --- |
| State = Arizona |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 3932.32735 | 3932.32735 | 220.44 | <.0001 |
| **Error** | 20 | 356.76285 | 17.83814 |  |  |
| **Corrected Total** | 21 | 4289.09020 |  |  |  |

|  |
| --- |
| State = Arkansas |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 692.44318 | 692.44318 | 79.03 | <.0001 |
| **Error** | 20 | 175.23480 | 8.76174 |  |  |
| **Corrected Total** | 21 | 867.67798 |  |  |  |

|  |
| --- |
| State = Delaware |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 47.29983 | 47.29983 | 31.15 | <.0001 |
| **Error** | 20 | 30.36611 | 1.51831 |  |  |
| **Corrected Total** | 21 | 77.66594 |  |  |  |

|  |
| --- |
| State = Florida |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 11614 | 11614 | 58.95 | <.0001 |
| **Error** | 20 | 3939.91709 | 196.99585 |  |  |
| **Corrected Total** | 21 | 15554 |  |  |  |

|  |
| --- |
| State = Georgia |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 4291.46549 | 4291.46549 | 41.17 | <.0001 |
| **Error** | 20 | 2084.70167 | 104.23508 |  |  |
| **Corrected Total** | 21 | 6376.16716 |  |  |  |

|  |
| --- |
| State = Hawaii |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 8.36717 | 8.36717 | 3.04 | 0.0964 |
| **Error** | 20 | 54.98731 | 2.74937 |  |  |
| **Corrected Total** | 21 | 63.35448 |  |  |  |

|  |
| --- |
| State = Idaho |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 204.98965 | 204.98965 | 288.90 | <.0001 |
| **Error** | 20 | 14.19094 | 0.70955 |  |  |
| **Corrected Total** | 21 | 219.18058 |  |  |  |

|  |
| --- |
| State = Illinois |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 4724.17871 | 4724.17871 | 63.86 | <.0001 |
| **Error** | 20 | 1479.47564 | 73.97378 |  |  |
| **Corrected Total** | 21 | 6203.65436 |  |  |  |

|  |
| --- |
| State = Texas |

| **Analysis of Variance** | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Source** | | | | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | | | | 1 | 11169 | 11169 | 8.55 | 0.0084 |
| **Error** | | | | 20 | 26142 | 1307.10175 |  |  |
| **Corrected Total** | | | | 21 | 37311 |  |  |  |
|  |  |  |  |

|  |
| --- |
| State = Virginia |

| **Analysis of Variance** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 1 | 91.72587 | 91.72587 | 1.30 | 0.2670 |
| **Error** | 20 | 1406.71563 | 70.33578 |  |  |
| **Corrected Total** | 21 | 1498.44150 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

**Finding:**

We find that we can reject the null hypothesis that regression=0 for most of the states. The highlighted values indicate that we have a significant relationship between green house gas emission and population.

**Step 2: Are the slopes equal?**

In order to check this condition we perform the

|  |
| --- |
| State = Covariance test for equal slopes |

The Mixed Procedure

| **Type 3 Tests of Fixed Effects** | | | | |
| --- | --- | --- | --- | --- |
| **Effect** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| **State** | 50 | 1019 | 30.68 | <.0001 |
| **Pop** | 1 | 1019 | 4.32 | 0.0380 |
| **Pop\*State** | 50 | 1019 | 6.70 | <.0001 |

The results for covariate regression slopes (re-parameterization of ANCOVA)

**Finding:**

Here we see that the slope is not equal. Therefore we can’t simply remove the interaction term and compare the treatment means at the mean level of the covariate.

# Results and Conclusion

The simple one-way ANOVA indicated that the null hypothesis that all states have same mean GHG emissions can be rejected. We also observer that while the covariate population is significant it has different slopes for different states and therefore we can’t simply remove the interaction term and compare the treatment means at the mean level of the covariate.

# References

* Penn State University online notes:
* Dataset from CAIT: http://www.wri.org/resources/data-sets/cait-historical-emissions-data-countries-us-states-unfccc

# Appendices

## Appendix A – One-Way Anova – Tukey test comparsion results

Means

State N Mean StDev 95% CI

Alabama 22 1.93407 0.01589 (1.92551, 1.94263)

Alaska 43 1.66006 0.01459 (1.65394, 1.66618)

Arizona 44 1.79945 0.03640 (1.79340, 1.80550)

Arkansas 44 1.76417 0.01916 (1.75812, 1.77022)

California 22 2.20528 0.01482 (2.19672, 2.21384)

Colorado 22 1.83306 0.03537 (1.82451, 1.84162)

Connecticut 22 1.63678 0.01334 (1.62822, 1.64534)

Delaware 44 1.45127 0.02188 (1.44522, 1.45732)

DistrictOfColumbia 22 1.22491 0.01753 (1.21635, 1.23347)

Florida 44 2.05464 0.02873 (2.04859, 2.06069)

Georgia 44 1.95861 0.02547 (1.95256, 1.96466)

Hawaii 44 1.49997 0.01428 (1.49391, 1.50602)

Idaho 44 1.51684 0.02625 (1.51079, 1.52289)

Illinois 44 2.06636 0.01754 (2.06031, 2.07241)

Indiana 22 2.05346 0.02230 (2.04490, 2.06201)

Iowa 22 1.85002 0.02320 (1.84146, 1.85858)

Kansas 22 1.83085 0.01254 (1.82229, 1.83940)

Kentucky 22 1.94224 0.01977 (1.93368, 1.95080)

Louisiana 22 2.03647 0.01204 (2.02791, 2.04503)

Maine 22 1.50374 0.01830 (1.49518, 1.51230)

Maryland 22 1.77894 0.01585 (1.77038, 1.78749)

Massachusetts 22 1.78757 0.01259 (1.77901, 1.79613)

Michigan 22 2.00299 0.01421 (1.99443, 2.01155)

Minnesota 22 1.85589 0.01698 (1.84733, 1.86445)

Mississippi 22 1.74297 0.02730 (1.73441, 1.75153)

Missouri 22 1.92421 0.02514 (1.91565, 1.93277)

Montana 22 1.63517 0.01764 (1.62661, 1.64373)

Nebraska 22 1.73662 0.02739 (1.72807, 1.74518)

Nevada 22 1.63287 0.02704 (1.62431, 1.64143)

NewHampshire 22 1.45421 0.02098 (1.44566, 1.46277)

NewJersey 22 1.88546 0.01151 (1.87690, 1.89402)

NewMexico 22 1.74332 0.02196 (1.73476, 1.75188)

NewYork 22 2.02610 0.01598 (2.01754, 2.03466)

NorthCarolina 22 1.92988 0.02506 (1.92132, 1.93844)

NorthDakota 22 1.69814 0.01993 (1.68958, 1.70670)

Ohio 22 2.09447 0.01252 (2.08592, 2.10303)

Oklahoma 22 1.88374 0.01526 (1.87518, 1.89230)

Oregon 22 1.65904 0.01882 (1.65048, 1.66759)

Pennsylvania 22 2.10111 0.01004 (2.09255, 2.10967)

RhodeIsland 22 1.39495 0.01800 (1.38639, 1.40351)

SouthCarolina 22 1.78415 0.03023 (1.77560, 1.79271)

SouthDakota 22 1.55030 0.02021 (1.54174, 1.55885)

Tennessee 22 1.89246 0.01959 (1.88390, 1.90102)

Texas 44 2.37215 0.01700 (2.36609, 2.37820)

Utah 22 1.74018 0.01960 (1.73162, 1.74874)

Vermont 22 1.30146 0.00975 (1.29291, 1.31002)

Virginia 44 1.89404 0.01509 (1.88799, 1.90009)

Washington 22 1.80196 0.01169 (1.79340, 1.81052)

WestVirginia 22 1.88845 0.01262 (1.87989, 1.89701)

Wisconsin 22 1.86497 0.01420 (1.85641, 1.87353)

Wyoming 22 1.77205 0.01502 (1.76349, 1.78061)

Pooled StDev = 0.0204632

**Tukey Pairwise Comparisons**

Grouping Information Using the Tukey Method and 95% Confidence

State N Mean Grouping

Texas 44 2.37215 A

California 22 2.20528 B

Pennsylvania 22 2.10111 C

Ohio 22 2.09447 C

Illinois 44 2.06636 D

Florida 44 2.05464 D E

Indiana 22 2.05346 D E

Louisiana 22 2.03647 E F

NewYork 22 2.02610 F G

Michigan 22 2.00299 G

Georgia 44 1.95861 H

Kentucky 22 1.94224 H I

Alabama 22 1.93407 I

NorthCarolina 22 1.92988 I

Missouri 22 1.92421 I

Virginia 44 1.89404 J

Tennessee 22 1.89246 J

WestVirginia 22 1.88845 J K

NewJersey 22 1.88546 J K

Oklahoma 22 1.88374 J K

Wisconsin 22 1.86497 K L

Minnesota 22 1.85589 L M

Iowa 22 1.85002 L M N

Colorado 22 1.83306 M N

Kansas 22 1.83085 N

Washington 22 1.80196 O

Arizona 44 1.79945 O

Massachusetts 22 1.78757 O P

SouthCarolina 22 1.78415 O P Q

Maryland 22 1.77894 O P Q

Wyoming 22 1.77205 P Q

Arkansas 44 1.76417 Q R

NewMexico 22 1.74332 R S

Mississippi 22 1.74297 R S

Utah 22 1.74018 S

Nebraska 22 1.73662 S

NorthDakota 22 1.69814 T

Alaska 43 1.66006 U

Oregon 22 1.65904 U V

Connecticut 22 1.63678 V W

Montana 22 1.63517 V W

Nevada 22 1.63287 W

SouthDakota 22 1.55030 X

Idaho 44 1.51684 Y

Maine 22 1.50374 Y

Hawaii 44 1.49997 Y

NewHampshire 22 1.45421 Z

Delaware 44 1.45127 Z

RhodeIsland 22 1.39495 AA

Vermont 22 1.30146 AB

DistrictOfColumbia 22 1.22491 AC

Means that do not share a letter are significantly different.

## Appendix B – Re-parameterizaton of ANCOVA

|  |
| --- |
| Reparameterizaton of ANCOVA |

The Mixed Procedure

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.GHGALLSTATEDATA |
| **Dependent Variable** | GHG |
| **Covariance Structure** | Diagonal |
| **Estimation Method** | REML |
| **Residual Variance Method** | Profile |
| **Fixed Effects SE Method** | Model-Based |
| **Degrees of Freedom Method** | Residual |

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **State** | 51 | Alabama Alaska Arizona Arkansas Californ Colorado Connecti Delaware District Florida Georgia Hawaii Idaho Illinois Indiana Iowa Kansas Kentucky Louisian Maine Maryland Massachu Michigan Minnesot Mississi Missouri Montana Nebraska Nevada NewHamps NewJerse NewMexic NewYork NorthCar NorthDak Ohio Oklahoma Oregon Pennsylv RhodeIsl SouthCar SouthDak Tennesse Texas Utah Vermont Virginia Washingt WestVirg Wisconsi Wyoming |

| **Dimensions** | |
| --- | --- |
| **Covariance Parameters** | 1 |
| **Columns in X** | 102 |
| **Columns in Z** | 0 |
| **Subjects** | 1 |
| **Max Obs per Subject** | 1121 |

| **Number of Observations** | |
| --- | --- |
| **Number of Observations Read** | 1121 |
| **Number of Observations Used** | 1121 |
| **Number of Observations Not Used** | 0 |

| **Covariance Parameter Estimates** | |
| --- | --- |
| **Cov Parm** | **Estimate** |
| **Residual** | 73.4258 |

| **Fit Statistics** | |
| --- | --- |
| **-2 Res Log Likelihood** | 8817.1 |
| **AIC (Smaller is Better)** | 8819.1 |
| **AICC (Smaller is Better)** | 8819.1 |
| **BIC (Smaller is Better)** | 8824.0 |

| **Solution for Fixed Effects** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Effect** | **State** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **State** | **Alabama** | 60.8223 | 37.8452 | 1019 | 1.61 | 0.1083 |
| **State** | **Alaska** | 54.9541 | 26.1305 | 1019 | 2.10 | 0.0357 |
| **State** | **Arizona** | 14.7786 | 10.8018 | 1019 | 1.37 | 0.1716 |
| **State** | **Arkansas** | -7.1765 | 28.1274 | 1019 | -0.26 | 0.7987 |
| **State** | **Californ** | 194.18 | 26.4023 | 1019 | 7.35 | <.0001 |
| **State** | **Colorado** | -8.7954 | 14.5088 | 1019 | -0.61 | 0.5445 |
| **State** | **Connecti** | 41.5944 | 62.6203 | 1019 | 0.66 | 0.5067 |
| **State** | **Delaware** | 33.5036 | 19.8443 | 1019 | 1.69 | 0.0917 |
| **State** | **District** | 16.8321 | 69.7421 | 1019 | 0.24 | 0.8093 |
| **State** | **Florida** | 60.4871 | 15.6308 | 1019 | 3.87 | 0.0001 |
| **State** | **Georgia** | 65.2592 | 14.7084 | 1019 | 4.44 | <.0001 |
| **State** | **Hawaii** | 12.1011 | 31.3665 | 1019 | 0.39 | 0.6997 |
| **State** | **Idaho** | 1.8092 | 13.9006 | 1019 | 0.13 | 0.8965 |
| **State** | **Illinois** | -167.46 | 54.1129 | 1019 | -3.09 | 0.0020 |
| **State** | **Indiana** | -38.6830 | 38.7282 | 1019 | -1.00 | 0.3181 |
| **State** | **Iowa** | -270.40 | 68.1410 | 1019 | -3.97 | <.0001 |
| **State** | **Kansas** | -0.4437 | 44.4712 | 1019 | -0.01 | 0.9920 |
| **State** | **Kentucky** | -55.1326 | 36.7752 | 1019 | -1.50 | 0.1341 |
| **State** | **Louisian** | 223.12 | 79.4912 | 1019 | 2.81 | 0.0051 |
| **State** | **Maine** | 4.8430 | 64.1443 | 1019 | 0.08 | 0.9398 |
| **State** | **Maryland** | 55.7484 | 31.2285 | 1019 | 1.79 | 0.0745 |
| **State** | **Massachu** | 180.30 | 64.2643 | 1019 | 2.81 | 0.0051 |
| **State** | **Michigan** | 57.9364 | 81.6941 | 1019 | 0.71 | 0.4784 |
| **State** | **Minnesot** | 6.1541 | 30.7490 | 1019 | 0.20 | 0.8414 |
| **State** | **Mississi** | -102.47 | 42.3079 | 1019 | -2.42 | 0.0156 |
| **State** | **Missouri** | -111.95 | 37.8369 | 1019 | -2.96 | 0.0032 |
| **State** | **Montana** | -5.6585 | 29.7431 | 1019 | -0.19 | 0.8492 |
| **State** | **Nebraska** | -116.20 | 42.3851 | 1019 | -2.74 | 0.0062 |
| **State** | **Nevada** | 29.7448 | 7.7159 | 1019 | 3.85 | 0.0001 |
| **State** | **NewHamps** | -3.5209 | 29.8632 | 1019 | -0.12 | 0.9062 |
| **State** | **NewJerse** | 76.1767 | 45.5974 | 1019 | 1.67 | 0.0951 |
| **State** | **NewMexic** | 2.8004 | 20.9696 | 1019 | 0.13 | 0.8938 |
| **State** | **NewYork** | 330.51 | 82.5289 | 1019 | 4.00 | <.0001 |
| **State** | **NorthCar** | 67.6622 | 16.2613 | 1019 | 4.16 | <.0001 |
| **State** | **NorthDak** | -153.89 | 98.5391 | 1019 | -1.56 | 0.1187 |
| **State** | **Ohio** | -53.3863 | 106.36 | 1019 | -0.50 | 0.6158 |
| **State** | **Oklahoma** | -9.7256 | 34.8051 | 1019 | -0.28 | 0.7800 |
| **State** | **Oregon** | 13.2762 | 21.0687 | 1019 | 0.63 | 0.5287 |
| **State** | **Pennsylv** | 428.39 | 99.5610 | 1019 | 4.30 | <.0001 |
| **State** | **RhodeIsl** | 11.6790 | 86.4965 | 1019 | 0.14 | 0.8926 |
| **State** | **SouthCar** | -15.3311 | 20.9489 | 1019 | -0.73 | 0.4644 |
| **State** | **SouthDak** | -29.4435 | 40.5089 | 1019 | -0.73 | 0.4675 |
| **State** | **Tennesse** | 89.9190 | 22.9445 | 1019 | 3.92 | <.0001 |
| **State** | **Texas** | 584.87 | 15.0882 | 1019 | 38.76 | <.0001 |
| **State** | **Utah** | 34.5711 | 13.1126 | 1019 | 2.64 | 0.0085 |
| **State** | **Vermont** | 3.6071 | 55.2811 | 1019 | 0.07 | 0.9480 |
| **State** | **Virginia** | 110.67 | 22.9892 | 1019 | 4.81 | <.0001 |
| **State** | **Washingt** | 92.3350 | 19.6462 | 1019 | 4.70 | <.0001 |
| **State** | **WestVirg** | 364.68 | 199.49 | 1019 | 1.83 | 0.0678 |
| **State** | **Wisconsi** | 25.3571 | 41.0048 | 1019 | 0.62 | 0.5365 |
| **State** | **Wyoming** | 22.2365 | 28.6672 | 1019 | 0.78 | 0.4381 |
| **Pop\*State** | **Alabama** | 0.000022 | 8.487E-6 | 1019 | 2.61 | 0.0091 |
| **Pop\*State** | **Alaska** | -8.77E-6 | 0.000041 | 1019 | -0.21 | 0.8299 |
| **Pop\*State** | **Arizona** | 0.000015 | 2.056E-6 | 1019 | 7.32 | <.0001 |
| **Pop\*State** | **Arkansas** | 0.000032 | 0.000011 | 1019 | 3.07 | 0.0022 |
| **Pop\*State** | **Californ** | 7.205E-6 | 0 | 1019 | Infty | <.0001 |
| **Pop\*State** | **Colorado** | 0.000027 | 3.363E-6 | 1019 | 8.03 | <.0001 |
| **Pop\*State** | **Connecti** | 8.011E-7 | 0.000018 | 1019 | 0.04 | 0.9650 |
| **Pop\*State** | **Delaware** | -0.00002 | 0.000025 | 1019 | -0.80 | 0.4224 |
| **Pop\*State** | **District** | -0.00002 | 0.000120 | 1019 | -0.17 | 0.8628 |
| **Pop\*State** | **Florida** | 0.000012 | 0 | 1019 | Infty | <.0001 |
| **Pop\*State** | **Georgia** | 0.000014 | 1.773E-6 | 1019 | 7.65 | <.0001 |
| **Pop\*State** | **Hawaii** | 8.503E-6 | 0.000025 | 1019 | 0.34 | 0.7358 |
| **Pop\*State** | **Idaho** | 0.000018 | 0.000010 | 1019 | 1.67 | 0.0951 |
| **Pop\*State** | **Illinois** | 0.000035 | 4.388E-6 | 1019 | 8.02 | <.0001 |
| **Pop\*State** | **Indiana** | 0.000048 | 6.36E-6 | 1019 | 7.57 | <.0001 |
| **Pop\*State** | **Iowa** | 0.000131 | 0.000023 | 1019 | 5.64 | <.0001 |
| **Pop\*State** | **Kansas** | 0.000039 | 0.000017 | 1019 | 2.37 | 0.0179 |
| **Pop\*State** | **Kentucky** | 0.000055 | 9.074E-6 | 1019 | 6.01 | <.0001 |
| **Pop\*State** | **Louisian** | 3.335E-6 | 0.000018 | 1019 | 0.19 | 0.8527 |
| **Pop\*State** | **Maine** | 0.000014 | 0.000050 | 1019 | 0.29 | 0.7754 |
| **Pop\*State** | **Maryland** | 5.323E-6 | 5.839E-6 | 1019 | 0.91 | 0.3622 |
| **Pop\*State** | **Massachu** | -0.00001 | 0.000010 | 1019 | -1.45 | 0.1480 |
| **Pop\*State** | **Michigan** | 0.000015 | 8.316E-6 | 1019 | 1.86 | 0.0638 |
| **Pop\*State** | **Minnesot** | 0.000022 | 6.249E-6 | 1019 | 3.60 | 0.0003 |
| **Pop\*State** | **Mississi** | 0.000062 | 0.000015 | 1019 | 4.13 | <.0001 |
| **Pop\*State** | **Missouri** | 0.000048 | 6.744E-6 | 1019 | 7.04 | <.0001 |
| **Pop\*State** | **Montana** | 0.000055 | 0.000033 | 1019 | 1.67 | 0.0943 |
| **Pop\*State** | **Nebraska** | 0.000109 | 0.000025 | 1019 | 4.40 | <.0001 |
| **Pop\*State** | **Nevada** | 6.881E-6 | 3.683E-6 | 1019 | 1.87 | 0.0620 |
| **Pop\*State** | **NewHamps** | 0.000017 | 0.000024 | 1019 | 0.72 | 0.4722 |
| **Pop\*State** | **NewJerse** | 6.605E-6 | 5.438E-6 | 1019 | 1.21 | 0.2248 |
| **Pop\*State** | **NewMexic** | 0.000038 | 0.000011 | 1019 | 3.32 | 0.0009 |
| **Pop\*State** | **NewYork** | -5.39E-6 | 4.374E-6 | 1019 | -1.23 | 0.2183 |
| **Pop\*State** | **NorthCar** | 0.000011 | 1.984E-6 | 1019 | 5.58 | <.0001 |
| **Pop\*State** | **NorthDak** | 0.000328 | 0.000152 | 1019 | 2.16 | 0.0310 |
| **Pop\*State** | **Ohio** | 0.000031 | 9.393E-6 | 1019 | 3.28 | 0.0011 |
| **Pop\*State** | **Oklahoma** | 0.000041 | 0.000010 | 1019 | 4.04 | <.0001 |
| **Pop\*State** | **Oregon** | 0.000011 | 6.135E-6 | 1019 | 1.71 | 0.0867 |
| **Pop\*State** | **Pennsylv** | -0.00001 | 8.071E-6 | 1019 | -1.27 | 0.2060 |
| **Pop\*State** | **RhodeIsl** | 1.263E-6 | 0.000083 | 1019 | 0.02 | 0.9879 |
| **Pop\*State** | **SouthCar** | 0.000025 | 5.135E-6 | 1019 | 4.88 | <.0001 |
| **Pop\*State** | **SouthDak** | 0.000077 | 0.000053 | 1019 | 1.45 | 0.1471 |
| **Pop\*State** | **Tennesse** | 8.012E-6 | 4.016E-6 | 1019 | 2.00 | 0.0463 |
| **Pop\*State** | **Texas** | 8.72E-6 | 0 | 1019 | Infty | <.0001 |
| **Pop\*State** | **Utah** | 0.000016 | 5.719E-6 | 1019 | 2.82 | 0.0050 |
| **Pop\*State** | **Vermont** | 6.607E-6 | 0.000091 | 1019 | 0.07 | 0.9424 |
| **Pop\*State** | **Virginia** | 3.578E-6 | 3.201E-6 | 1019 | 1.12 | 0.2640 |
| **Pop\*State** | **Washingt** | 8.457E-8 | 3.305E-6 | 1019 | 0.03 | 0.9796 |
| **Pop\*State** | **WestVirg** | -0.00013 | 0.000110 | 1019 | -1.16 | 0.2461 |
| **Pop\*State** | **Wisconsi** | 0.000018 | 7.632E-6 | 1019 | 2.33 | 0.0198 |
| **Pop\*State** | **Wyoming** | 0.000118 | 0.000057 | 1019 | 2.08 | 0.0380 |

| **Type 3 Tests of Fixed Effects** | | | | |
| --- | --- | --- | --- | --- |
| **Effect** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| **State** | 51 | 1019 | 35.69 | <.0001 |
| **Pop\*State** | 51 | 1019 | 20.24 | <.0001 |

| **Contrasts** | | | | |
| --- | --- | --- | --- | --- |
| **Label** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| **slopes equal hypothesis** | 1 | 1019 | 0.55 | 0.4582 |