Homework 3 - Submission 1

ECON 470

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Homework 3 Summary Statistics and ATE Analysis

Link to Github

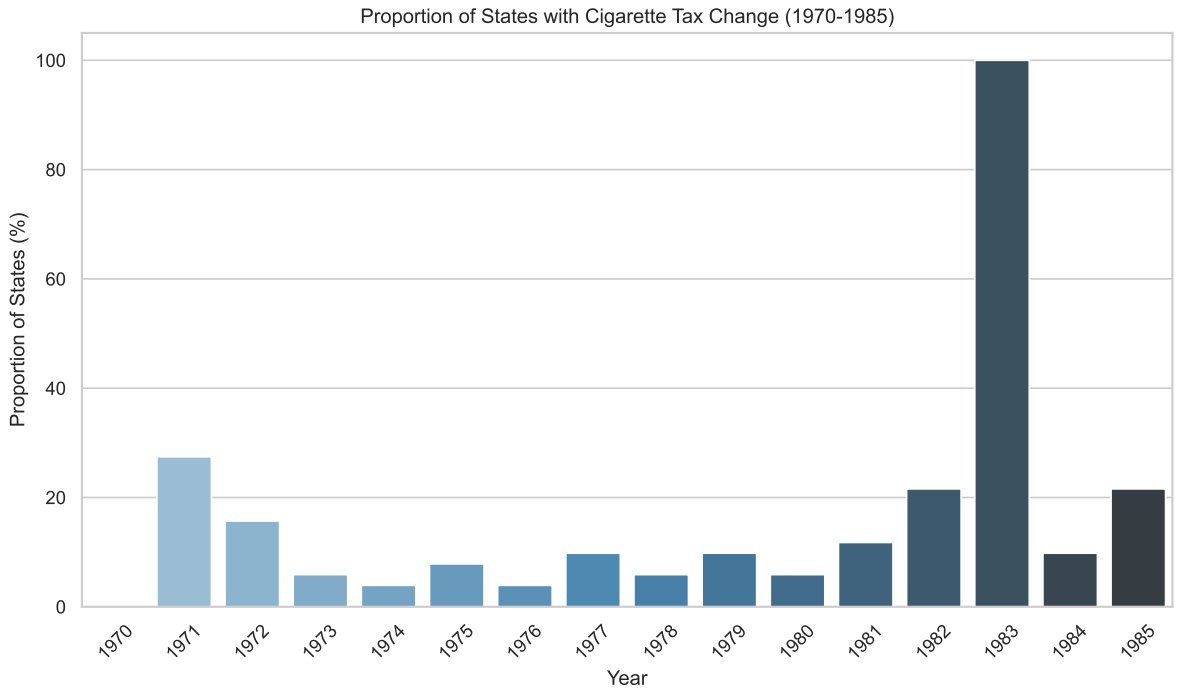
Collecting and Cleaning Data

CDC Tax Burden on Tobacco Data was collected from a provided repository and inflation data was collected from the BLI database. Raw data was downloaded and then put into real dollars using 2012 as the base year.

1. Summarizing the Data

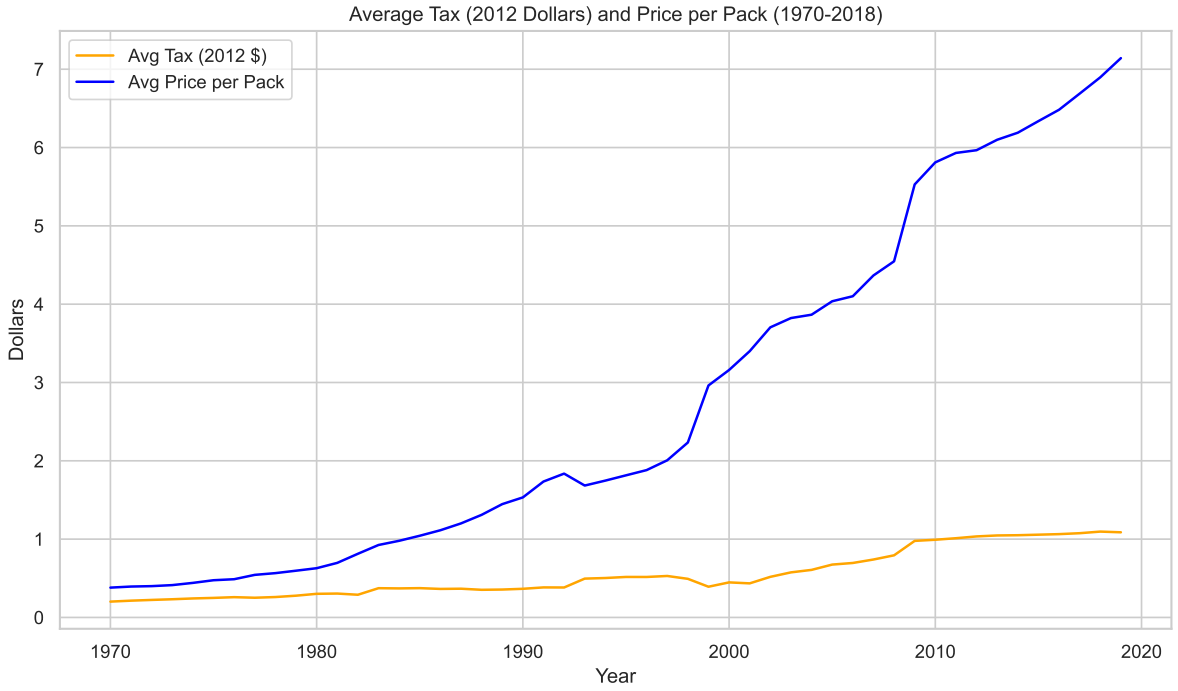
1.1 Proportion of States with a change in their cigarette tax each year from 1970 to 1985

As seen in the figure below, there is a large spike in proportion of states at 1983. It is possible that this conincides with a major policy shift on cigarettes.



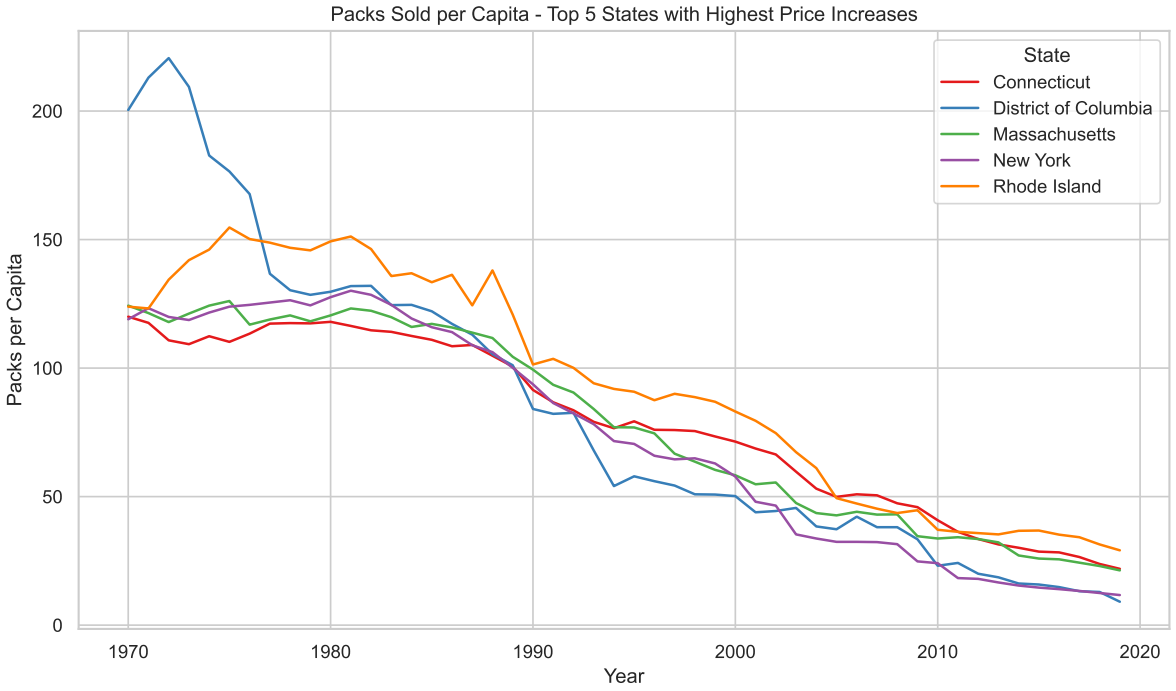
1.2 Average Price per Pack, 1970-2018 (in 2012 dolalrs)

While both tax and price per pack have risen in past years, price per pack has grown exponentially more. This makes sense as the government has tried to use economic disincentives to sway people away from cigarettes.



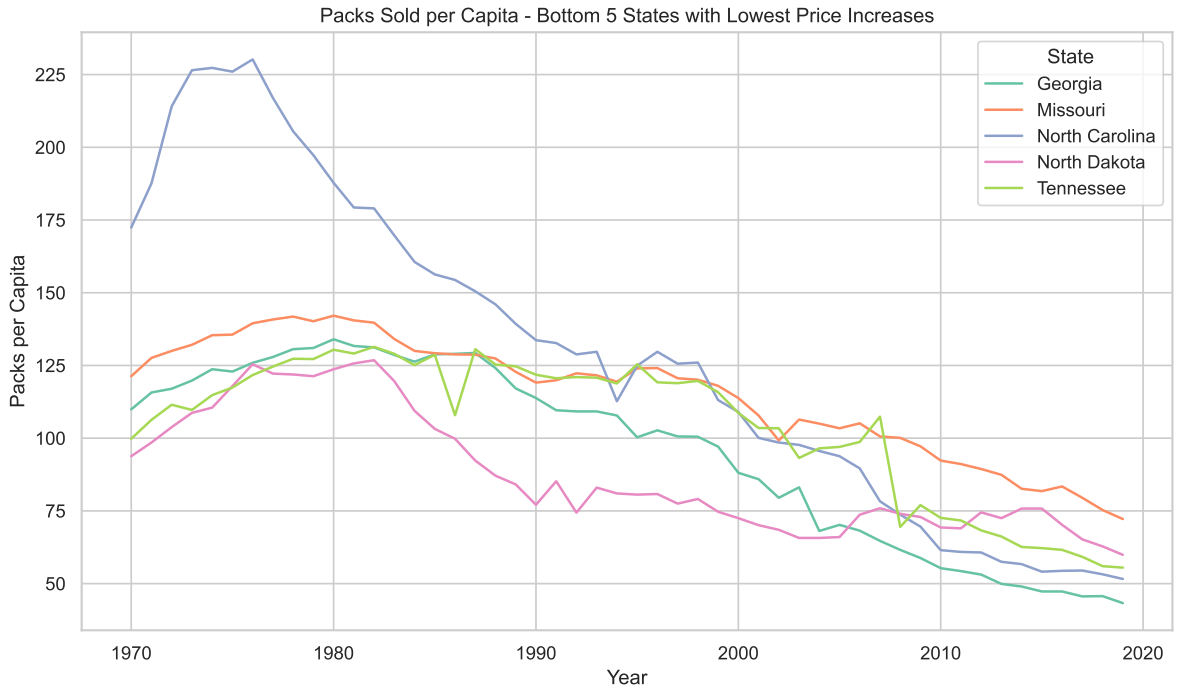
1.3 Top 5 states with highest increases in cigarette prices

In the top 5 states with the highest price increases, there has been a significant decrease in the number of packs per person. This might point to some movement in the right direction for policy makers.



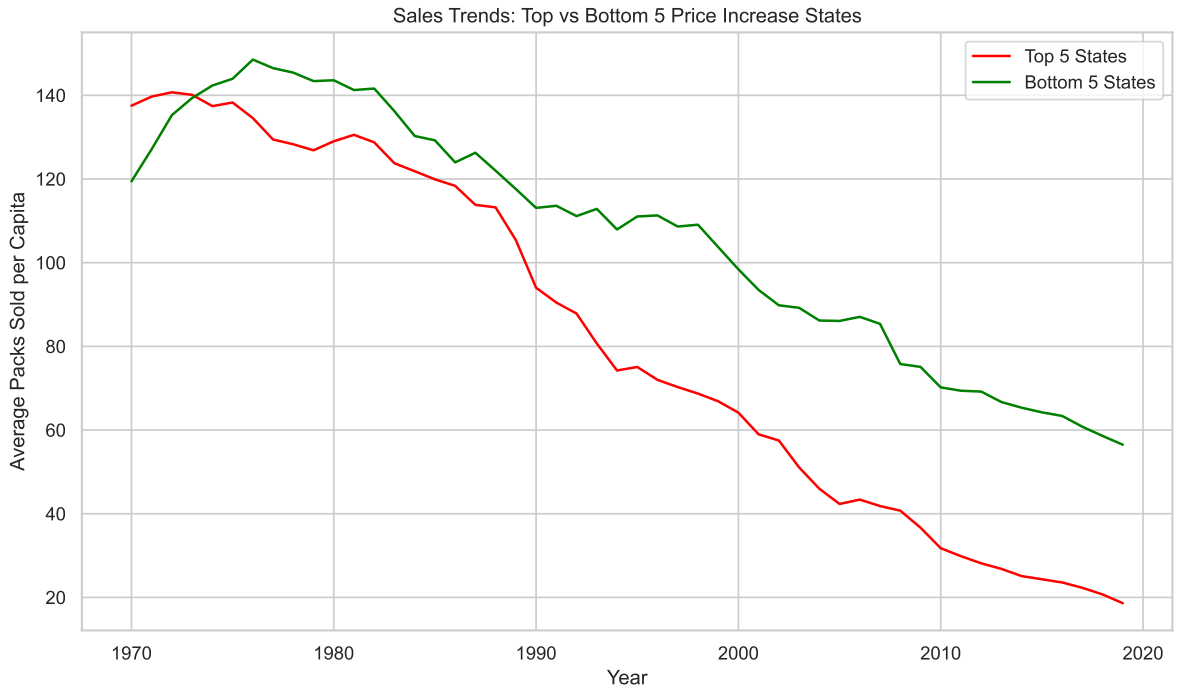
1.4 Top 5 states with lowes increases in cigarette prices

Decline in the top 5 states with the lowest increases mimic the previous graph, just a higher number of packs per person. While they directionally are comaprable, their scales are different.



1.5 Comparison of trends between these 10 states:

Contrasting the 10 states, it is easier to see the differences between the states with the highest taxes and those with the lowest. These graphs do show some indication that increasing the tax burden might decrease the number of packs per person, but there are many outside variables that have not been taken into account.



2. ATE

```
--- Period: 1970-1990 ---
OLS Elasticity Estimate: -0.1715
IV Elasticity Estimate: -0.2843

First Stage (log_price ~ log_tax):
                            OLS Regression Results
==============================================================================
Dep. Variable:              log_price   R-squared:                       0.683
Model:                            OLS   Adj. R-squared:                  0.683
Method:                 Least Squares   F-statistic:                     2301.
Date:                Sun, 16 Mar 2025   Prob (F-statistic):          8.21e-269
Time:                        21:13:35   Log-Likelihood:                -86.164
No. Observations:                1071   AIC:                             176.3
```

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Df Residuals:                     1069   BIC:                             186.3
Df Model:                            1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.1786      0.033     35.712      0.000       1.114       1.243
log_tax        1.0803      0.023     47.973      0.000       1.036       1.125
==============================================================================
Omnibus:                       30.760   Durbin-Watson:                   0.408
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               32.668
Skew:                           0.421   Prob(JB):                     8.06e-08
Kurtosis:                       3.156   Cond. No.                         8.72
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Reduced Form (log_sales ~ log_tax):
                            OLS Regression Results
==============================================================================
Dep. Variable:              log_sales   R-squared:                       0.236
Model:                            OLS   Adj. R-squared:                  0.235
Method:                 Least Squares   F-statistic:                     330.3
Date:                Sun, 16 Mar 2025   Prob (F-statistic):           1.56e-64
Time:                        21:13:35   Log-Likelihood:                 221.17
No. Observations:                1071   AIC:                            -438.3
Df Residuals:                    1069   BIC:                            -428.4
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.3750      0.025    176.627      0.000       4.326       4.424
log_tax       -0.3072      0.017    -18.175      0.000      -0.340      -0.274
==============================================================================
Omnibus:                       83.338   Durbin-Watson:                   0.157
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              430.014
Skew:                           0.023   Prob(JB):                     4.20e-94
Kurtosis:                       6.104   Cond. No.                         8.72
==============================================================================

Notes:
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[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
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--- Period: 1991-2015 ---
OLS Elasticity Estimate: -0.6656
IV Elasticity Estimate: -0.7626

First Stage (log_price ~ log_tax):
                            OLS Regression Results
==============================================================================
Dep. Variable:              log_price   R-squared:                       0.869
Model:                            OLS   Adj. R-squared:                  0.869
Method:                 Least Squares   F-statistic:                     8442.
Date:                Sun, 16 Mar 2025   Prob (F-statistic):               0.00
Time:                        21:13:35   Log-Likelihood:                396.65
No. Observations:                1275   AIC:                            -789.3
Df Residuals:                    1273   BIC:                            -779.0
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          1.2072      0.005    242.906      0.000       1.197       1.217
log_tax        0.6300      0.007     91.881      0.000       0.617       0.643
==============================================================================
Omnibus:                       10.474   Durbin-Watson:                   0.330
Prob(Omnibus):                  0.005   Jarque-Bera (JB):               10.642
Skew:                           0.223   Prob(JB):                      0.00489
Kurtosis:                       2.965   Cond. No.                         1.38
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Reduced Form (log_sales ~ log_tax):
                            OLS Regression Results
==============================================================================
Dep. Variable:              log_sales   R-squared:                       0.608
Model:                            OLS   Adj. R-squared:                  0.607
Method:                 Least Squares   F-statistic:                     1972.
Date:                Sun, 16 Mar 2025   Prob (F-statistic):          6.43e-261
Time:                        21:13:35   Log-Likelihood:                -184.97
No. Observations:                1275   AIC:                             373.9
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Df Residuals:                     1273   BIC:                             384.2
Df Model:                            1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.2369      0.008    540.256      0.000       4.221       4.252
log_tax       -0.4805      0.011    -44.405      0.000      -0.502      -0.459
==============================================================================
Omnibus:                       44.690   Durbin-Watson:                   0.217
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              107.551
Skew:                           0.134   Prob(JB):                     4.42e-24
Kurtosis:                       4.397   Cond. No.                         1.38
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
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Elasticity Comparison:
1970-1990 OLS: -0.1715, IV: -0.2843
1991-2015 OLS: -0.6656, IV: -0.7626
```