The Great Migration

How Housing Prices are Influencing State Populations within the US

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Project Due Date: 3/16/2022

Part 1: Research Question

Do more people move based on cost of housing and income during times of economic uncertainty? Times of economic uncertainty in this timespan relate to the Great Recession (2008-2010) and, more recently, the impacts of COVID-19. While there are other conditions that cause economic hardship for different groups of people, everyone was affected by the two events stated earlier. Based on the inter-state migration of people in recent years, we are hypothesizing that the population for each state fluctuates based on the Housing Price Index and income.

Part 2: Significance of Research

Two members of the group live in states where there has been a huge influx of people from areas with higher housing costs recently, thus impacting housing prices in the new areas. By understanding this phenomenon via testing the hypothesis that more people are moving during times of economic uncertainty, like the COVID-19 pandemic, we may be able to better predict how housing costs impact population growth in each state. On a smaller level, this could help prepare people for what to expect in future housing searches. However, on a larger level, this could help people in the Planning, Development, and Survey sectors plan for more efficient types of infrastructure needed to support this influx of people.

Part 3: Datasets Used

The final dataset used for analysis consists of mean Housing Price Index, median income and population for each state for the years 2000-2020. The inputs for this final dataset consists of 5 separate datasets described below. Since most states have different costs of living, income, and data, the data was sorted by state to provide similar context for each data point.

The data for the Housing Price Index (HPI) was from the Master HPI database on the Federal Housing Finance Agency's website (https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#mpo).[1] The HPI is a measure of the average cost of homes on a monthly basis in thousands of dollars. In cleaning this data, the mean of the HPI values for each year by state (including Washington, D.C.) was used to show the growth of housing costs on an annual basis between 2000 and 2020.

The data for the median household income by state was taken from the U.S. Census Bureau, specifically

[1]Federal Housing Finance Agency. "Get Started Here:" House Price Index Datasets | Federal Housing Finance Agency. Federal Housing Finance Agency, April 1, 2021. https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#mpo

the table H-8 Median Household income by State from https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html.[2] The income data was already compiled on an annual basis, so the data for the years 2000-2020 was pulled and sorted by state. In doing so, it painted a clear picture of income trends over the past two decades.

The population data for 2000-2020 was broken in three tables in the U.S. Census Bureau website.

The data for 2000-2010 is from: https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html.[3] The data for 2010-2019 is from: https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-total.html.[4] Finally, the data for 2020 is from: https://www.census.gov/data/tables/time-series/demo/popest/2020s-state-total.html.[5]

The data in these three tables were already sorted by state and year, but required additional cleaning to be consistent with the other data.

Part 4: Data Preparation

A lot of the datasets used in this project needed to be cleaned and organized in order to get their values to line up with each other correctly. Within the HPI data, the column names needed to be matched with the new data frame and sorted by year. For the income data, we had to pull specific columns to exclude the standard error columns for each year and exclude the row containing the United States. We included only the years 2000-2020. There were also two "tables" in that excel file - one in "current dollars" and one in "2020 dollars". We went with the "current dollars" table since the HPI would be in the current dollars as well.

The majority of the location exclusions came in the census data, because the census includes territories such as Puerto Rico in the data while the HPI only included states and Washington, D.C. Cleaning and compiling the population data was a bit more tedious than the income data despite being from the same source. Not only was the population data split between three files, but there were also inconsistencies between the population state labels and the labels in the previously established dataset. There were some extra characters in the "State" column in each file. In order to get the population values to match the income and HPI data for each state, the data had to be cleaned in order to remove these excess characters and establish

[2]US Census Bureau. "Historical Income Tables: Households." Census.gov. US Census Bureau, November 8, 2021. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html

[3]US Census Bureau. "Historical Income Tables: Households." Census.gov. US Census Bureau, November 8, 2021. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html

[4]US Census Bureau. "State Intercensal Tables: 2000-2010." Census.gov. US Census Bureau, October 8, 2021. https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html

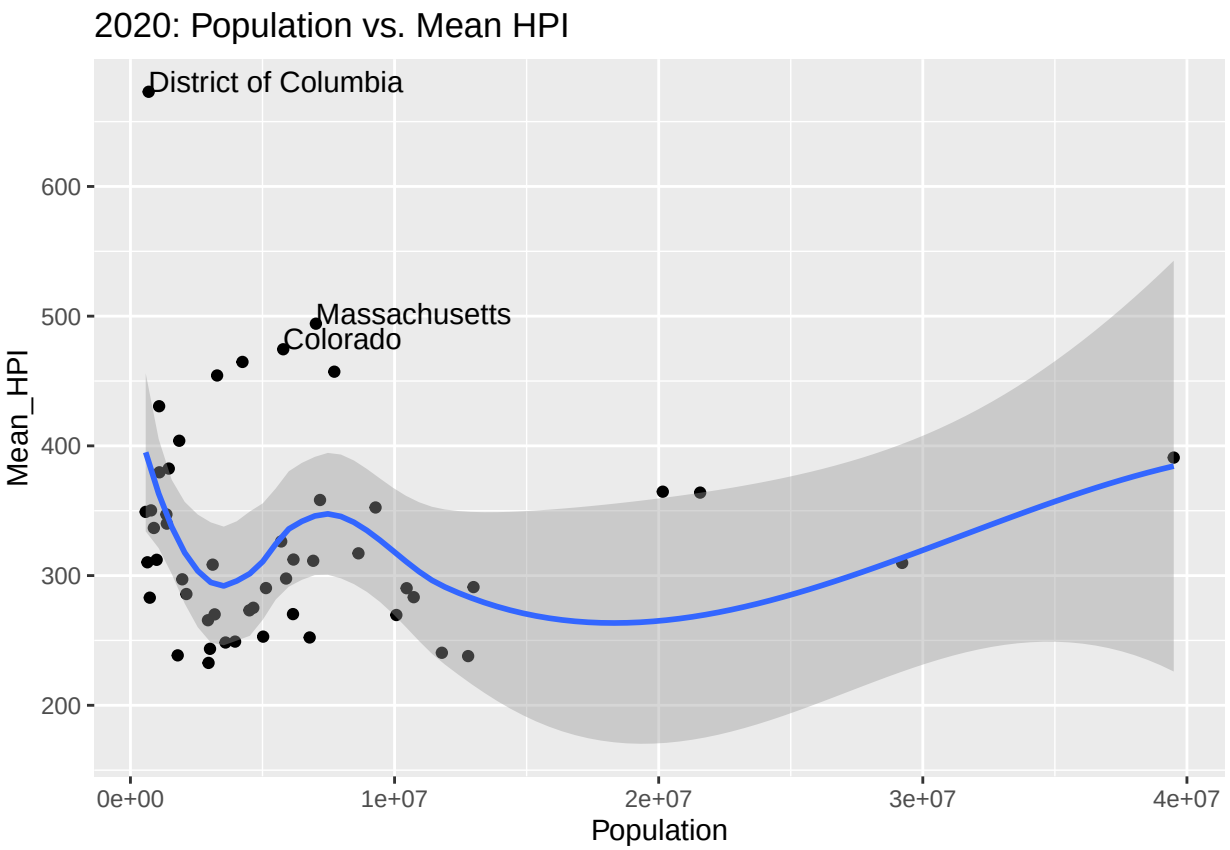
[5]US Census Bureau. "State Population Totals and Components of Change: 2010-2019." Census.gov. US Census Bureau, November 4, 2021. https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-total.html

consistency between the "State" columns.

When it comes to outliers, Washington, D.C. was the biggest and it heavily skewed the mean HPI data for places with lower populations (outputs 4.a and 5.a). In order to get a more realistic representation of the relation between HPI and median income, the data from Washington, D.C. had to be dropped. In doing so, it can be seen that there were a few states that did not fit the normal distribution that previously did (outputs 4.b and 5.b).

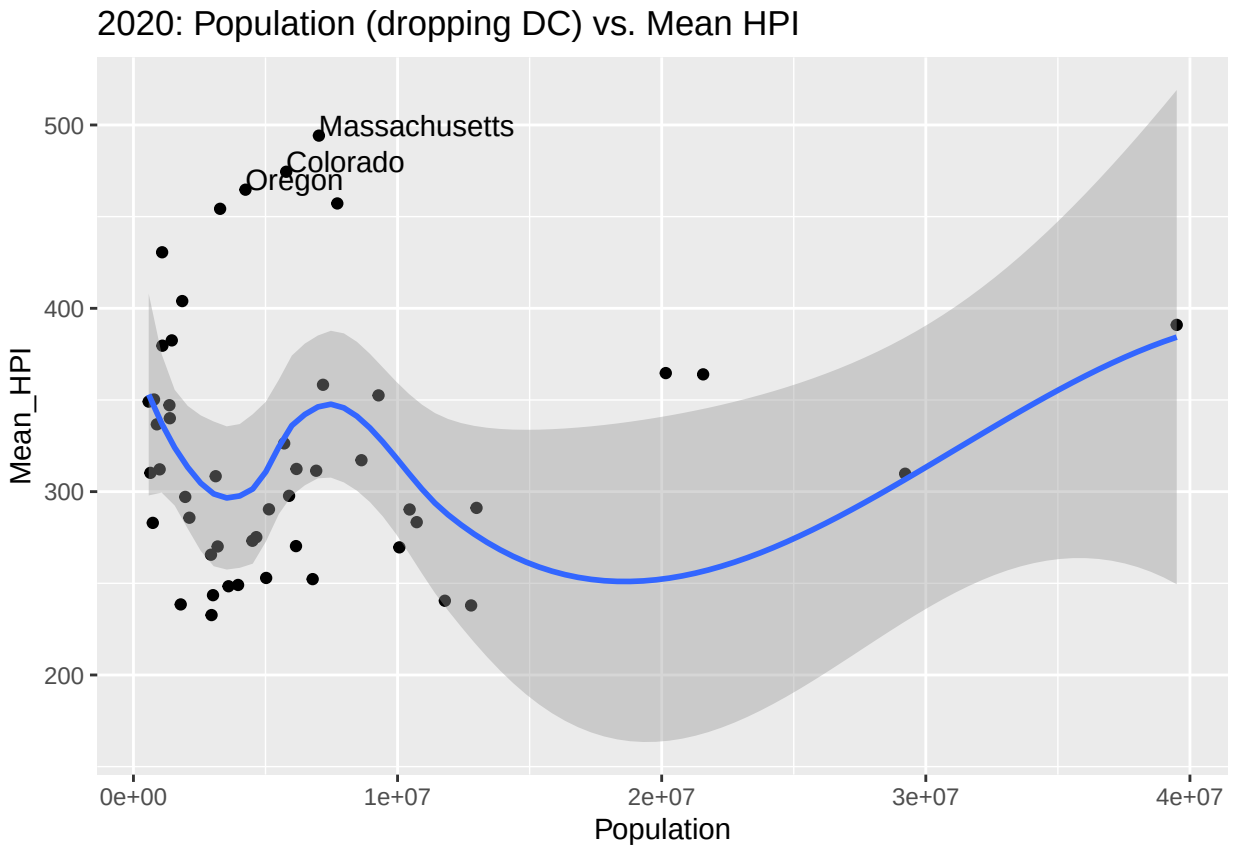
```
output_4.a
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



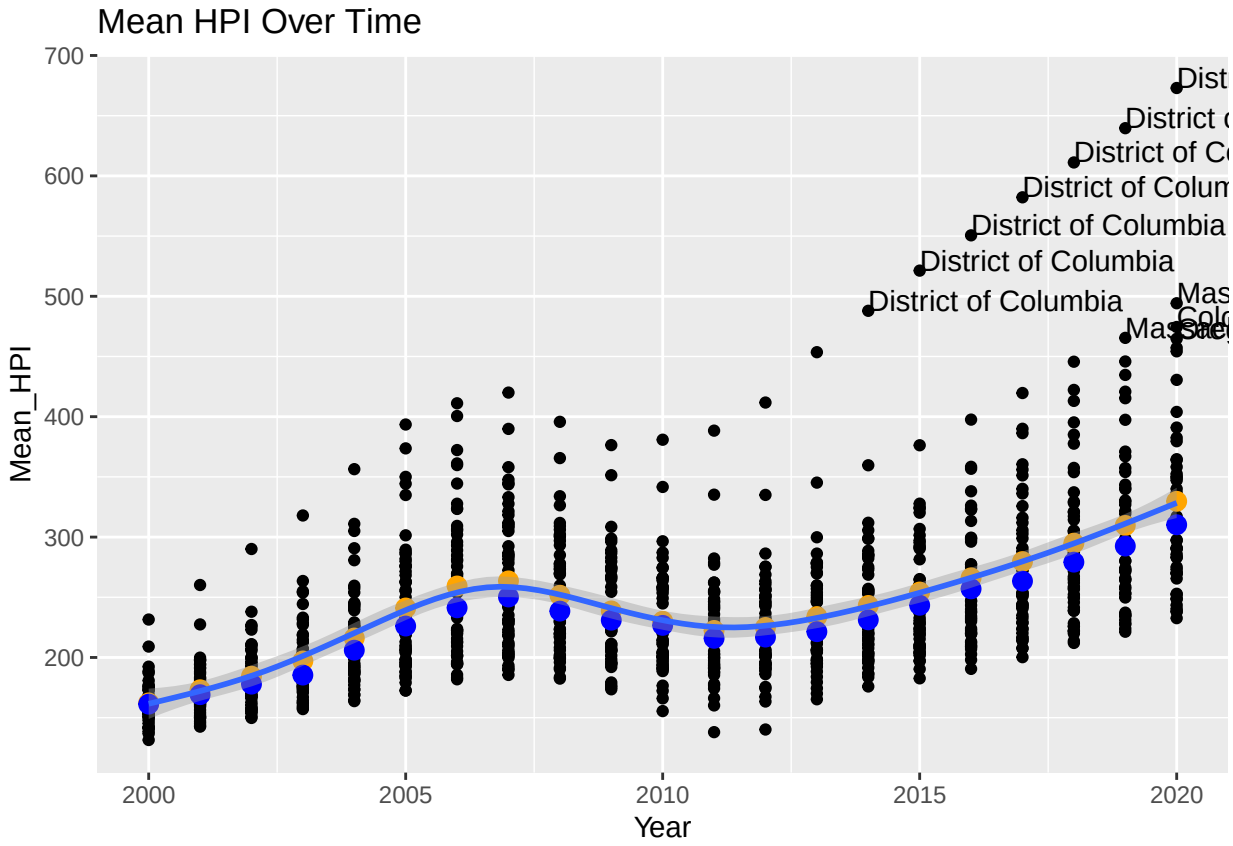

```
output_4.b
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



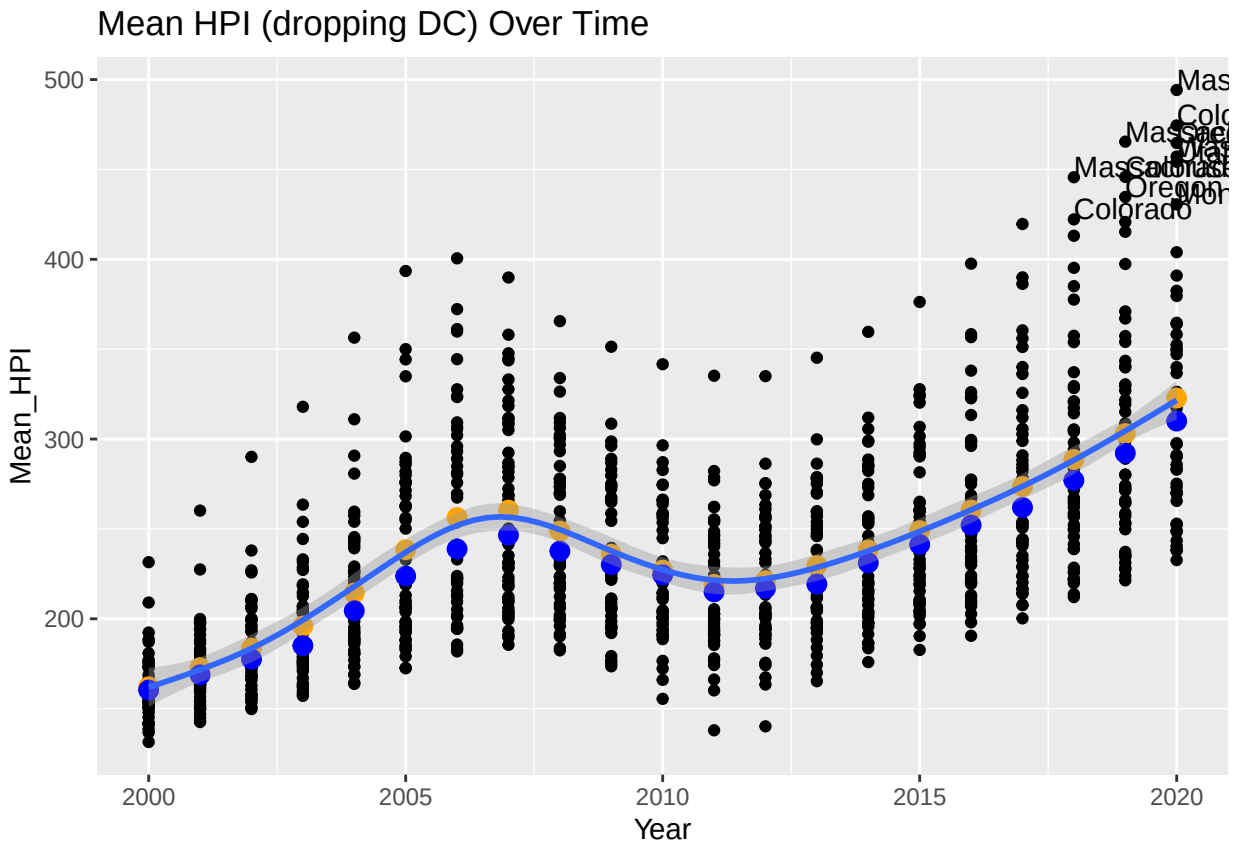

```
output_5.a
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
output_5.b
```

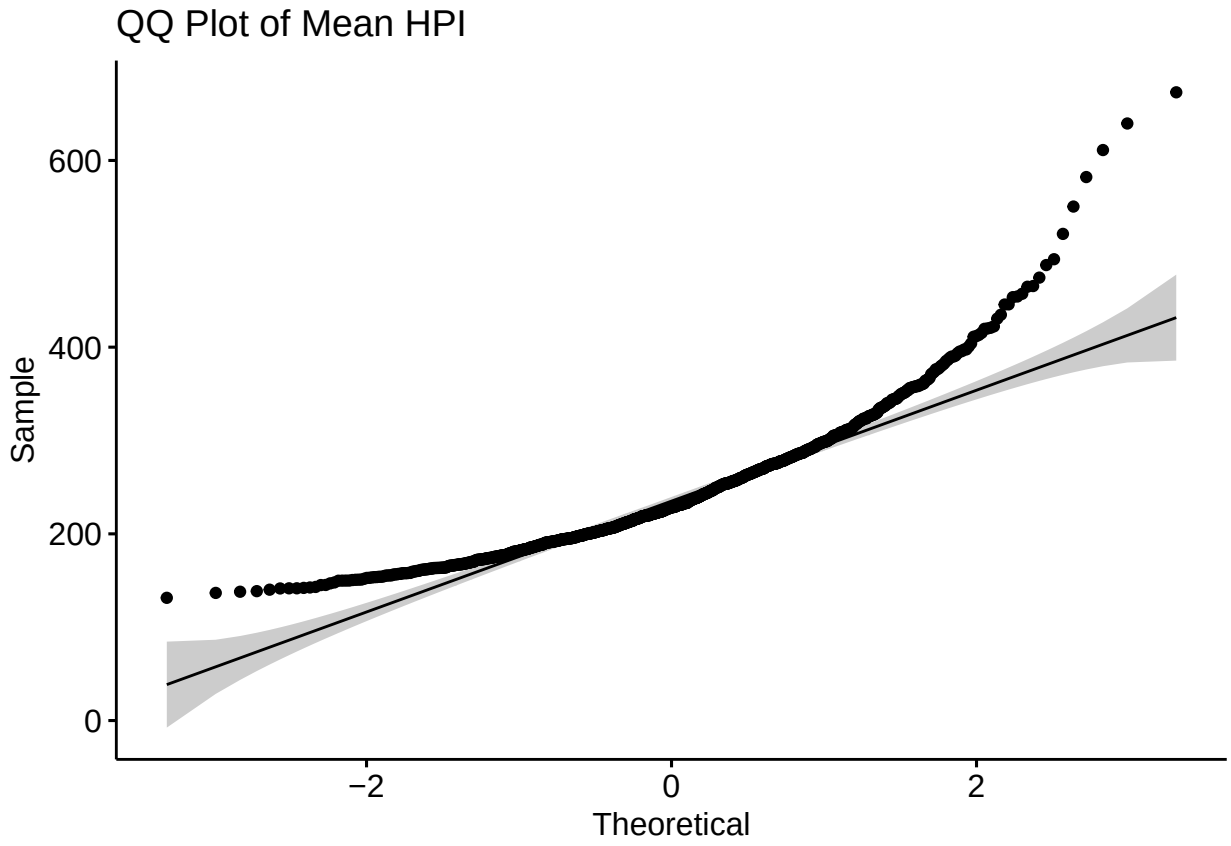
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



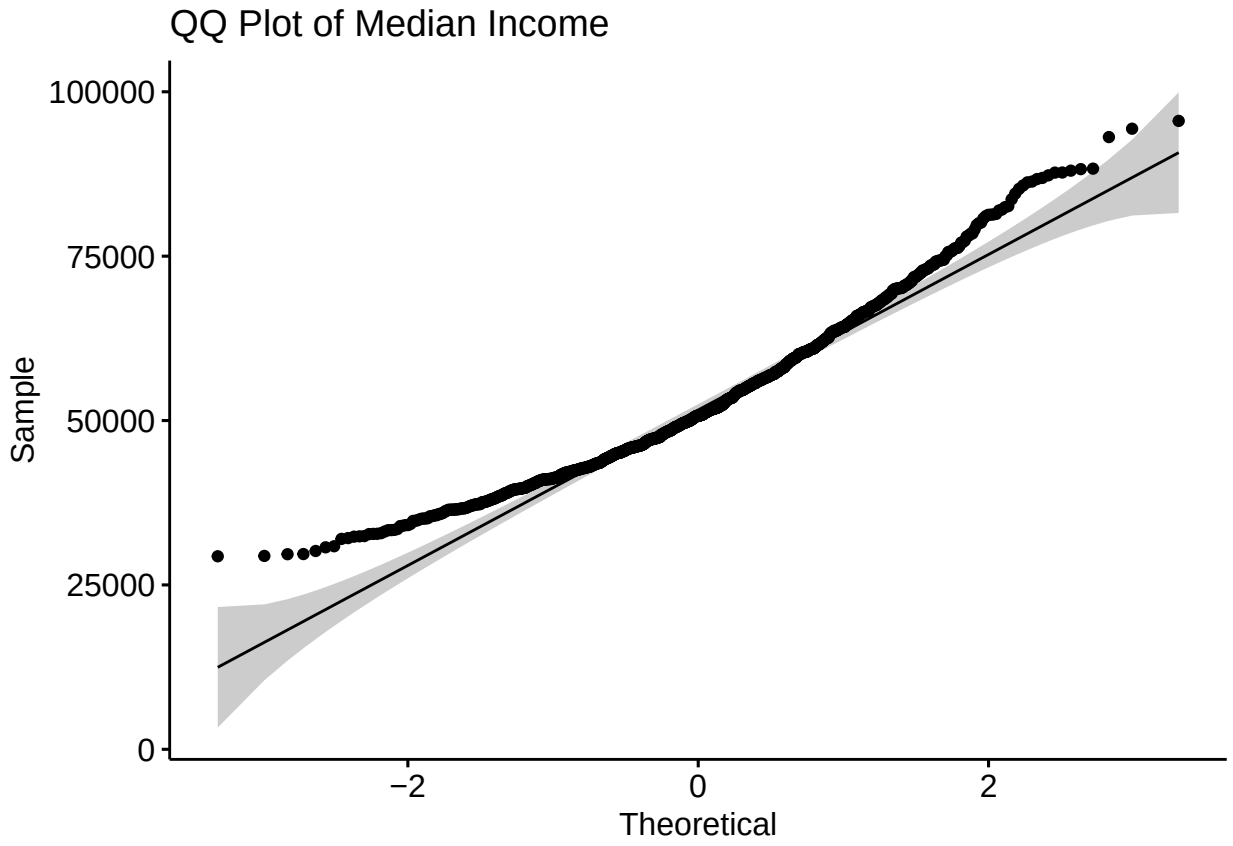
Part 5: Data Visualization

Here we visualize the data, generating QQ plots for mean HPI, median income, and state population. From outputs 1, 2, and 3, we see that the data is not normally distributed across each variable.

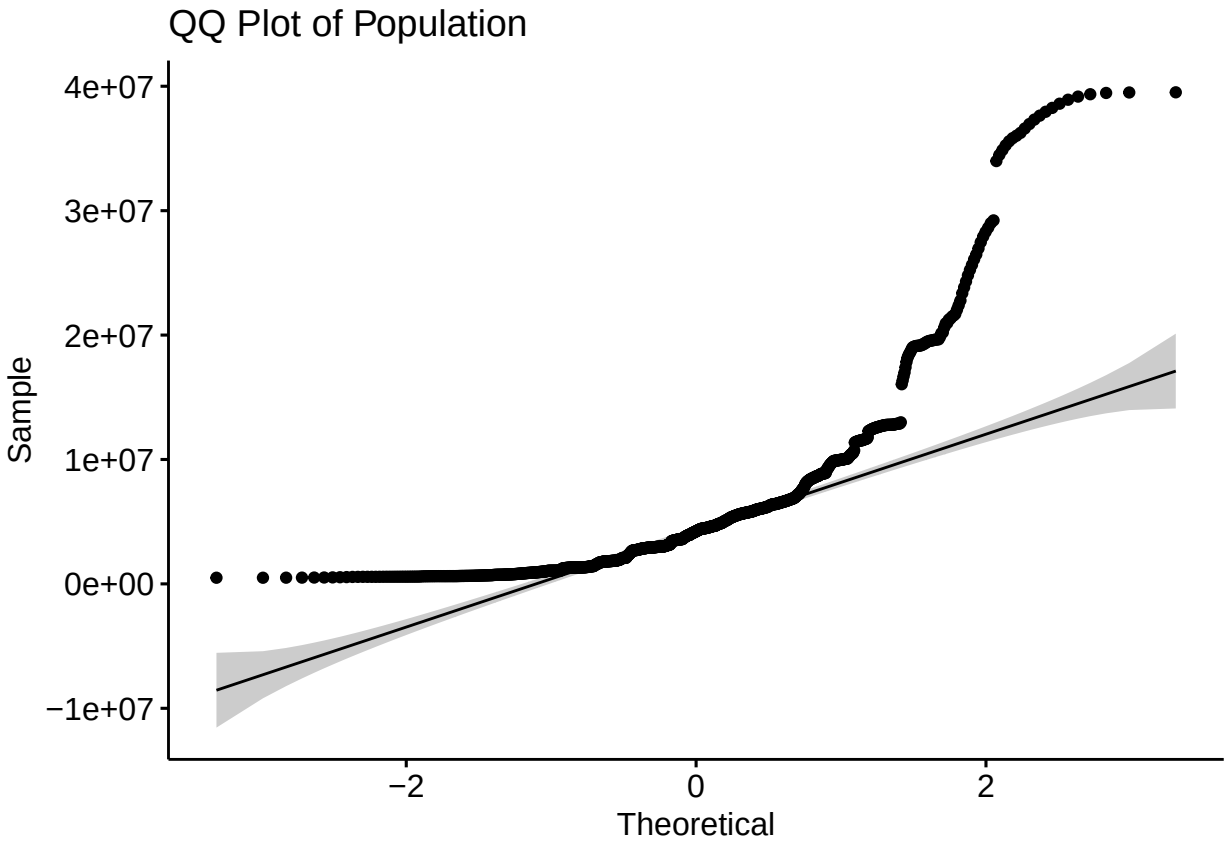
```
output_1
```




```
output_2
```


QQ Plot of Median Income
100000
75000
50000
25000
0
Sample
−2
0
2
Theoretical

```
output_3
```



Part 6: Methodology behind the Model

In this case, a linear model and a time series graph was used to get a clear picture of growth trends within the mean HPI, median income, and total population for each state from 2000 to 2020. The linear model is a model for a continuous outcome Y (i.e. population) based on the covariates X (i.e. mean HPI and median income), and can be used to fit linear models to data frames. Given a dataset of n statistical measures $\{y_i, x_{i1}, ..., x_{ip}\}_{i=1}^{n}$, the model takes on the form[6]:

$$y_i = \beta_0 + \beta_1 x_{i1} + ... + \beta_p x_{ip} + \epsilon_i, \quad i = 1, ..., n$$

The function "summary()" of the linear model in R is used to obtain and print a summary and analysis of the variance table of the results. R-squared values, p-values for co-variances X, and the overall p-value are included in the summary. The null hypothesis for the linear model is that the individual states' mean HPI and median income have no impact on their respective states' populations.

[6]Wikipedia. "Linear Regression." Wikipedia. Wikimedia Foundation, March 11, 2022. https://en.wikipedia.org/wiki/Linear_regression

The time series graph can be used to accurately show past data trends based on units of time, as well as forecast future statistics based on previous results. When it comes to forecasting and determining its error, there are multiple methods that can be used. While some are more accurate than others based on the application, in our case it was best to use Holt's method. Holt's method is found to be more accurate because it generates forecasts by providing more weight to recent trends as opposed to past observations.[7] Given that the time period of our data spans two decades, it was important to find a forecast that takes all of the data into consideration. The method used in determining the error of the forecast is Mean Absolute Percentage Error (MAPE). MAPE measures the performance of regression models in a percentage. It is found by comparing the forecasted value to the actual value using the following equation:

$$M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|$$

The lower the MAPE score, the more accurate the forecast is. Fortunately, running the "summary()" function on the Holt model within R also generates a MAPE score in addition to other error metrics for comparison, eliminating the need to calculate it by hand.[8]

Part 7: Data Analysis

The linear model (output 8) for state population with the co-variances X of mean HPI and median income has the p-value of 0.1885, a very low Multiple R-squared (0.00312), and a very low adjusted R-squared value (0.001253), which means we cannot reject the null hypothesis that the individual states' mean HPI and median income has no impact on the respective state population. Based on this non-rejection of the null hypothesis, we decided to explore the impact of the states' mean HPI by their respective median incomes and populations. The summary of the new linear model (output 9) with these adjusted parameters has a much higher Multiple R-squared value (0.4739) and Adjusted R-squared value (0.4729) in addition to the super low p-value of 2.2e-16. Since the p-value is below the 0.05 threshold, we can reject the null hypothesis that the states' median incomes and populations have no impact on the respective states' mean HPI. Furthermore, there were three stars (aka p-value of 0) for median income but no stars (aka p-value above 0.05) for the population, which indicate that the median income is a significant factor on the HPI whereas the population isn't.

[7] Singh, Deepika. "Deepika Singh." Time Series Forecasting Using R. Pluralsight, July 12, 2019. https://www.pluralsight.com/guides/time-series-forecasting-using-r

[8] Allwright, Stephen. "What Is a Good MAPE Score and How Do I Calculate It?" Stephen Allwright. Stephen Allwright, November 13, 2021. https://stephenallwright.com/good-mape-score/

Based on the time series graphs (outputs 5.b and 10), you can see that the growth of both HPI and income decreased and slowed at the start of the recession. However, when it came to the growth of population by state, it's evident that growth remained the same without any of the slowing or decreasing we saw with HPI and income (output 11).

Since our initial hypothesis that state populations fluctuate based on HPI and income was incorrect, we decided to forecast the HPI and income for the state of Alabama for the next five years using Holt's method. In doing so, this paints a picture of what people can expect to happen with their housing costs and if their income is projected to keep up. You can see that both HPI and income are expected to keep going up (outputs 12 and 13, respectively). However, the HPI is increasing approximately 5.5% annually, while the median income is increasing much slower, approximately 1.5% annually.

```
output_8
```

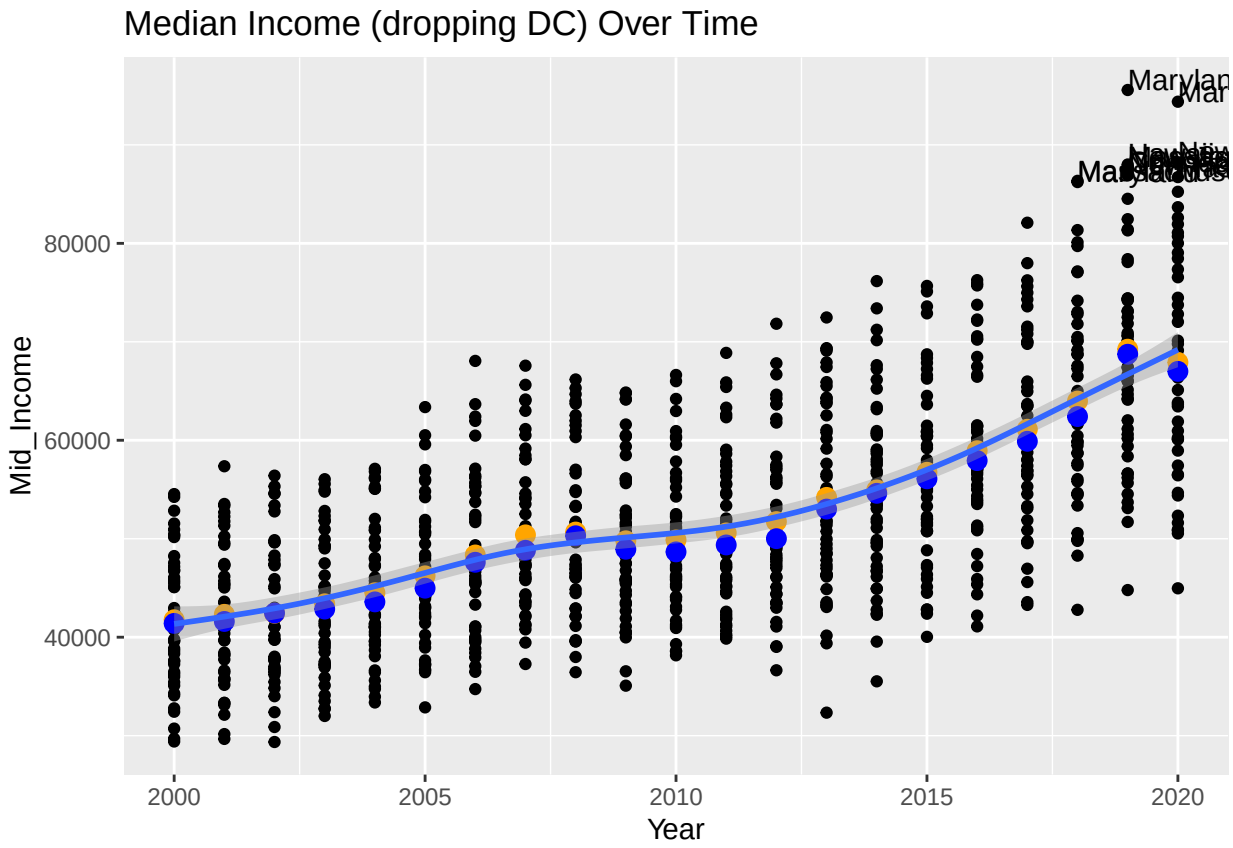
```
##
## Call:
## lm(formula = Final_data$Population ~ Final_data$Mean_HPI + Final_data$Mid_Income)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6344811 -4338844 -1551077   804070 33136265
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)           4781721.29  967002.32   4.945 8.84e-07 ***
## Final_data$Mean_HPI     -4406.19    4259.63  -1.034   0.3012
## Final_data$Mid_Income      44.24      24.50   1.806   0.0712 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6780000 on 1068 degrees of freedom
## Multiple R-squared:  0.00312,    Adjusted R-squared:  0.001253
## F-statistic: 1.671 on 2 and 1068 DF,  p-value: 0.1885
```

```
output_9
```

```
##
## Call:
## lm(formula = Final_data$Mean_HPI ~ Final_data$Mid_Income + Final_data$Population)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -145.944  -29.267   -5.893   20.763  288.049
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)             3.507e+01  6.940e+00   5.053  5.1e-07 ***
## Final_data$Mid_Income   3.964e-03  1.278e-04  31.013  < 2e-16 ***
## Final_data$Population -2.272e-07  2.196e-07  -1.034    0.301
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 48.68 on 1068 degrees of freedom
## Multiple R-squared:  0.4739, Adjusted R-squared:  0.4729
## F-statistic:   481 on 2 and 1068 DF,  p-value: < 2.2e-16
```

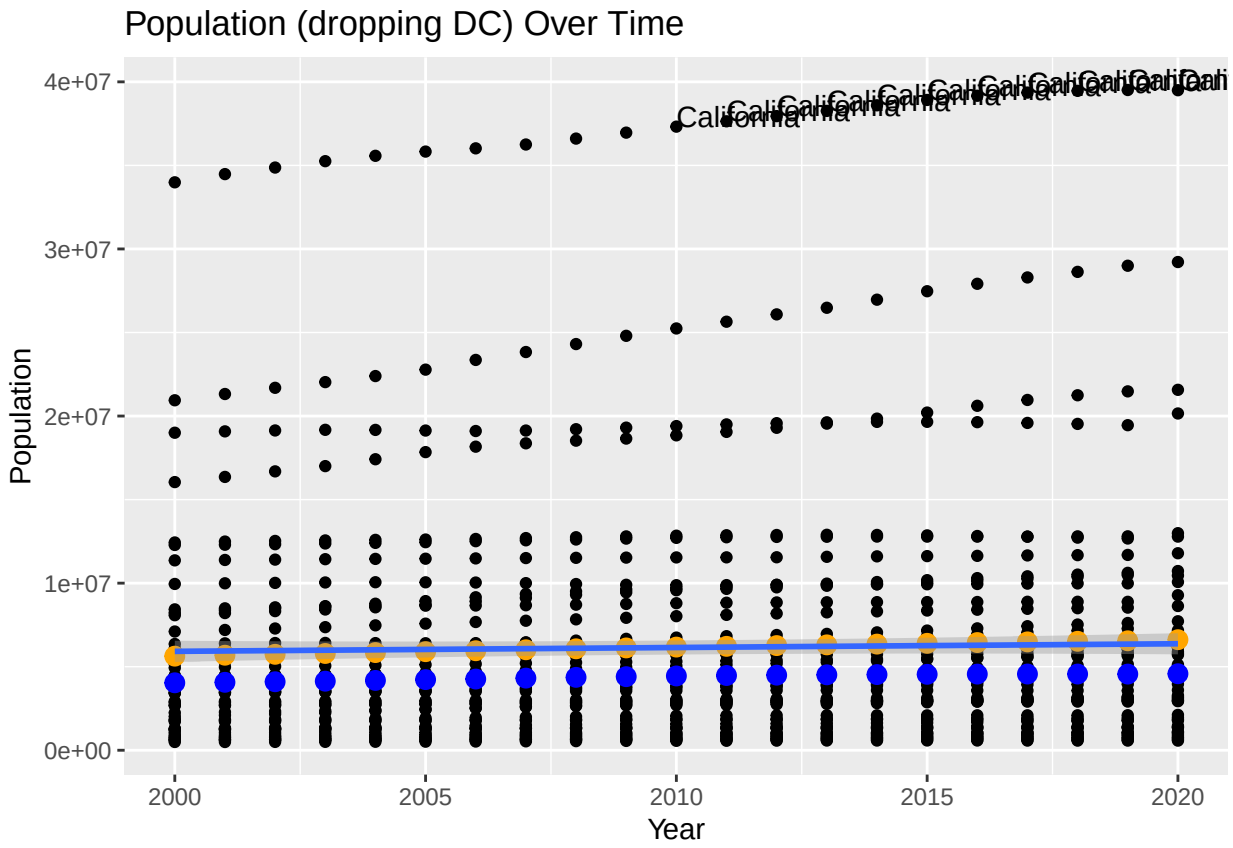
```
output_10
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
output_11
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
output_12
```

```
##
## Forecast method: Holt's method
##
## Model Information:
## Holt's method
##
## Call:
##  holt(y = ts_hpi_2025, h = 5)
##
##   Smoothing parameters:
##     alpha = 0.9999
##     beta  = 0.9999
##
##   Initial states:
##     l = 153.1067
```

```
##     b = 1.6166
##
##   sigma:  4.508
##
##      AIC     AICc      BIC
## 132.7435 136.7435 137.9661
##
## Error measures:
##                     ME     RMSE      MAE       MPE    MAPE      MASE      ACF1
## Training set 0.6703741 4.056019 3.262765 0.3710254 1.61376 0.4522491 0.4527344
##
## Forecasts:
##      Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## 2021       268.6162 262.8390 274.3935 259.7807 277.4518
## 2022       284.3091 271.3918 297.2263 264.5539 304.0643
## 2023       300.0020 278.3876 321.6163 266.9457 333.0583
## 2024       315.6949 284.0548 347.3349 267.3056 364.0841
## 2025       331.3877 288.5470 374.2285 265.8685 396.9070
```

```
output_13
```

```
##
## Forecast method: Holt's method
##
## Model Information:
## Holt's method
##
## Call:
##  holt(y = ts_income_2025, h = 5)
##
##   Smoothing parameters:
##     alpha = 0.3109
##     beta  = 1e-04
##
```

```
##   Initial states:
##     l = 33988.3226
##     b = 845.4874
##
##   sigma:  2601.31
##
##      AIC     AICc      BIC
## 399.7758 403.7758 404.9984
##
## Error measures:
##                     ME    RMSE      MAE       MPE     MAPE      MASE      ACF1
## Training set 262.4278 2340.49 1881.117 0.2055497 4.253398 0.8180014 0.1288489
##
## Forecasts:
##      Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## 2021       54299.48 50965.77 57633.19 49201.01 59397.95
## 2022       55145.52 51654.30 58636.74 49806.16 60484.88
## 2023       55991.56 52349.54 59633.58 50421.57 61561.55
## 2024       56837.60 53050.69 60624.51 51046.02 62629.18
## 2025       57683.63 53757.09 61610.18 51678.50 63688.77
```

Part 8: Model Evaluation

Linear model is a good choice to evaluate the impact of states' population by mean HPI and median income (and after initial analysis, the impact of states' mean HPI by median income and state population), because it allows us to see which covariance X has a significant contribution/impact (if any) on the Y.

For time series forecasting, using the Holt model is a good choice to evaluate the future values of mean HPI and median income. The MAPE score associated with the forecasting was 1.61% for the HPI and 4.25% for the income which tells us that there's a small percentage of error occurring in the outputs. In other words, the forecast is fairly accurate. If we had used the Naive method, the associated MAPE scores would be larger. Outputs 14 and 15 show MAPE scores of 15.5% and 22.5% for mean HPI and median income, respectively.

```
output_14
```

```
## [1] 15.53306
```

```
output_15
```

```
## [1] 22.5073
```

Part 9: Conclusion

Considering the initial question refers to people moving, it was expected that the population for each state would fluctuate more during the years affected by economic uncertainty due to loss of jobs, housing affordability, and other issues related to lower income. However, as you can see by the linear models in the appendix (outputs 8 and 9), change in population is not significantly related to HPI or income. We came up with a second hypothesis: the mean HPI is affected by the median income and state population. The linear model's summary indicated that the median income is a significant factor whereas the population isn't. This paints a picture that HPI and income are more correlated with each other than population growth.

Even though we found that the cost of housing is not tied to population fluctuation, the time series' forecast is still a relevant tool that can be useful in helping predict trends. In this instance, twenty years of the mean HPI and median income were used to forecast the next five years of HPI and income via Holt's Smoothing Method for the state of Alabama. In doing so, it provided additional insight into the disproportional growth of housing costs compared to income within Alabama.

Appendix A: Source

Allwright, Stephen. "What Is a Good MAPE Score and How Do I Calculate It?" Stephen Allwright. Stephen Allwright, November 13, 2021. https://stephenallwright.com/good-mape-score/

Federal Housing Finance Agency. "Get Started Here:" House Price Index Datasets | Federal Housing Finance Agency. Federal Housing Finance Agency, April 1, 2021 https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#mpo

US Census Bureau. "Historical Income Tables: Households." Census.gov. US Census Bureau, November 8, 2021. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html

US Census Bureau. “State Intercensal Tables: 2000-2010.” Census.gov. US Census Bureau, October 8, 2021. https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html

US Census Bureau. “State Population Totals and Components of Change: 2010-2019.” Census.gov. US Census Bureau, November 4, 2021. https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-total.html

US Census Bureau. “State Population Totals and Components of Change: 2020-2021.” Census.gov. US Census Bureau, December 21, 2021. https://www.census.gov/data/tables/time-series/demo/popest/2020s-state-total.html

Wikipedia. “Linear Regression.” Wikipedia. Wikimedia Foundation, March 11, 2022. https://en.wikipedia.org/wiki/Linear_regression. Singh, Deepika. “Deepika Singh.” Time Series Forecasting Using R. Pluralsight, July 12, 2019. https://www.pluralsight.com/guides/time-series-forecasting-using-r

Appendix B: Code

```
# create Final Data frame to store relevant data
Final_data <- data.frame()

# load Housing Price Index Dataset
HPI_data <- read_csv("HousingPriceIndex.csv")

# clean data by year and state and add to Final Data
for (year in 2000:2020){
  tempData <- unique(HPI_data[HPI_data$yr == year &
                                (HPI_data$place_name %in% state.name |
                                   HPI_data$place_name == "District of Columbia"),] %>%
    group_by(Place = place_name) %>%
    summarize(Year = yr, Mean_HPI = mean(index_nsa)))
  Final_data <- rbind(Final_data, tempData)
}

# load Median Household Income
Income_data <- read_excel("h08.xlsx")
```

```r
# clean and add to Final Data
tmp_Final <- data.frame()
yrVec <- c(1999:2020)
tmp_Inc_data <- Income_data[c(7,10:60),c(1,rev(c(2,4,6,8,12,14,16,18,22,
                                                 24,26,28,30,32,34,36,38,40,42,44,46)))]
for (colNum in 2:22){
  tempData <- tmp_Inc_data[2:52,c(1,colNum)]
  tempData$Year <- yrVec[colNum]
  colnames(tempData) <- c("Place", "Mid_Income", "Year")
  tmp_Final <- rbind(tmp_Final, tempData)
}
Final_data <- merge(Final_data, tmp_Final, by=c("Place", "Year"))

# load State Population data
pop_2000_2010 <- as.data.frame(read_excel("st-est00int-01.xls"))
pop_2010_2019 <- as.data.frame(read_excel("nst-est2019-01.xlsx"))
pop_2020_2021 <- as.data.frame(read_excel("NST-EST2021-POP.xlsx"))

# clean and add State Population data to Final Data
Final_data$Population <- NA
for(i in 9:59){
  for(j in 3:12){
    Final_data[which(Final_data$Place == str_remove(pop_2000_2010[i,1],".") &
                       Final_data$Year == pop_2000_2010[3,j]),]$Population <- pop_2000_2010[i,j]
  }
}
for(i in 9:59){
  for(j in 4:13){
    Final_data[which(Final_data$Place == str_remove(pop_2010_2019[i,1],".") &
                       Final_data$Year == pop_2010_2019[3,j]),]$Population <- pop_2010_2019[i,j]
  }
}
```

```
for(i in 9:59){
  Final_data[which(Final_data$Place == str_remove(pop_2020_2021[i,1],".") &
                     Final_data$Year == pop_2020_2021[3,3]),]$Population <- pop_2020_2021[i,3]
}
Final_data$Mid_Income <- as.numeric(gsub(",", "", as.character(Final_data$Mid_Income)))
Final_data$Population <- as.numeric(gsub(",", "", as.character(Final_data$Population)))
```

```
data_glimpse <- glimpse(Final_data)

hist(Final_data[Final_data$Year == 2003,]$Mean_HPI)
ggqqplot(Final_data[Final_data$Year == 2003,]$Mean_HPI)

#output 1
output_1 <- ggqqplot(Final_data$Mean_HPI, title="QQ Plot of Mean HPI")
#output 2
output_2 <- ggqqplot(Final_data$Mid_Income, title="QQ Plot of Median Income")
#output 3
output_3 <- ggqqplot(Final_data$Population, title="QQ Plot of Population")

#output 4.a
output_4.a <- ggplot(Final_data[Final_data$Year == 2020,], aes(Population, Mean_HPI, label=Place)) +
  labs(title="2020: Population vs. Mean HPI") +
  geom_point() +
  geom_smooth() +
  geom_text(aes(label= ifelse(Mean_HPI > quantile(Mean_HPI, 0.95),
     as.character(Place),'')),hjust=0,vjust=0)

#output 4.b
output_4.b <- ggplot(Final_data[Final_data$Year == 2020 & Final_data$Place != "District of Columbia",],
  labs(title="2020: Population (dropping DC) vs. Mean HPI") +
  geom_point() +
  geom_smooth() +
  geom_text(aes(label= ifelse(Mean_HPI > quantile(Mean_HPI, 0.95),
```

```
     as.character(Place),'')),hjust=0,vjust=0)


model1 <- lm(Final_data$Population~ Final_data$Mean_HPI+Final_data$Mid_Income)


#output 8
output_8 <- summary(model1)


model2 <- lm(Final_data$Mean_HPI ~ Final_data$Mid_Income + Final_data$Population )
#output 9
output_9 <- summary(model2)


year_sum <- Final_data %>% group_by(Year) %>%
  summarize(hpi.mean = mean(Mean_HPI),hpi.mid = median(Mean_HPI))


#output 5.a
output_5.a <- ggplot(Final_data, aes(Year, Mean_HPI)) +
  labs(title="Mean HPI Over Time") +
  geom_point() +
  geom_point(data = year_sum, aes(x = Year, y = hpi.mean), color="orange", size = 3) +
  geom_point(data = year_sum, aes(x = Year, y = hpi.mid), color="blue", size=3) +
  geom_smooth() +
  geom_text(aes(label= ifelse(Mean_HPI > quantile(Mean_HPI, 0.99),
     as.character(Place),'')),hjust=0,vjust=0)


year_sum <- Final_data[Final_data$Place != "District of Columbia",] %>% group_by(Year) %>%
  summarize(hpi.mean = mean(Mean_HPI),hpi.mid = median(Mean_HPI))


#output 5.b
output_5.b <- ggplot(Final_data[Final_data$Place != "District of Columbia",], aes(Year, Mean_HPI)) +
  labs(title="Mean HPI (dropping DC) Over Time") +
  geom_point() +
  geom_point(data = year_sum, aes(x = Year, y = hpi.mean), color="orange", size = 3) +
```

```
  geom_point(data = year_sum, aes(x = Year, y = hpi.mid), color="blue", size=3) +
  geom_smooth() +
  geom_text(aes(label= ifelse(Mean_HPI > quantile(Mean_HPI, 0.99),
     as.character(Place),'')),hjust=0,vjust=0)

year_sum_inc <- Final_data[Final_data$Place != "District of Columbia",] %>% group_by(Year) %>%
  summarize(inc.mean = mean(Mid_Income),inc.mid = median(Mid_Income))

#output 10
output_10 <- ggplot(Final_data[Final_data$Place != "District of Columbia",], aes(Year, Mid_Income)) +
  labs(title="Median Income (dropping DC) Over Time") +
  geom_point() +
  geom_point(data = year_sum_inc, aes(x = Year, y = inc.mean), color="orange", size = 3) +
  geom_point(data = year_sum_inc, aes(x = Year, y = inc.mid), color="blue", size=3) +
  geom_smooth() +
  geom_text(aes(label= ifelse(Mid_Income > quantile(Mid_Income, 0.99),
     as.character(Place),'')),hjust=0,vjust=0)

year_sum_pop <- Final_data[Final_data$Place != "District of Columbia",] %>% group_by(Year) %>%
  summarize(pop.mean = mean(Population),pop.mid = median(Population))

#output 11
output_11 <- ggplot(Final_data[Final_data$Place != "District of Columbia",], aes(Year, Population)) +
  labs(title="Population (dropping DC) Over Time") +
  geom_point() +
  geom_point(data = year_sum_pop, aes(x = Year, y = pop.mean), color="orange", size = 3) +
  geom_point(data = year_sum_pop, aes(x = Year, y = pop.mid), color="blue", size=3) +
  geom_smooth() +
  geom_text(aes(label= ifelse(Population > quantile(Population, 0.99),
     as.character(Place),'')),hjust=0,vjust=0)

#output 6
```

```r
output_6 <- hist(Final_data$Mean_HPI/Final_data$Mid_Income)
#output 7
output_7 <- ggqqplot(Final_data$Mean_HPI/Final_data$Mid_Income)
```

```r
#forecasting model and it's accuracy

#append "train" and "test" class
Class<- c("train", "train", "train", "train", "train", "train", "train", "train", "train", "train", "tra
Final_data$Class<-Class

#create train/test subsets
dat_train_10 <- subset(Final_data, Class == "train" & Year< 2011)
dat_test <- subset(Final_data, Class == "test")

dat_test

#create time series function for Alabama

ts_hpi <- ts(dat_train_10[,3], start = 2000, end = 2010, frequency = 1)
ts_income <- ts(dat_train_10[,4], start = 2000, end = 2010, frequency = 1)

#create mape accuracy test function
mape <- function(actual,pred){
  mape <- mean(abs((actual - pred)/actual))*100
  return (mape)
}

#run Holt on years 2000*2010 to forecast values for 2011-2015 in Alabama
holt_mod_hpi<-holt(ts_hpi, h=5)
summary(holt_mod_hpi)
df_holt_hpi<-as.data.frame(holt_mod_hpi)

holt_mod_income<-holt(ts_income, h=5)
```

```
summary(holt_mod_income)
df_holt_inc<-as.data.frame(holt_mod_income)

#compare forecast for 2011-2015 to actual values for 2011-2015 for Alabama
dat_test$holt_hpi=df_holt_hpi$"Point Forecast"
HPI_forecast_15<- mape(dat_test$Mean_HPI, dat_test$naive)

dat_test$holt_inc=df_holt_inc$"Point Forecast"
income_forecast_15<- mape(dat_test$Mid_Income, dat_test$naiveinc)

#run forecast for 2021-2025 for Alabama
ts_hpi_2025<- ts(Final_data[,3], start = 2000, end = 2020, frequency = 1)
ts_income_2025<- ts(Final_data[,4], start = 2000, end = 2020, frequency = 1)

holt_25_hpi<- holt(ts_hpi_2025, h=5)

#output 12
output_12 <- summary(holt_25_hpi)

holt_25_income<- holt(ts_income_2025, h=5)

#output 13
output_13 <- summary(holt_25_income)

#naive model forecast
naive_mod<-naive(ts_hpi, h=5)
dat_test$naive<-201.355

#output 14
output_14 <- mape(dat_test$Mean_HPI,dat_test$naive)

naive_mod_income<-naive(ts_income, h=5)
```

```
dat_test$naiveinc<-40933


#output 15
output_15 <- mape(dat_test$Mid_Income,dat_test$naiveinc)
```

Appendix C: Data

```
data_glimpse
```

```
##                    Place Year Mean_HPI Mid_Income Population
## 1                Alabama 2000 156.6731      35424    4452173
## 2                Alabama 2001 163.4062      35160    4467634
## 3                Alabama 2002 167.9294      37603    4480089
## 4                Alabama 2003 174.5913      37255    4503491
## 5                Alabama 2004 181.3131      36629    4530729
## 6                Alabama 2005 194.3656      37150    4569805
## 7                Alabama 2006 209.4469      37952    4628981
## 8                Alabama 2007 217.9338      42212    4672840
## 9                Alabama 2008 216.6825      44476    4718206
## 10               Alabama 2009 211.2812      39980    4757938
## 11               Alabama 2010 201.3550      40933    4785437
## 12               Alabama 2011 193.9137      42590    4799069
## 13               Alabama 2012 194.0394      43464    4815588
## 14               Alabama 2013 195.1500      47320    4830081
## 15               Alabama 2014 198.0538      42278    4841799
## 16               Alabama 2015 203.2675      44509    4852347
## 17               Alabama 2016 209.2506      47221    4863525
## 18               Alabama 2017 216.5094      50865    4874486
## 19               Alabama 2018 225.7644      49936    4887681
## 20               Alabama 2019 237.2306      56200    4903185
## 21               Alabama 2020 252.9238      54393    5024803
## 22                Alaska 2000 142.1156      52847     627963
## 23                Alaska 2001 149.8650      57363     633714
```

```
## 24                Alaska 2002 157.8619      52774     642337
## 25                Alaska 2003 167.0337      51837     648414
## 26                Alaska 2004 182.5144      55063     659286
## 27                Alaska 2005 203.8756      55891     666946
## 28                Alaska 2006 222.3769      56418     675302
## 29                Alaska 2007 230.8800      62993     680300
## 30                Alaska 2008 229.3625      63989     687455
## 31                Alaska 2009 227.5075      61604     698895
## 32                Alaska 2010 226.6619      57848     713910
## 33                Alaska 2011 229.4150      57431     722128
## 34                Alaska 2012 231.0969      63648     730443
## 35                Alaska 2013 237.6675      72472     737068
## 36                Alaska 2014 242.7881      67629     736283
## 37                Alaska 2015 251.5819      75112     737498
## 38                Alaska 2016 256.9969      75723     741456
## 39                Alaska 2017 260.4319      77987     739700
## 40                Alaska 2018 264.3994      68734     735139
## 41                Alaska 2019 272.2688      78394     731545
## 42                Alaska 2020 282.9581      74476     732441
## 43               Arizona 2000 162.3331      39783    5160586
## 44               Arizona 2001 172.2312      42704    5273477
## 45               Arizona 2002 181.3075      39734    5396255
## 46               Arizona 2003 192.6150      41166    5510364
## 47               Arizona 2004 215.7856      43846    5652404
## 48               Arizona 2005 276.1469      45245    5839077
## 49               Arizona 2006 323.3950      46657    6029141
## 50               Arizona 2007 318.3775      47215    6167681
## 51               Arizona 2008 268.9769      46914    6280362
## 52               Arizona 2009 222.8100      45739    6343154
## 53               Arizona 2010 197.8619      46896    6407172
## 54               Arizona 2011 178.0175      48621    6472643
## 55               Arizona 2012 191.4800      47044    6554978
## 56               Arizona 2013 216.6413      52611    6632764
```

```
## 57              Arizona 2014 233.2287      49254    6730413
## 58              Arizona 2015 247.9750      52248    6829676
## 59              Arizona 2016 263.8706      57100    6941072
## 60              Arizona 2017 283.7987      59700    7044008
## 61              Arizona 2018 305.2256      62283    7158024
## 62              Arizona 2019 326.9625      70674    7278717
## 63              Arizona 2020 358.2862      66628    7177986
## 64             Arkansas 2000 145.2575      29697    2678588
## 65             Arkansas 2001 151.8812      33339    2691571
## 66             Arkansas 2002 157.1275      32387    2705927
## 67             Arkansas 2003 164.0531      32002    2724816
## 68             Arkansas 2004 173.4750      34984    2749686
## 69             Arkansas 2005 185.2912      36658    2781097
## 70             Arkansas 2006 196.3375      37057    2821761
## 71             Arkansas 2007 201.9994      40795    2848650
## 72             Arkansas 2008 199.4975      39586    2874554
## 73             Arkansas 2009 196.1450      36538    2896843
## 74             Arkansas 2010 191.0513      38587    2921964
## 75             Arkansas 2011 188.0087      41302    2940667
## 76             Arkansas 2012 191.2587      39018    2952164
## 77             Arkansas 2013 194.5487      39376    2959400
## 78             Arkansas 2014 197.0894      44922    2967392
## 79             Arkansas 2015 201.6675      42798    2978048
## 80             Arkansas 2016 207.0650      45907    2989918
## 81             Arkansas 2017 213.9888      49751    3001345
## 82             Arkansas 2018 222.1494      49781    3009733
## 83             Arkansas 2019 231.2450      54539    3017804
## 84             Arkansas 2020 243.5269      50540    3012232
## 85           California 2000 158.1531      46816   33987977
## 86           California 2001 177.9750      47262   34479458
## 87           California 2002 199.9719      47437   34871843
## 88           California 2003 228.6400      49300   35253159
## 89           California 2004 280.7862      49222   35574576
```

```
## 90            California 2005 344.3069      51755   35827943
## 91            California 2006 372.2769      55319   36021202
## 92            California 2007 347.7188      55734   36250311
## 93            California 2008 275.8131      57014   36604337
## 94            California 2009 237.7862      56134   36961229
## 95            California 2010 228.3919      54283   37319502
## 96            California 2011 213.9719      53367   37638369
## 97            California 2012 216.9338      57020   37948800
## 98            California 2013 246.0987      60794   38260787
## 99            California 2014 273.1006      60487   38596972
## 100           California 2015 292.5944      63636   38918045
## 101           California 2016 313.3963      66637   39167117
## 102           California 2017 336.2063      70038   39358497
## 103           California 2018 357.4456      70489   39461588
## 104           California 2019 371.0081      78105   39512223
## 105           California 2020 390.9594      77358   39499738
## 106             Colorado 2000 209.0569      48240    4326921
## 107             Colorado 2001 227.4538      49397    4425687
## 108             Colorado 2002 238.0075      48294    4490406
## 109             Colorado 2003 244.4194      49940    4528732
## 110             Colorado 2004 254.0100      50886    4575013
## 111             Colorado 2005 268.2856      50449    4631888
## 112             Colorado 2006 280.3419      55697    4720423
## 113             Colorado 2007 284.9169      61141    4803868
## 114             Colorado 2008 277.6669      60943    4889730
## 115             Colorado 2009 272.3619      55930    4972195
## 116             Colorado 2010 263.8737      60233    5047349
## 117             Colorado 2011 254.0106      58629    5121108
## 118             Colorado 2012 261.0156      57255    5192647
## 119             Colorado 2013 277.7075      67912    5269035
## 120             Colorado 2014 298.5138      60940    5350101
## 121             Colorado 2015 327.7588      66596    5450623
## 122             Colorado 2016 358.3600      70566    5539215
```

```
## 123             Colorado 2017 389.9450      74984    5611885
## 124             Colorado 2018 422.2244      73034    5691287
## 125             Colorado 2019 445.8438      72499    5758736
## 126             Colorado 2020 474.4844      82611    5784308
## 127          Connecticut 2000 155.5437      50172    3411777
## 128          Connecticut 2001 169.7419      53347    3432835
## 129          Connecticut 2002 186.9431      53387    3458749
## 130          Connecticut 2003 204.3825      54965    3484336
## 131          Connecticut 2004 229.1131      55100    3496094
## 132          Connecticut 2005 256.2050      56835    3506956
## 133          Connecticut 2006 269.4837      62404    3517460
## 134          Connecticut 2007 268.9325      64141    3527270
## 135          Connecticut 2008 254.7388      64682    3545579
## 136          Connecticut 2009 238.8806      64851    3561807
## 137          Connecticut 2010 229.1169      65998    3579114
## 138          Connecticut 2011 221.4344      65415    3588283
## 139          Connecticut 2012 216.7925      64247    3594547
## 140          Connecticut 2013 215.7788      69291    3594841
## 141          Connecticut 2014 215.7113      70161    3594524
## 142          Connecticut 2015 218.8663      72889    3587122
## 143          Connecticut 2016 221.0344      75923    3578141
## 144          Connecticut 2017 224.0219      74304    3573297
## 145          Connecticut 2018 228.4412      72812    3571520
## 146          Connecticut 2019 234.2975      87291    3565287
## 147          Connecticut 2020 248.3975      79043    3600260
## 148             Delaware 2000 168.7733      50365     786373
## 149             Delaware 2001 181.2717      49602     795699
## 150             Delaware 2002 196.4408      49650     806169
## 151             Delaware 2003 214.6483      49019     818003
## 152             Delaware 2004 243.5617      48049     830803
## 153             Delaware 2005 279.9483      51235     845150
## 154             Delaware 2006 306.6742      52438     859268
## 155             Delaware 2007 311.7117      54589     871749
```

```
## 156              Delaware 2008 296.9900      50702     883874
## 157              Delaware 2009 279.7375      52114     891730
## 158              Delaware 2010 265.7558      55214     899593
## 159              Delaware 2011 248.6350      54660     907381
## 160              Delaware 2012 243.6117      48972     915179
## 161              Delaware 2013 249.6667      54091     923576
## 162              Delaware 2014 253.5808      57522     932487
## 163              Delaware 2015 260.9025      57756     941252
## 164              Delaware 2016 267.4167      58046     948921
## 165              Delaware 2017 272.6775      64961     956823
## 166              Delaware 2018 283.6683      65012     965479
## 167              Delaware 2019 294.0683      74194     973764
## 168              Delaware 2020 312.1583      69132     991886
## 169  District of Columbia 2000 166.1267      41222     572046
## 170  District of Columbia 2001 191.5008      41169     574504
## 171  District of Columbia 2002 223.1183      39070     573158
## 172  District of Columbia 2003 254.9533      45044     568502
## 173  District of Columbia 2004 305.0792      43451     567754
## 174  District of Columbia 2005 373.6633      44993     567136
## 175  District of Columbia 2006 411.1142      48477     570681
## 176  District of Columbia 2007 420.0158      50783     574404
## 177  District of Columbia 2008 395.7317      55590     580236
## 178  District of Columbia 2009 376.3933      53141     592228
## 179  District of Columbia 2010 380.8675      56928     605226
## 180  District of Columbia 2011 388.3967      55251     619800
## 181  District of Columbia 2012 411.7450      65246     634924
## 182  District of Columbia 2013 453.5567      60057     650581
## 183  District of Columbia 2014 487.9442      68277     662328
## 184  District of Columbia 2015 521.3225      70071     675400
## 185  District of Columbia 2016 550.6208      70982     685815
## 186  District of Columbia 2017 582.2133      81282     694906
## 187  District of Columbia 2018 611.1425      85750     701547
## 188  District of Columbia 2019 639.6075      93111     705749
```

```
## 189  District of Columbia 2020 672.9867      88311     690093
## 190               Florida 2000 152.8969      38856   16047515
## 191               Florida 2001 167.3881      36421   16356966
## 192               Florida 2002 185.4412      38024   16689370
## 193               Florida 2003 207.1037      38972   17004085
## 194               Florida 2004 242.6681      40535   17415318
## 195               Florida 2005 301.4619      42990   17842038
## 196               Florida 2006 344.4563      45676   18166990
## 197               Florida 2007 333.1469      45794   18367842
## 198               Florida 2008 273.6106      44857   18527305
## 199               Florida 2009 230.9644      45631   18652644
## 200               Florida 2010 210.9338      44066   18845537
## 201               Florida 2011 197.3044      45105   19053237
## 202               Florida 2012 200.4950      46071   19297822
## 203               Florida 2013 216.9494      48532   19545621
## 204               Florida 2014 232.8906      46140   19845911
## 205               Florida 2015 254.0813      48825   20209042
## 206               Florida 2016 277.2412      51176   20613477
## 207               Florida 2017 298.9681      53086   20963613
## 208               Florida 2018 320.8044      54644   21244317
## 209               Florida 2019 339.8662      58368   21477737
## 210               Florida 2020 363.9725      57435   21569932
## 211               Georgia 2000 165.8869      41901    8227303
## 212               Georgia 2001 176.6325      42576    8377038
## 213               Georgia 2002 184.6156      42939    8508256
## 214               Georgia 2003 192.0913      42438    8622793
## 215               Georgia 2004 200.6506      40984    8769252
## 216               Georgia 2005 213.0100      45926    8925922
## 217               Georgia 2006 223.8175      49344    9155813
## 218               Georgia 2007 228.7013      48641    9349988
## 219               Georgia 2008 219.4638      46227    9504843
## 220               Georgia 2009 206.3294      43340    9620846
## 221               Georgia 2010 191.5012      44117    9711881
```

```
## 222              Georgia 2011 176.8388      45973    9802431
## 223              Georgia 2012 174.2025      48121    9901430
## 224              Georgia 2013 183.9656      46992    9972479
## 225              Georgia 2014 195.6056      49555   10067278
## 226              Georgia 2015 207.4800      50768   10178447
## 227              Georgia 2016 219.8319      53527   10301890
## 228              Georgia 2017 232.7094      57985   10410330
## 229              Georgia 2018 249.5362      55821   10511131
## 230              Georgia 2019 264.3938      56628   10617423
## 231              Georgia 2020 283.3531      58952   10725800
## 232               Hawaii 2000 131.4694      51546    1213519
## 233               Hawaii 2001 142.5712      47439    1225948
## 234               Hawaii 2002 155.4119      47303    1239613
## 235               Hawaii 2003 176.3663      51834    1251154
## 236               Hawaii 2004 219.7794      56242    1273569
## 237               Hawaii 2005 275.3856      59586    1292729
## 238               Hawaii 2006 309.2763      60470    1309731
## 239               Hawaii 2007 311.2613      64022    1315675
## 240               Hawaii 2008 293.2875      61521    1332213
## 241               Hawaii 2009 266.4950      55649    1346717
## 242               Hawaii 2010 253.6000      59539    1363963
## 243               Hawaii 2011 244.0062      59047    1379329
## 244               Hawaii 2012 251.4387      56263    1394804
## 245               Hawaii 2013 269.6725      64235    1408243
## 246               Hawaii 2014 288.6069      71223    1414538
## 247               Hawaii 2015 306.7887      64514    1422052
## 248               Hawaii 2016 323.3631      72133    1427559
## 249               Hawaii 2017 340.0606      73599    1424393
## 250               Hawaii 2018 353.9119      80108    1420593
## 251               Hawaii 2019 367.0819      88006    1415872
## 252               Hawaii 2020 382.5000      80729    1451911
## 253                Idaho 2000 156.5856      37611    1299430
## 254                Idaho 2001 163.5525      38241    1319962
```

```
## 255              Idaho 2002 168.1831      37715    1340372
## 256              Idaho 2003 175.9212      42372    1363380
## 257              Idaho 2004 190.8156      44358    1391802
## 258              Idaho 2005 219.0306      44176    1428241
## 259              Idaho 2006 253.6181      46213    1468669
## 260              Idaho 2007 268.5437      49184    1505105
## 261              Idaho 2008 259.8056      47420    1534320
## 262              Idaho 2009 239.4825      46778    1554439
## 263              Idaho 2010 214.6056      47050    1570746
## 264              Idaho 2011 195.2694      47459    1583910
## 265              Idaho 2012 202.9444      47922    1595324
## 266              Idaho 2013 217.2125      48467    1611206
## 267              Idaho 2014 228.5925      53438    1631112
## 268              Idaho 2015 243.3688      51624    1651059
## 269              Idaho 2016 261.6469      56564    1682380
## 270              Idaho 2017 285.7862      59497    1717715
## 271              Idaho 2018 320.9588      58728    1750536
## 272              Idaho 2019 357.3106      65988    1787065
## 273              Idaho 2020 403.9494      66499    1847772
## 274           Illinois 2000 163.4975      46064   12434161
## 275           Illinois 2001 172.9719      46171   12488445
## 276           Illinois 2002 182.6544      42710   12525556
## 277           Illinois 2003 192.7831      45153   12556006
## 278           Illinois 2004 206.0350      46077   12589773
## 279           Illinois 2005 221.4425      48398   12609903
## 280           Illinois 2006 233.0656      48671   12643955
## 281           Illinois 2007 235.1669      52506   12695866
## 282           Illinois 2008 223.6219      53254   12747038
## 283           Illinois 2009 208.9050      52870   12796778
## 284           Illinois 2010 200.3831      50728   12840503
## 285           Illinois 2011 190.9475      50637   12867454
## 286           Illinois 2012 188.9137      51738   12882510
## 287           Illinois 2013 192.3106      53937   12895129
```

```
## 288            Illinois 2014 197.7756      54916   12884493
## 289            Illinois 2015 204.0656      60413   12858913
## 290            Illinois 2016 210.4800      61386   12820527
## 291            Illinois 2017 216.4950      65969   12778828
## 292            Illinois 2018 222.1687      70145   12723071
## 293            Illinois 2019 228.5337      74399   12671821
## 294            Illinois 2020 237.9288      73753   12785245
## 295             Indiana 2000 157.9275      40865    6091866
## 296             Indiana 2001 163.9919      40379    6127760
## 297             Indiana 2002 167.9650      41047    6155967
## 298             Indiana 2003 172.2363      42425    6196638
## 299             Indiana 2004 177.0588      42329    6233007
## 300             Indiana 2005 182.9450      42437    6278616
## 301             Indiana 2006 185.6700      45407    6332669
## 302             Indiana 2007 185.5137      47453    6379599
## 303             Indiana 2008 183.7356      46520    6424806
## 304             Indiana 2009 179.2375      44305    6459325
## 305             Indiana 2010 176.6238      46139    6490432
## 306             Indiana 2011 174.2875      44445    6516528
## 307             Indiana 2012 175.5444      46158    6537703
## 308             Indiana 2013 179.4781      49455    6568713
## 309             Indiana 2014 183.6350      48060    6593644
## 310             Indiana 2015 190.3900      51983    6608422
## 311             Indiana 2016 198.0525      56094    6634304
## 312             Indiana 2017 207.6956      58767    6658078
## 313             Indiana 2018 221.5344      59892    6695497
## 314             Indiana 2019 235.0962      66693    6732219
## 315             Indiana 2020 252.2912      66360    6785644
## 316                Iowa 2000 159.5325      40991    2929067
## 317                Iowa 2001 166.6937      40976    2931997
## 318                Iowa 2002 172.5669      41049    2934234
## 319                Iowa 2003 178.9669      41384    2941999
## 320                Iowa 2004 186.9225      43391    2953635
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## 321                Iowa 2005 195.5619      46500    2964454
## 322                Iowa 2006 201.8113      48126    2982644
## 323                Iowa 2007 205.9350      48908    2999212
## 324                Iowa 2008 206.0987      50142    3016734
## 325                Iowa 2009 205.1413      50721    3032870
## 326                Iowa 2010 204.0831      49016    3050745
## 327                Iowa 2011 202.6956      50219    3066336
## 328                Iowa 2012 206.4919      53442    3076190
## 329                Iowa 2013 211.4231      60156    3092997
## 330                Iowa 2014 216.0381      57810    3109350
## 331                Iowa 2015 223.6287      60855    3120960
## 332                Iowa 2016 231.6887      59094    3131371
## 333                Iowa 2017 240.6381      63467    3141550
## 334                Iowa 2018 250.1381      68718    3148618
## 335                Iowa 2019 258.7500      66054    3155070
## 336                Iowa 2020 270.0863      68469    3188669
## 337              Kansas 2000 154.0294      41059    2693681
## 338              Kansas 2001 161.4769      41415    2702162
## 339              Kansas 2002 167.7962      42619    2713535
## 340              Kansas 2003 173.6969      44232    2723004
## 341              Kansas 2004 180.7444      41066    2734373
## 342              Kansas 2005 187.7775      42027    2745299
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## 344              Kansas 2007 199.7131      48497    2783785
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## 351              Kansas 2014 204.0031      53444    2900475
## 352              Kansas 2015 210.6144      54865    2909011
## 353              Kansas 2016 220.0012      56810    2910844
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## 354              Kansas 2017 228.6744      56900    2908718
## 355              Kansas 2018 238.7869      63938    2911359
## 356              Kansas 2019 249.8044      73151    2913314
## 357              Kansas 2020 265.5950      72815    2935880
## 358            Kentucky 2000 161.8206      36265    4049021
## 359            Kentucky 2001 168.5419      38437    4068132
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## 361            Kentucky 2003 181.0131      36936    4117170
## 362            Kentucky 2004 189.3175      35610    4146101
## 363            Kentucky 2005 198.0856      36699    4182742
## 364            Kentucky 2006 205.1631      39485    4219239
## 365            Kentucky 2007 209.2600      39452    4256672
## 366            Kentucky 2008 208.2413      41148    4289878
## 367            Kentucky 2009 205.6450      42664    4317074
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## 369            Kentucky 2011 199.4638      39856    4369821
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## 371            Kentucky 2013 204.3575      44879    4404659
## 372            Kentucky 2014 207.7381      42786    4414349
## 373            Kentucky 2015 215.4313      42387    4425976
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## 377            Kentucky 2019 257.1488      55662    4467673
## 378            Kentucky 2020 273.2013      56525    4503958
## 379           Louisiana 2000 149.9613      30718    4471885
## 380           Louisiana 2001 156.4106      33322    4477875
## 381           Louisiana 2002 162.7450      34008    4497267
## 382           Louisiana 2003 170.9600      33507    4521042
## 383           Louisiana 2004 180.2738      36429    4552238
## 384           Louisiana 2005 192.3931      37236    4576628
## 385           Louisiana 2006 213.1163      36488    4302665
## 386           Louisiana 2007 223.0875      41313    4375581
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## 387           Louisiana 2008 223.3406      39563    4435586
## 388           Louisiana 2009 221.6813      45433    4491648
## 389           Louisiana 2010 219.8088      39300    4544532
## 390           Louisiana 2011 215.9256      40658    4575625
## 391           Louisiana 2012 219.3462      39085    4600972
## 392           Louisiana 2013 225.0588      46425    4624527
## 393           Louisiana 2014 231.2650      42406    4644013
## 394           Louisiana 2015 239.3519      45922    4664628
## 395           Louisiana 2016 246.7294      42196    4678135
## 396           Louisiana 2017 252.7081      43565    4670560
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## 404               Maine 2004 244.6975      41329    1313688
## 405               Maine 2005 271.4806      43923    1318787
## 406               Maine 2006 281.3050      45642    1323619
## 407               Maine 2007 284.2513      47894    1327040
## 408               Maine 2008 278.0138      47228    1330509
## 409               Maine 2009 267.6012      47502    1329590
## 410               Maine 2010 258.8094      47931    1327629
## 411               Maine 2011 253.9913      49693    1328284
## 412               Maine 2012 251.4056      49158    1327729
## 413               Maine 2013 253.9019      54957    1328009
## 414               Maine 2014 257.0063      51710    1330513
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## 416               Maine 2016 274.9563      50856    1331317
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## 418               Maine 2018 304.1606      58663    1339057
## 419               Maine 2019 321.7244      66546    1344212
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## 420               Maine 2020 347.1531      63440    1362280
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## 424            Maryland 2003 203.0244      52314    5496269
## 425            Maryland 2004 239.2287      57103    5546935
## 426            Maryland 2005 289.5475      60512    5592379
## 427            Maryland 2006 323.7250      63668    5627367
## 428            Maryland 2007 327.6900      65630    5653408
## 429            Maryland 2008 300.9413      63711    5684965
## 430            Maryland 2009 273.7100      64186    5730388
## 431            Maryland 2010 257.8019      64201    5788645
## 432            Maryland 2011 246.4481      68876    5839419
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## 437            Maryland 2016 268.7369      73760    6003323
## 438            Maryland 2017 277.7738      82093    6023868
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## 449       Massachusetts 2007 389.8687      58463    6431559
## 450       Massachusetts 2008 365.6025      60320    6468967
## 451       Massachusetts 2009 351.3775      59373    6517613
## 452       Massachusetts 2010 341.6425      60934    6566307
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## 453        Massachusetts 2011 335.2281      63313    6613583
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## 455        Massachusetts 2013 345.2275      62529    6713315
## 456        Massachusetts 2014 359.6419      63151    6762596
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## 465             Michigan 2002 205.6681      42715   10015710
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## 467             Michigan 2004 220.1587      42256   10055315
## 468             Michigan 2005 226.2119      45933   10051137
## 469             Michigan 2006 222.6238      48647   10036081
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## 472             Michigan 2009 175.3069      45994    9901591
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## 474             Michigan 2011 160.1806      48879    9882412
## 475             Michigan 2012 163.4387      50015    9897145
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## 477             Michigan 2014 186.2163      52005    9929848
## 478             Michigan 2015 197.2556      54203    9931715
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## 485            Minnesota 2001 194.2556      52681    4982796
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## 494            Minnesota 2010 227.1662      52321    5310828
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## 517          Mississippi 2012 186.1350      36641    2983816
## 518          Mississippi 2013 188.3181      32338    2988711
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## 519          Mississippi 2014 191.4325      35521    2990468
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## 552              Montana 2005 254.9975      37313     940102
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## 584             Nebraska 2016 240.0087      59374    1905616
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## 585             Nebraska 2017 253.9038      59583    1915947
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## 617        New Hampshire 2007 286.7894      67576    1312540
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## 650           New Jersey 2019 330.4375      87726    8882190
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## 651          New Jersey 2020 352.5083      85239    9279743
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## 683            New York 2010 282.7831      49781   19399878
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## 684             New York 2011 277.0344      50636   19499241
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## 724          North Dakota 2009 225.4519      50075     664968
## 725          North Dakota 2010 231.5550      51006     674715
## 726          North Dakota 2011 242.5012      56361     685225
## 727          North Dakota 2012 263.4081      55766     701176
## 728          North Dakota 2013 286.3006      59152     722036
## 729          North Dakota 2014 305.6631      60730     737401
## 730          North Dakota 2015 320.2519      57415     754066
## 731          North Dakota 2016 322.6963      60184     754434
## 732          North Dakota 2017 325.7250      60167     754942
## 733          North Dakota 2018 329.4525      66505     758080
## 734          North Dakota 2019 340.7394      70031     762062
## 735          North Dakota 2020 350.2575      63657     778962
## 736                  Ohio 2000 162.7019      42962   11363543
## 737                  Ohio 2001 170.1219      41785   11387404
## 738                  Ohio 2002 175.7731      42684   11407889
## 739                  Ohio 2003 181.5888      43520   11434788
## 740                  Ohio 2004 187.1644      43055   11452251
## 741                  Ohio 2005 193.1744      44203   11463320
## 742                  Ohio 2006 194.3938      45900   11481213
## 743                  Ohio 2007 191.0106      49099   11500468
## 744                  Ohio 2008 182.4663      46934   11515391
## 745                  Ohio 2009 176.8269      45879   11528896
## 746                  Ohio 2010 172.3081      45886   11539336
## 747                  Ohio 2011 166.2106      44648   11544663
## 748                  Ohio 2012 167.3812      44375   11548923
## 749                  Ohio 2013 170.0106      50748   11576684
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## 750                Ohio 2014 175.9162      49644   11602700
## 751                Ohio 2015 182.6844      53301   11617527
## 752                Ohio 2016 190.5425      53985   11634370
## 753                Ohio 2017 200.2556      60688   11659650
## 754                Ohio 2018 212.0987      61633   11676341
## 755                Ohio 2019 223.9206      64663   11689100
## 756                Ohio 2020 240.4831      60110   11790587
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## 758            Oklahoma 2001 145.1319      35609    3467100
## 759            Oklahoma 2002 150.7956      36458    3489080
## 760            Oklahoma 2003 157.1394      35902    3504892
## 761            Oklahoma 2004 163.7525      39614    3525233
## 762            Oklahoma 2005 172.6469      37645    3548597
## 763            Oklahoma 2006 181.8806      38838    3594090
## 764            Oklahoma 2007 189.6312      43216    3634349
## 765            Oklahoma 2008 191.5412      46111    3668976
## 766            Oklahoma 2009 192.1012      45878    3717572
## 767            Oklahoma 2010 190.3887      43103    3759944
## 768            Oklahoma 2011 187.4981      48455    3788379
## 769            Oklahoma 2012 190.8850      48407    3818814
## 770            Oklahoma 2013 195.3344      46162    3853214
## 771            Oklahoma 2014 200.9581      47199    3878187
## 772            Oklahoma 2015 208.5675      47077    3909500
## 773            Oklahoma 2016 213.2063      50943    3926331
## 774            Oklahoma 2017 220.2175      51882    3931316
## 775            Oklahoma 2018 226.0362      54434    3940235
## 776            Oklahoma 2019 235.4812      59397    3956971
## 777            Oklahoma 2020 249.0975      52341    3962031
## 778              Oregon 2000 188.6538      42499    3429708
## 779              Oregon 2001 197.9900      41273    3467937
## 780              Oregon 2002 207.0813      41802    3513424
## 781              Oregon 2003 219.1606      41638    3547376
## 782              Oregon 2004 240.8425      40994    3569463
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## 783              Oregon 2005 281.9625      44159    3613202
## 784              Oregon 2006 327.6994      47091    3670883
## 785              Oregon 2007 343.7875      50236    3722417
## 786              Oregon 2008 326.3969      51727    3768748
## 787              Oregon 2009 296.2788      49098    3808600
## 788              Oregon 2010 274.4644      50602    3837491
## 789              Oregon 2011 255.2269      51526    3872036
## 790              Oregon 2012 257.3913      51775    3899001
## 791              Oregon 2013 278.7200      48999    3922468
## 792              Oregon 2014 299.0531      58875    3963244
## 793              Oregon 2015 323.7456      60834    4015792
## 794              Oregon 2016 356.7281      59135    4089976
## 795              Oregon 2017 386.3456      62498    4143625
## 796              Oregon 2018 413.1106      69165    4181886
## 797              Oregon 2019 434.6919      74413    4217737
## 798              Oregon 2020 464.7094      76554    4241544
## 799        Pennsylvania 2000 150.9031      42176   12284173
## 800        Pennsylvania 2001 160.2719      43499   12298970
## 801        Pennsylvania 2002 170.2088      42498   12331031
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## 804        Pennsylvania 2005 218.9581      46300   12449990
## 805        Pennsylvania 2006 235.0919      48477   12510809
## 806        Pennsylvania 2007 241.4150      48437   12563937
## 807        Pennsylvania 2008 238.5162      51402   12612285
## 808        Pennsylvania 2009 233.1081      48172   12666858
## 809        Pennsylvania 2010 229.1700      48314   12711160
## 810        Pennsylvania 2011 224.3156      49910   12745815
## 811        Pennsylvania 2012 224.5081      51904   12767118
## 812        Pennsylvania 2013 227.6937      55156   12776309
## 813        Pennsylvania 2014 231.0000      55173   12788313
## 814        Pennsylvania 2015 236.6756      60389   12784826
## 815        Pennsylvania 2016 243.3950      60979   12782275
```

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## 816          Pennsylvania 2017 251.5662      61285   12787641
## 817          Pennsylvania 2018 262.0969      64524   12800922
## 818          Pennsylvania 2019 274.2225      70582   12801989
## 819          Pennsylvania 2020 291.1325      70117   12989625
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## 821          Rhode Island 2001 194.2375      45723    1057142
## 822          Rhode Island 2002 226.9542      42417    1065995
## 823          Rhode Island 2003 263.5258      44711    1071342
## 824          Rhode Island 2004 310.9975      47935    1074579
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## 826          Rhode Island 2006 359.8067      53736    1063096
## 827          Rhode Island 2007 344.8067      54210    1057315
## 828          Rhode Island 2008 311.7342      53241    1055003
## 829          Rhode Island 2009 286.7725      51634    1053646
## 830          Rhode Island 2010 274.6992      51623    1053959
## 831          Rhode Island 2011 262.1542      49033    1053649
## 832          Rhode Island 2012 255.9325      56065    1054621
## 833          Rhode Island 2013 259.5600      56323    1055081
## 834          Rhode Island 2014 268.7517      58633    1055936
## 835          Rhode Island 2015 281.5225      55701    1056065
## 836          Rhode Island 2016 296.1925      61528    1056770
## 837          Rhode Island 2017 316.0808      65401    1055673
## 838          Rhode Island 2018 337.1958      62266    1058287
## 839          Rhode Island 2019 354.0517      70151    1059361
## 840          Rhode Island 2020 379.6133      80012    1096229
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## 848       South Carolina 2007 231.4156      44213    4444110
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## 849        South Carolina 2008 229.6744      42155    4528996
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## 855        South Carolina 2014 211.1750      44929    4823617
## 856        South Carolina 2015 221.8919      46360    4891938
## 857        South Carolina 2016 232.8275      54336    4957968
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## 863          South Dakota 2001 169.8744      39671     757972
## 864          South Dakota 2002 176.8081      37873     760020
## 865          South Dakota 2003 184.7431      39522     763729
## 866          South Dakota 2004 195.3075      41107     770396
## 867          South Dakota 2005 208.7650      43151     775493
## 868          South Dakota 2006 219.5681      45427     783033
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## 871          South Dakota 2009 233.6344      45826     807067
## 872          South Dakota 2010 231.9938      45352     816166
## 873          South Dakota 2011 231.8356      47223     823579
## 874          South Dakota 2012 236.5969      49415     833566
## 875          South Dakota 2013 246.1481      53413     842316
## 876          South Dakota 2014 254.5156      53053     849129
## 877          South Dakota 2015 265.1137      55065     853988
## 878          South Dakota 2016 277.4594      57450     862996
## 879          South Dakota 2017 290.9362      56914     872868
## 880          South Dakota 2018 305.2775      59463     878698
## 881          South Dakota 2019 319.4475      64255     884659
```

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## 882          South Dakota 2020 336.7075      69787     887099
## 883             Tennessee 2000 161.2375      34096    5703719
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## 896             Tennessee 2013 206.2281      43361    6494340
## 897             Tennessee 2014 214.1163      43716    6541223
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## 901             Tennessee 2018 271.6562      56060    6771631
## 902             Tennessee 2019 289.0550      56627    6829174
## 903             Tennessee 2020 311.4075      54665    6920119
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## 905                 Texas 2001 149.9331      40860   21319622
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## 909                 Texas 2005 172.4794      41422   22778123
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## 913                 Texas 2009 195.3731      47475   24801761
## 914                 Texas 2010 193.9500      47266   25241971
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## 915                Texas 2011 191.4225      49047   25645629
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## 920                Texas 2016 247.2125      58146   27914410
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## 922                Texas 2018 279.1731      59785   28628666
## 923                Texas 2019 293.2537      67444   28995881
## 924                Texas 2020 309.7663      68093   29217653
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## 937                 Utah 2012 249.4644      58341    2853375
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## 939                 Utah 2014 284.5738      63383    2936879
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## 941                 Utah 2016 323.6025      67481    3041868
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## 943                 Utah 2018 385.0419      77067    3153550
## 944                 Utah 2019 415.3206      84523    3205958
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## 947              Vermont 2001 167.3294      40794     612223
```

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## 948              Vermont 2002 180.8094      42999     615442
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## 957              Vermont 2011 255.1687      51862     627049
## 958              Vermont 2012 256.0188      55582     626090
## 959              Vermont 2013 257.0256      65513     626210
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## 961              Vermont 2015 260.4794      59494     625216
## 962              Vermont 2016 263.9919      60837     623657
## 963              Vermont 2017 272.5556      63682     624344
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## 967             Virginia 2000 152.7781      47163    7105817
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## 969             Virginia 2002 179.4419      49631    7286873
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## 973             Virginia 2006 289.0425      57119    7673725
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## 980             Virginia 2013 247.5775      65907    8252427
```

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## 981             Virginia 2014 252.8281      66155    8310993
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## 1014       West Virginia 2005 184.1350      36445    1820492
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## 1047          Wisconsin 2017 250.6987      63482    5790186
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## 1071            Wyoming 2020 349.1150      65108     577267
```