ECON 470 Homework 3

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The link to my repository: https://github.com/ellenwu-git/homework3

1. Present a bar graph showing the proportion of states with a change in their cigarette tax in each year from 1970 to 1985.

**Proportion of States with Cigarette Tax Changes (1970-1985)**
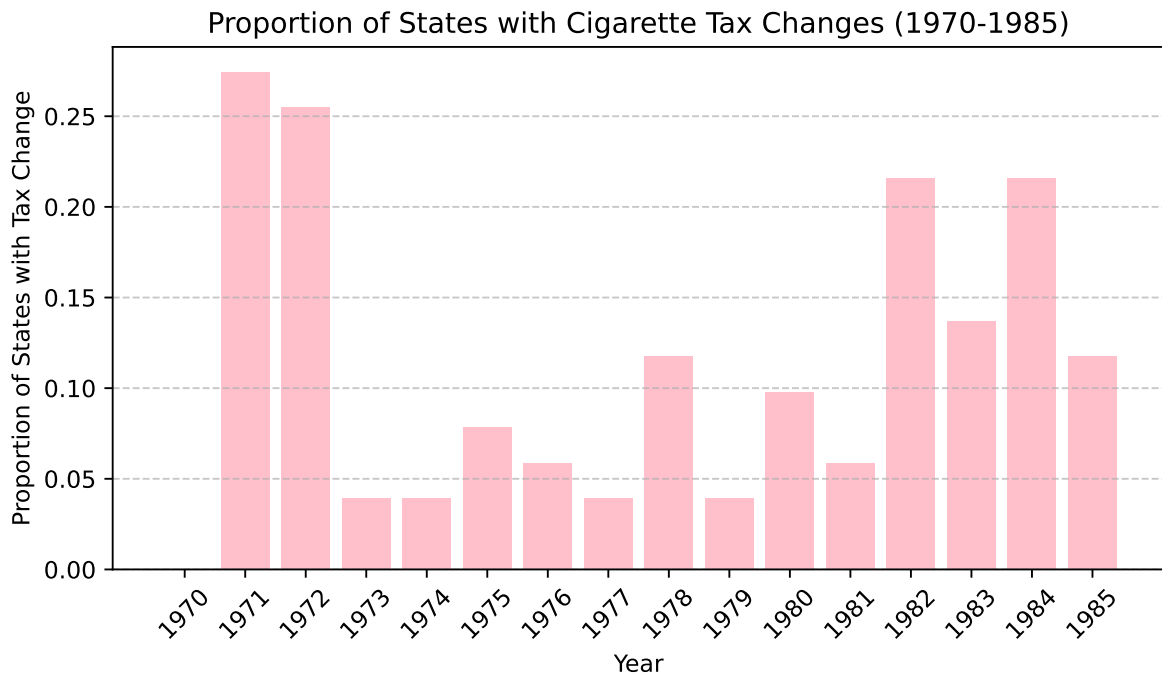
2. Plot on a single graph the average tax (in 2012 dollars) on cigarettes and the average price of a pack of cigarettes from 1970 to 2018.

Average Price and Tax per Pack (1970-2018) in 2012 Dollars
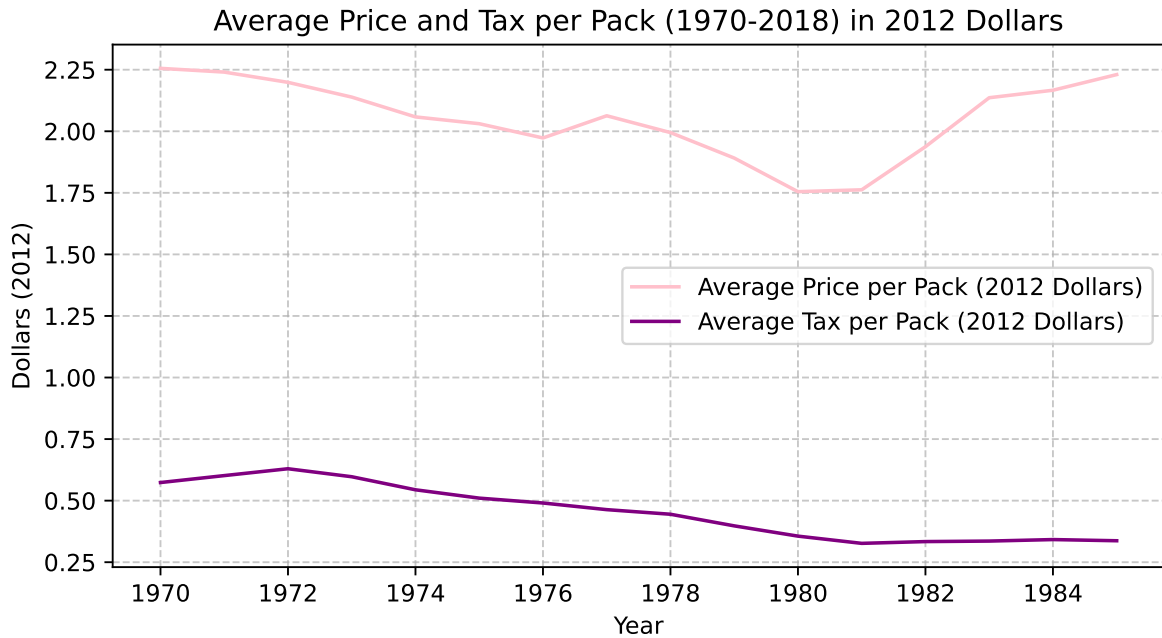
3. Identify the 5 states with the highest increases in cigarette prices (in dollars) over the time period. Plot the average number of packs sold per capita for those states from 1970 to 2018.

`No artists with labels found to put in legend.  Note that artists whose label start with an u`

Average Packs Sold Per Capita (Top 5 States with Highest Price Increases)
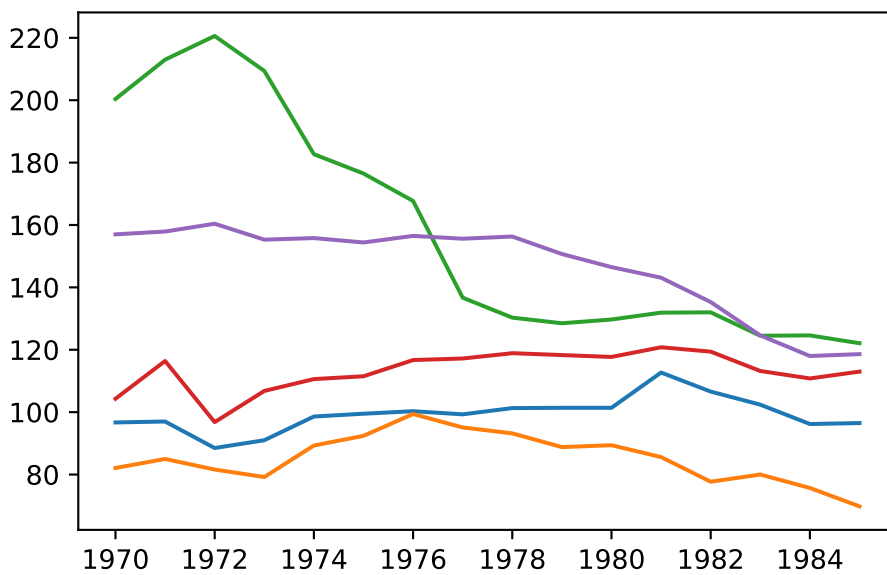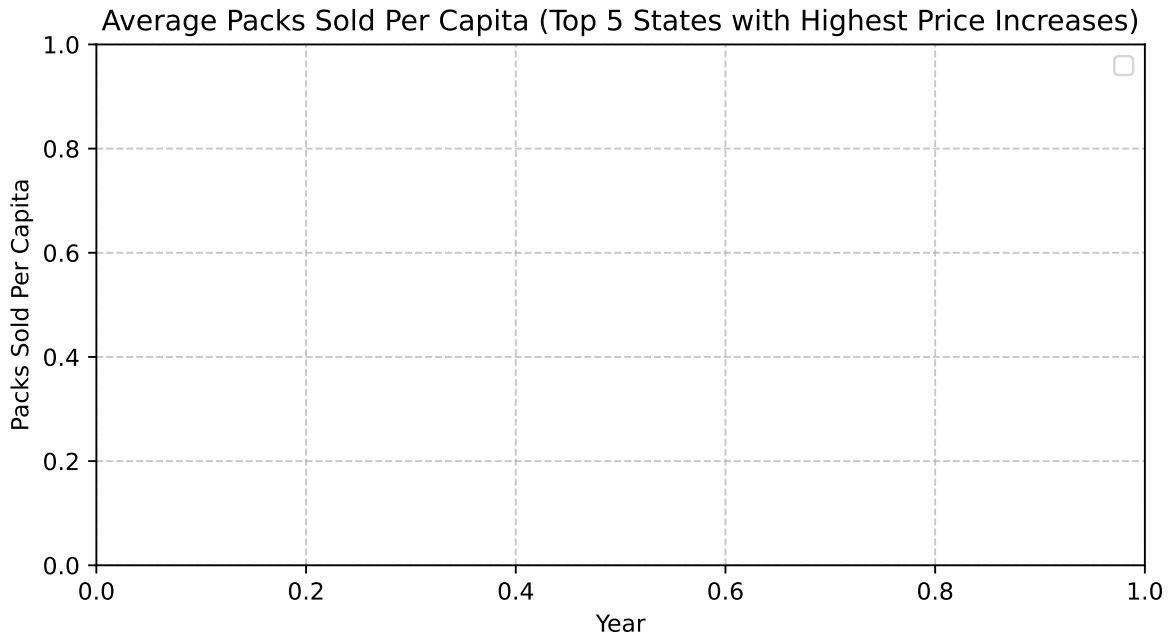
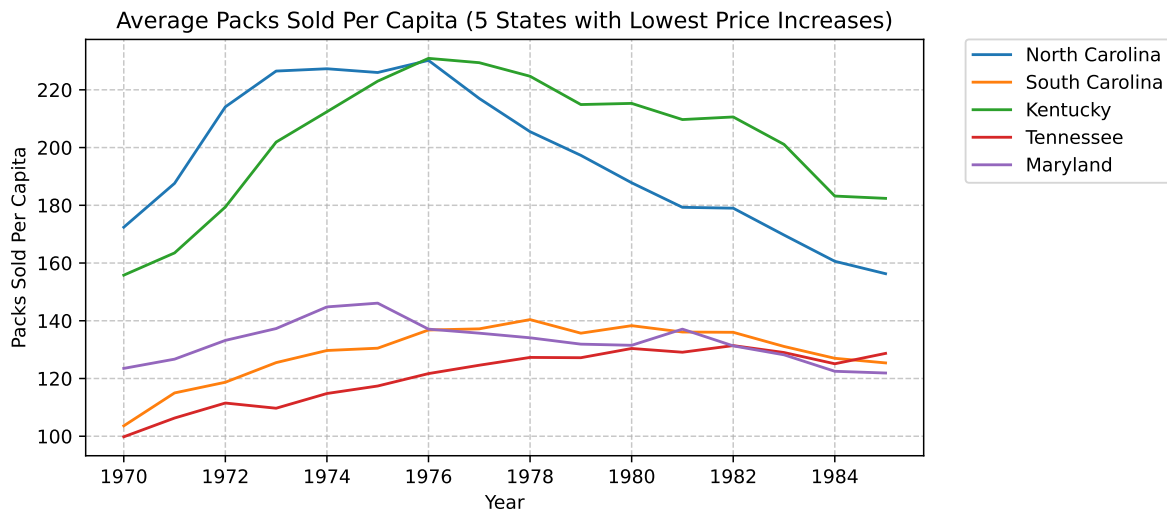4. Identify the 5 states with the lowest increases in cigarette prices over the time period. Plot the average number of packs sold per capita for those states from 1970 to 2018.

Average Packs Sold Per Capita (5 States with Lowest Price Increases)

5. Compare the trends in sales from the 5 states with the highest price increases to those with the lowest price increases.

Average Packs Sold Per Capita (Comparison: Highest vs Lowest Price Increase States)
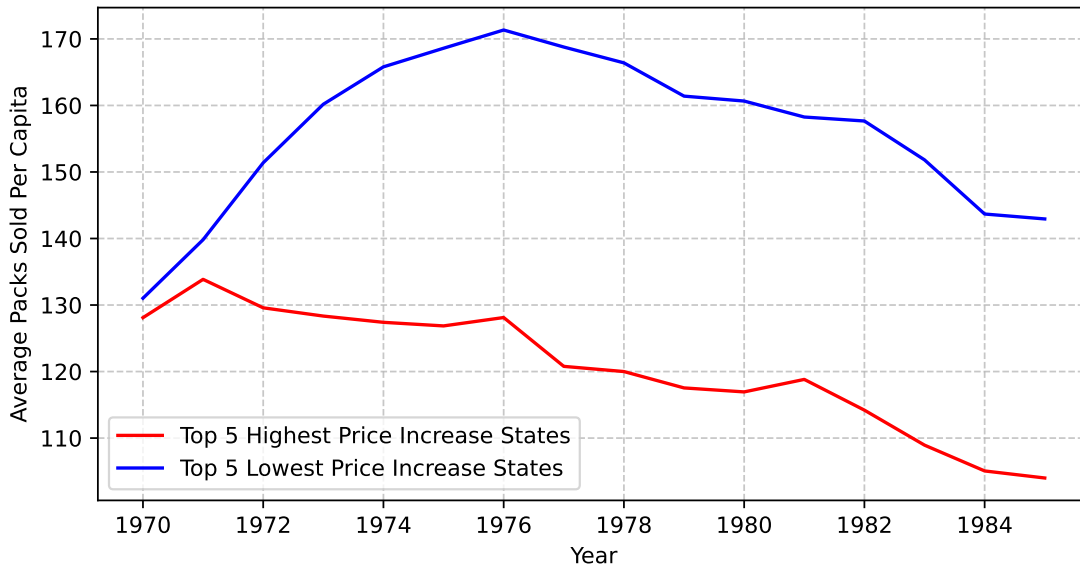
Based on the graph, states with the highest price increases experienced a steeper decline in average cigarette packs sold per capita over time compared to states with the lowest price increases. The states with the lowest price increases initially had higher per capita sales and, while they also saw a decline, the decline was more gradual. This suggests that higher cigarette prices are associated with sharper reductions in cigarette consumption, supporting the idea that cigarette demand is responsive to price increases.

6. Focusing only on the time period from 1970 to 1990, regress log sales on log prices to estimate the price elasticity of demand over that period. Interpret your results.

```
                         OLS Regression Results
==============================================================================
Dep. Variable:     log_sales_per_capita   R-squared:                       0.023
Model:                              OLS    Adj. R-squared:                  0.021
Method:                   Least Squares    F-statistic:                     18.82
Date:                  Wed, 05 Mar 2025    Prob (F-statistic):           1.62e-05
Time:                        16:46:48      Log-Likelihood:                 116.37
No. Observations:                   816    AIC:                            -228.7
Df Residuals:                       814    BIC:                            -219.3
Df Model:                             1
Covariance Type:                nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.8011      0.014    344.661      0.000       4.774       4.828
```

4

```
log_price_per_pack    -0.0929      0.021     -4.338      0.000      -0.135      -0.051
================================================================================
Omnibus:                         88.176   Durbin-Watson:                   0.150
Prob(Omnibus):                    0.000   Jarque-Bera (JB):              241.716
Skew:                             0.556   Prob(JB):                     3.25e-53
Kurtosis:                         5.424   Cond. No.                         3.89
================================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
Estimated Price Elasticity of Demand: -0.09
```

The estimated price elasticity of demand for cigarettes from 1970 to 1990 is approximately -0.09. This means that a 1% increase in the price of cigarettes is associated with only a 0.09% decrease in cigarette sales per capita. The elasticity is small in magnitude, indicating that cigarette demand was relatively inelastic during this period — meaning consumers were not highly responsive to price changes. The coefficient is statistically significant (p-value < 0.001), so there is strong evidence that price is related to cigarette sales, though the effect is quite small.

7. Again limiting to 1970 to 1990, regress log sales on log prices using the total (federal and state) cigarette tax (in dollars) as an instrument for log prices. Interpret your results and compare your estimates to those without an instrument. Are they different? If so, why?

```
                        IV-2SLS Estimation Summary
================================================================================
Dep. Variable:     log_sales_per_capita   R-squared:                    -0.0501
Estimator:                     IV-2SLS   Adj. R-squared:               -0.0514
No. Observations:                  816   F-statistic:                   79.982
Date:                 Wed, Mar 05 2025   P-value (F-stat)               0.0000
Time:                         16:46:48   Distribution:                 chi2(1)
Cov. Estimator:                 robust

                            Parameter Estimates
==================================================================================
                    Parameter  Std. Err.     T-stat    P-value   Lower CI   Upper CI
----------------------------------------------------------------------------------
const                  4.7090     0.0149     315.62     0.0000     4.6798     4.7383
log_price_per_pack    -0.2596     0.0290    -8.9433     0.0000    -0.3165    -0.2027
==================================================================================

Endogenous: log_price_per_pack
Instruments: tax_dollar
```

```
Robust Covariance (Heteroskedastic)
Debiased: False
```

```
Instrumented Price Elasticity of Demand: -0.26
```

8. Show the first stage and reduced-form results from the instrument.

```
First Stage Regression Results:
                         OLS Regression Results
==============================================================================
Dep. Variable:     log_price_per_pack   R-squared:                       0.583
Model:                            OLS   Adj. R-squared:                  0.582
Method:                 Least Squares   F-statistic:                     1138.
Date:                Wed, 05 Mar 2025   Prob (F-statistic):          1.00e-156
Time:                        16:46:48   Log-Likelihood:                 71.316
No. Observations:                 816   AIC:                            -138.6
Df Residuals:                     814   BIC:                            -129.2
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -1.4340      0.027    -52.581      0.000      -1.488      -1.380
tax_dollar     3.9366      0.117     33.728      0.000       3.708       4.166
==============================================================================
Omnibus:                       45.486   Durbin-Watson:                   0.445
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               35.777
Skew:                           0.423   Prob(JB):                     1.70e-08
Kurtosis:                       2.420   Cond. No.                         15.8
==============================================================================

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

Reduced Form Regression Results:
                         OLS Regression Results
==============================================================================
Dep. Variable:     log_sales_per_capita   R-squared:                     0.103
Model:                              OLS   Adj. R-squared:                0.102
Method:                   Least Squares   F-statistic:                   93.27
Date:                  Wed, 05 Mar 2025   Prob (F-statistic):         5.78e-21
Time:                          16:46:48   Log-Likelihood:               151.30
```

```
No. Observations:                   816   AIC:                        -298.6
Df Residuals:                       814   BIC:                        -289.2
Df Model:                             1
Covariance Type:              nonrobust
================================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const          5.0813      0.025    205.508      0.000       5.033       5.130
tax_dollar    -1.0219      0.106     -9.657      0.000      -1.230      -0.814
================================================================================
Omnibus:                        79.495   Durbin-Watson:                 0.187
Prob(Omnibus):                   0.000   Jarque-Bera (JB):            317.645
Skew:                            0.367   Prob(JB):                   1.06e-69
Kurtosis:                        5.967   Cond. No.                       15.8
================================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```
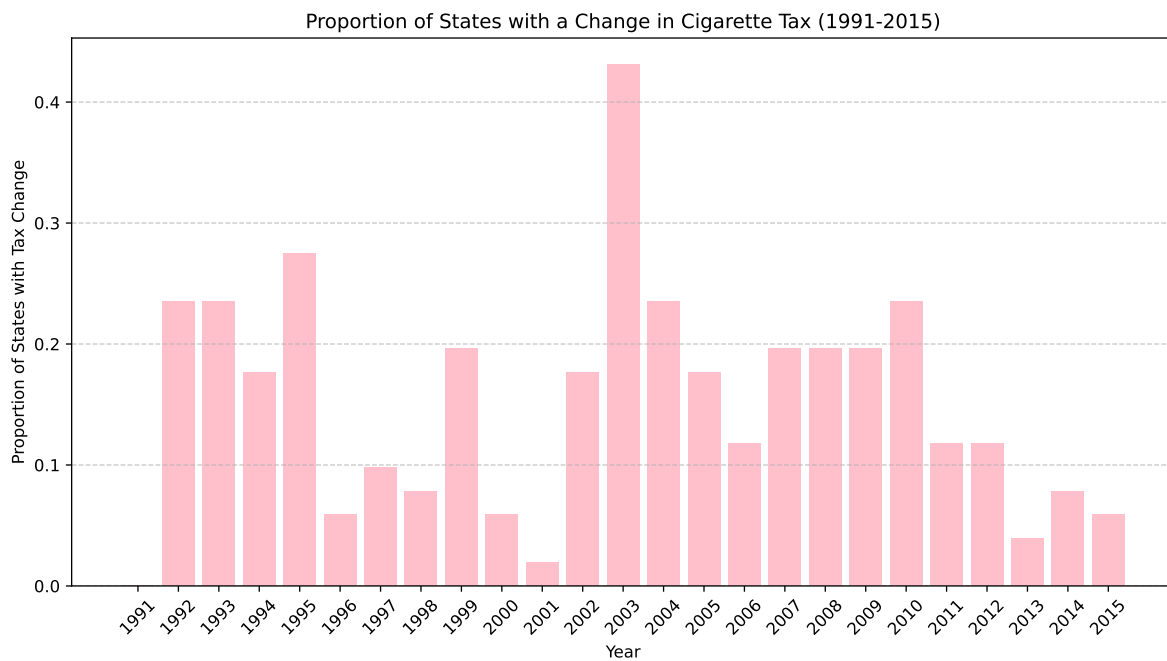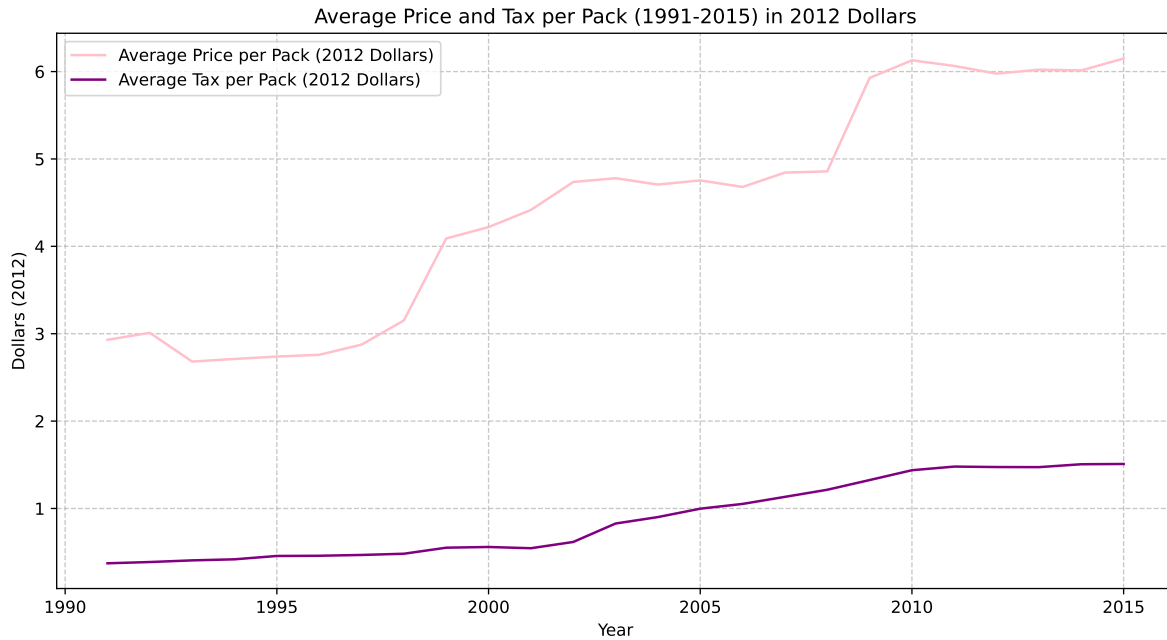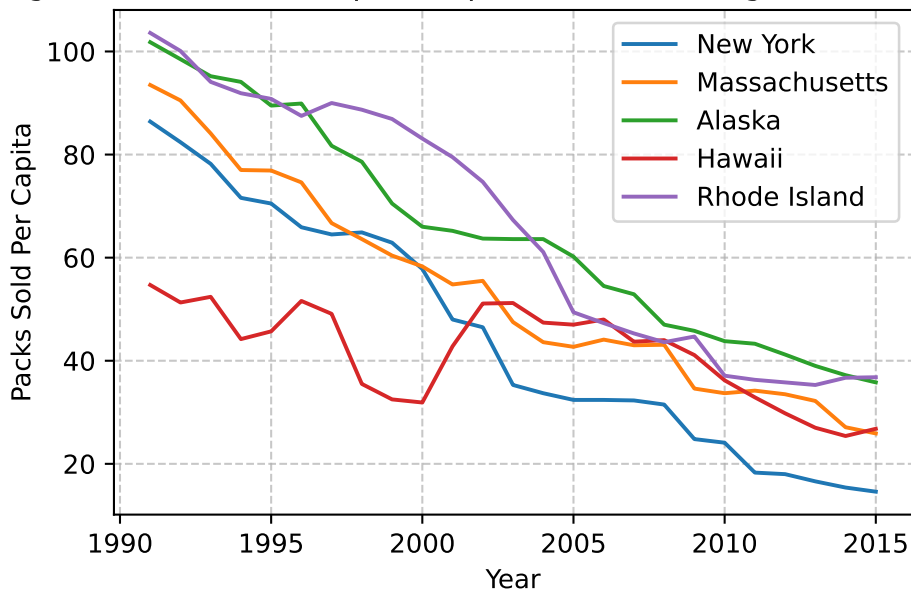
9. Repeat questions 1-3 focusing on the period from 1991 to 2015.

Proportion of States with a Change in Cigarette Tax (1991-2015)

Average Price and Tax per Pack (1991-2015) in 2012 Dollars

Average Packs Sold Per Capita (Top 5 States with Highest Price Increases)

10. Compare your elasticity estimates from 1970-1990 versus those from 1991-2015. Are they different? If so, why?

OLS Regression Results
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```
Dep. Variable:      log_sales_per_capita   R-squared:                    0.533
Model:                            OLS      Adj. R-squared:               0.532
Method:                 Least Squares      F-statistic:                  1451.
Date:                Wed, 05 Mar 2025      Prob (F-statistic):       1.52e-212
Time:                        16:46:48      Log-Likelihood:             -296.47
No. Observations:                1275      AIC:                          596.9
Df Residuals:                    1273      BIC:                          607.2
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                       coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const                5.0395      0.023    219.934      0.000       4.995       5.084
log_price_per_pack  -0.6656      0.017    -38.094      0.000      -0.700      -0.631
==============================================================================
Omnibus:                       19.351   Durbin-Watson:                   0.158
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               33.046
Skew:                           0.064   Prob(JB):                     6.67e-08
Kurtosis:                       3.778   Cond. No.                         5.37
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
Estimated Price Elasticity of Demand: -0.67
```