

Homework3-1

February 24, 2025

1 Homework 3-1

ECON470: Research in Health Economics

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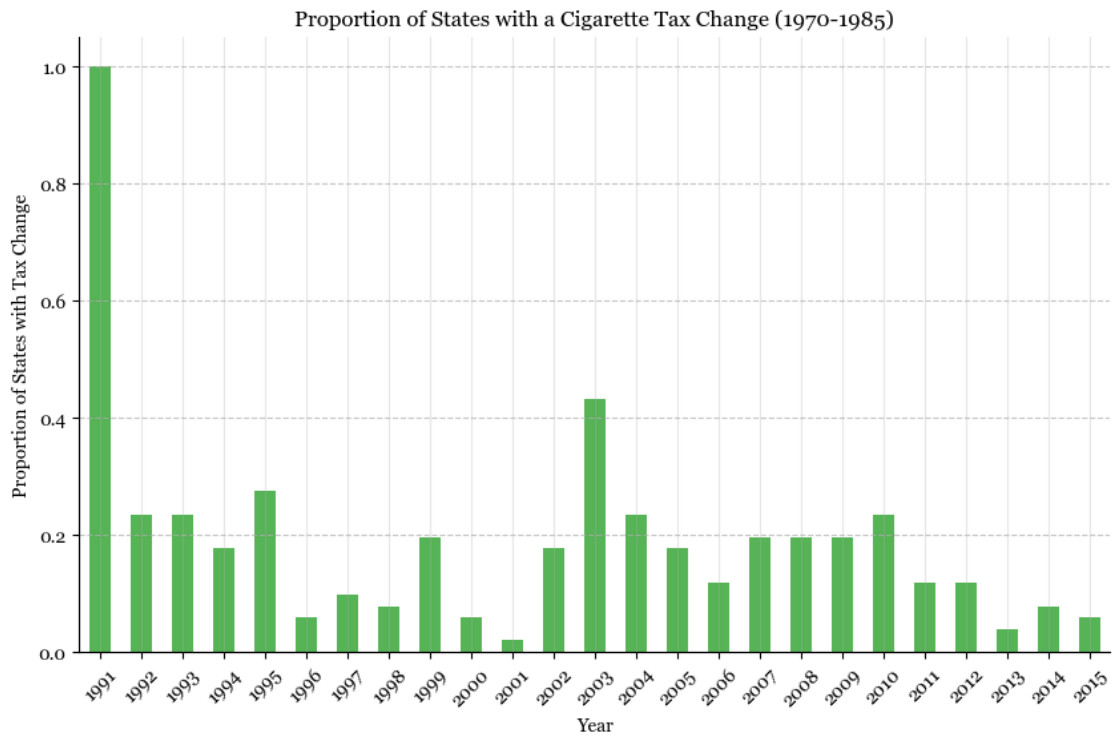
Dr. McCarthy

March 17, 2025

1.0.1 Summarize the Data

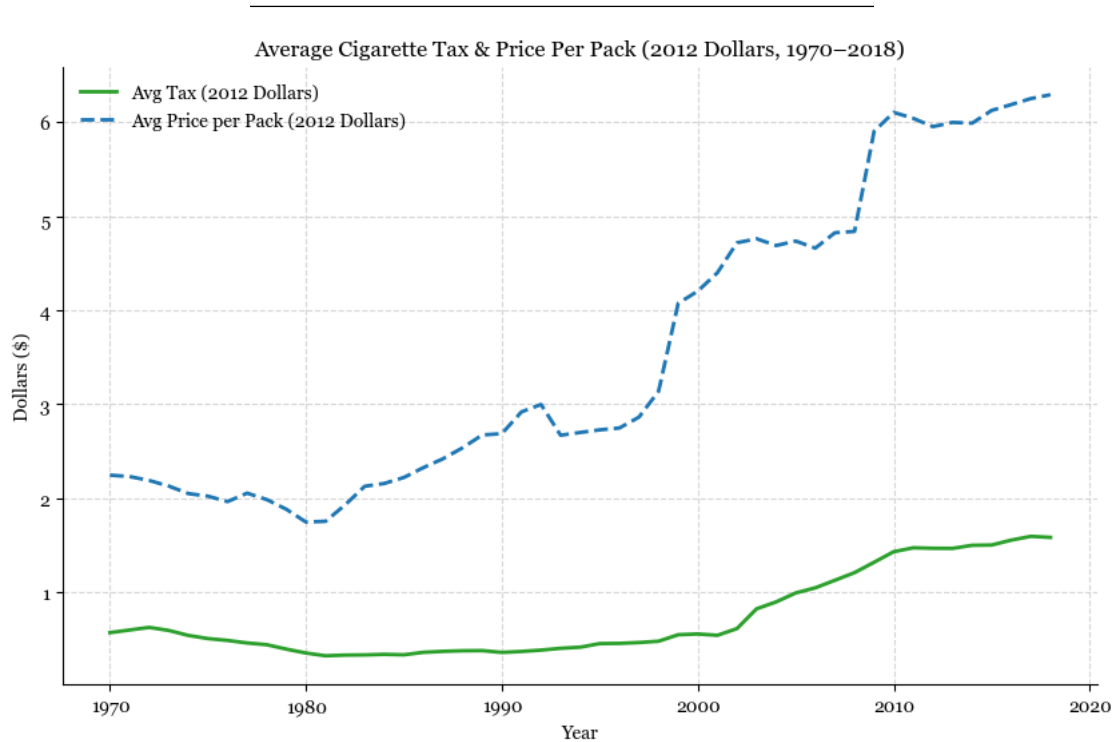
Question 1

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



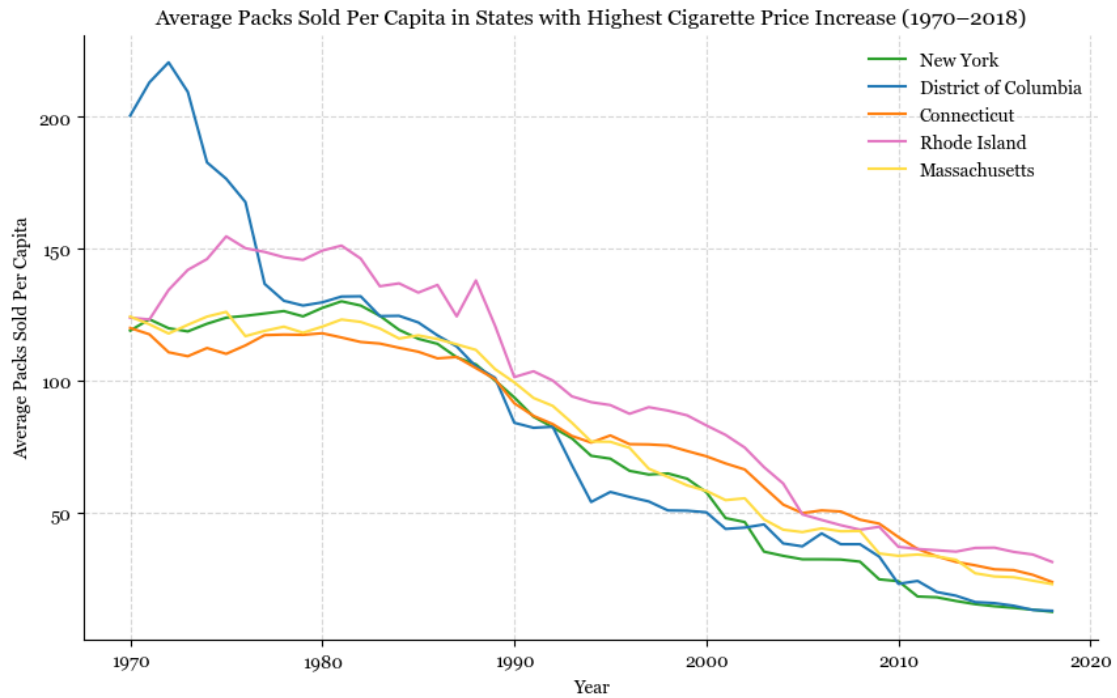
Question 2

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.



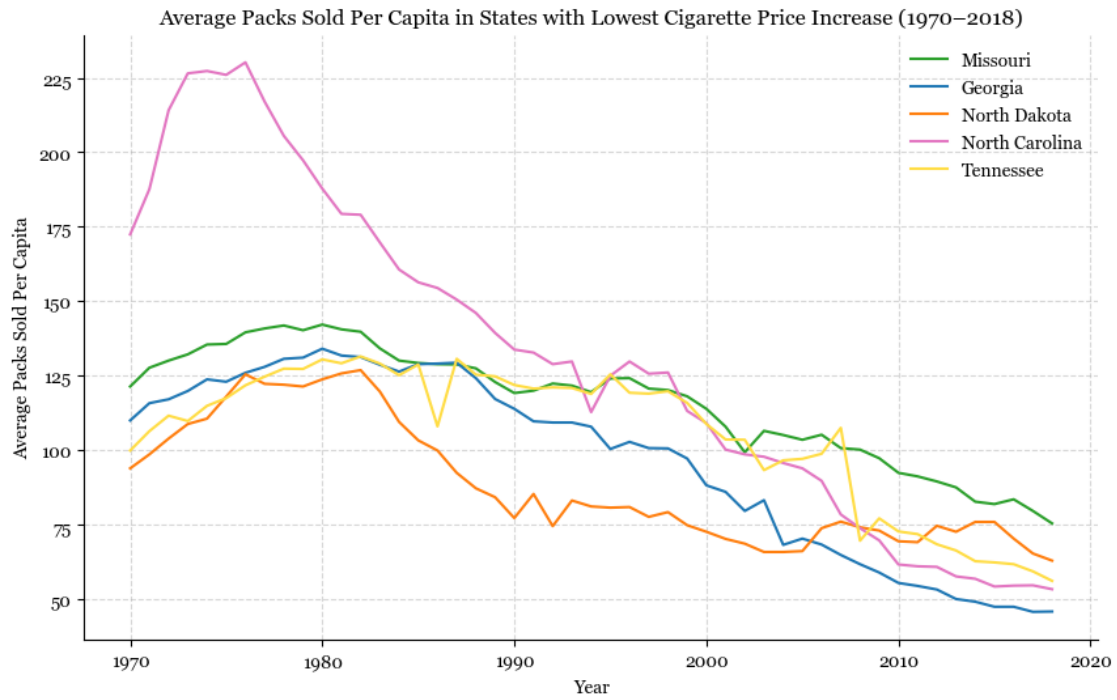
Question 3

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.



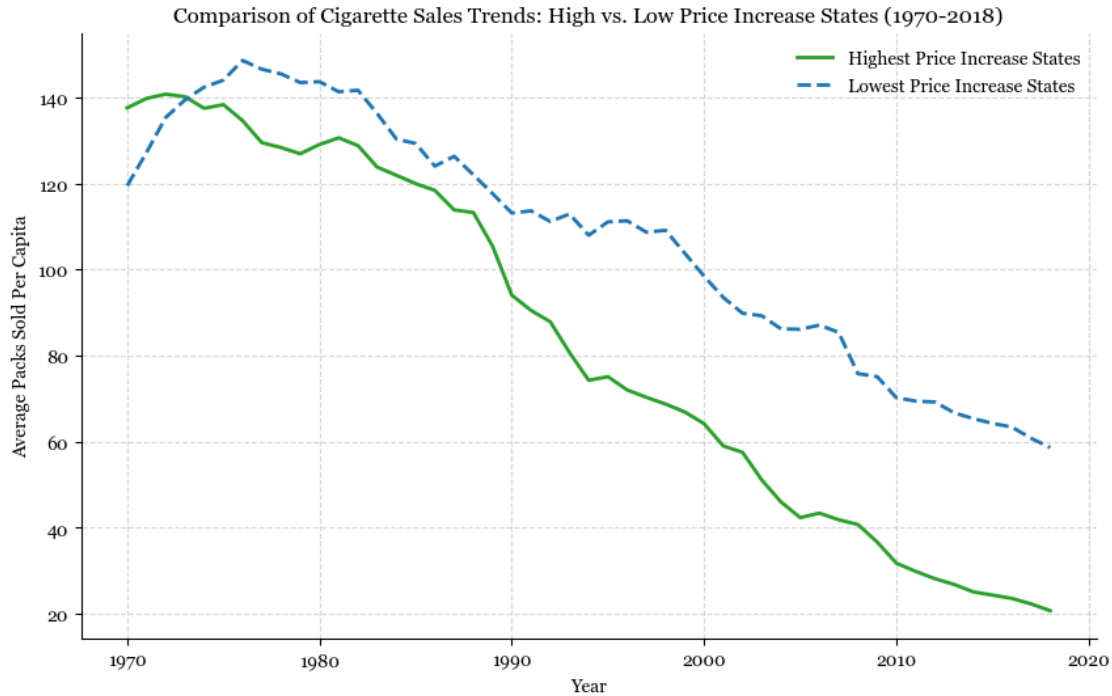
Question 4

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.



Question 5

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



1.0.2 Estimate ATEs

Now let's work on estimating a demand curve for cigarettes. Specifically, we're going to estimate the price elasticity of demand for cigarettes. When explaining your findings, try to limit your discussion just to a couple of sentences.

Question 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		R-squared:	0.126		
Model:	OLS		Adj. R-squared:	0.125		
Method:	Least Squares		F-statistic:	153.9		
Date:	Mon, 24 Feb 2025		Prob (F-statistic):	4.18e-33		
Time:	15:09:17		Log-Likelihood:	148.99		
No. Observations:	1071		AIC:	-294.0		
Df Residuals:	1069		BIC:	-284.0		
Df Model:	1					
Covariance Type:	nonrobust					
=====						
	coef	std err	t	P> t	[0.025	0.975]

const	4.7504	0.008	585.321	0.000	4.734	4.766
log_price	-0.1715	0.014	-12.404	0.000	-0.199	-0.144
=====						
Omnibus:		64.611	Durbin-Watson:			0.139
Prob(Omnibus):		0.000	Jarque-Bera (JB):			224.414
Skew:		0.173	Prob(JB):			1.86e-49
Kurtosis:		5.216	Cond. No.			2.48
=====						

Notes:

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

Estimated Price Elasticity of Demand: -0.172

The estimated price elasticity of demand is -0.172, meaning that a 1% increase in price is associated with a 0.172% decrease in sales.

Question 7A

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.

First Stage (Predicting log price using 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:	Mon, 24 Feb 2025	Prob (F-statistic):				8.21e-269
Time:	15:09:17	Log-Likelihood:				-86.164
No. Observations:	1071	AIC:				176.3
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.

Second Stage (IV Regression of log sales on predicted log price):

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:                  Mon, 24 Feb 2025  Prob (F-statistic):      1.56e-64
Time:                  15:09:17       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                4.7101          0.008    573.443    0.000      4.694
4.726
predicted_log_price  -0.2843          0.016   -18.175    0.000     -0.315
-0.254
=====
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.                 2.98
=====
```

Notes:

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

Question 7B

Interpret your results and compare your estimates to those without an instrument. Are they different? If so, why?

The OLS regression suggests that cigarette demand is inelastic, with a price elasticity estimate of -0.1715. This means that a 1% increase in cigarette prices results in only a 0.17% decline in sales per capita. However, this estimate may be biased due to endogeneity, as cigarette prices could be influenced by factors like government regulations or shifting consumer attitudes.

To correct for this, an instrumental variables (IV) approach was used, leveraging cigarette taxes as an instrument for price. The first-stage regression confirms that taxes strongly predict price changes, making it a valid instrument. If the IV estimate is larger in magnitude (more negative)

than OLS, it implies that OLS underestimated the true price elasticity by not accounting for external influences on price. Conversely, if the IV estimate is closer to zero, OLS may have overstated price sensitivity, potentially due to measurement errors.

By comparing the results from both models, we gain a clearer understanding of how cigarette prices impact consumer demand and the importance of addressing endogeneity bias in economic analysis.

Question 8

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

First Stage Regression: Predicting Log Price using 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:	Mon, 24 Feb 2025		Prob (F-statistic):	8.21e-269		
Time:	15:09:17		Log-Likelihood:	-86.164		
No. Observations:	1071		AIC:	176.3		
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 Regression: Predicting Log Sales using 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:	Mon, 24 Feb 2025	Prob (F-statistic):	1.56e-64
Time:	15:09:17	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			

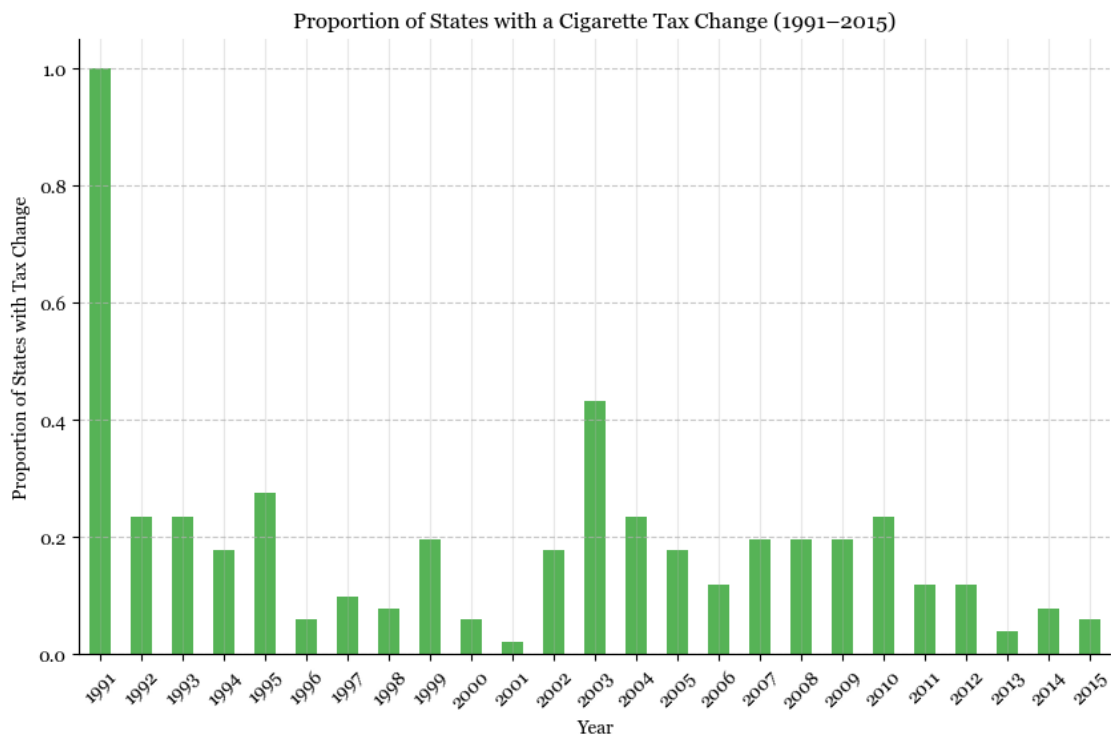
Notes:

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

Question 9: Repeat questions 1-3 focusing on the period from 1991 to 2015.

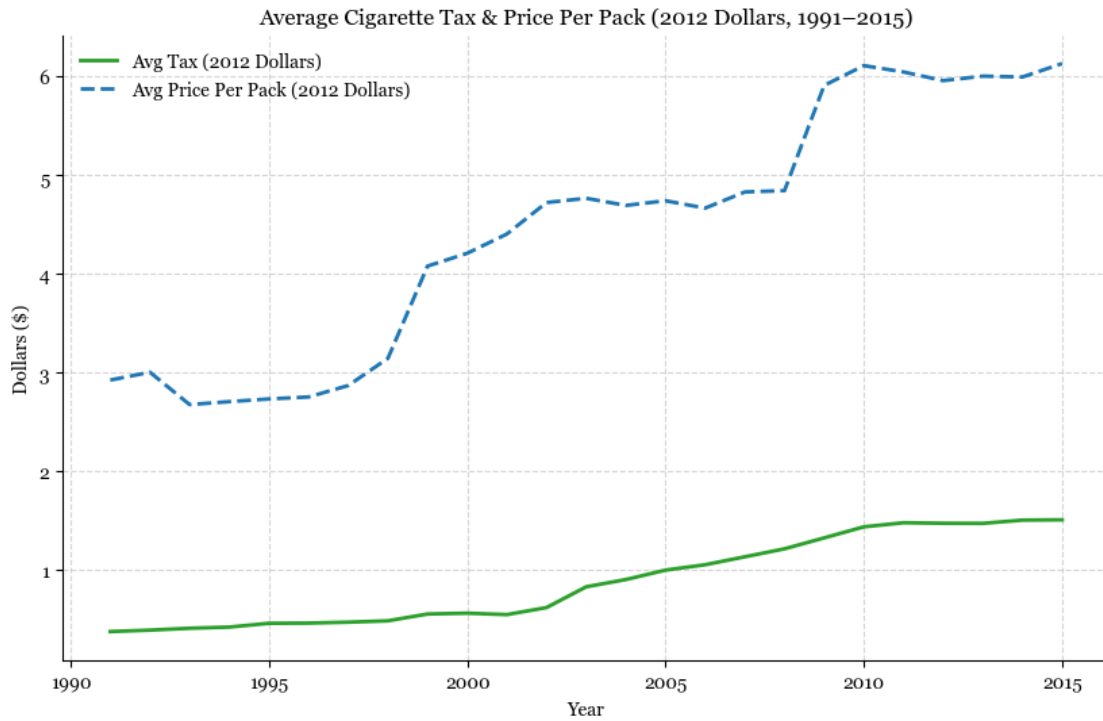
Question 9A

Present a bar graph showing the proportion of states with a change in their cigarette tax in each year from 1991 to 2015.



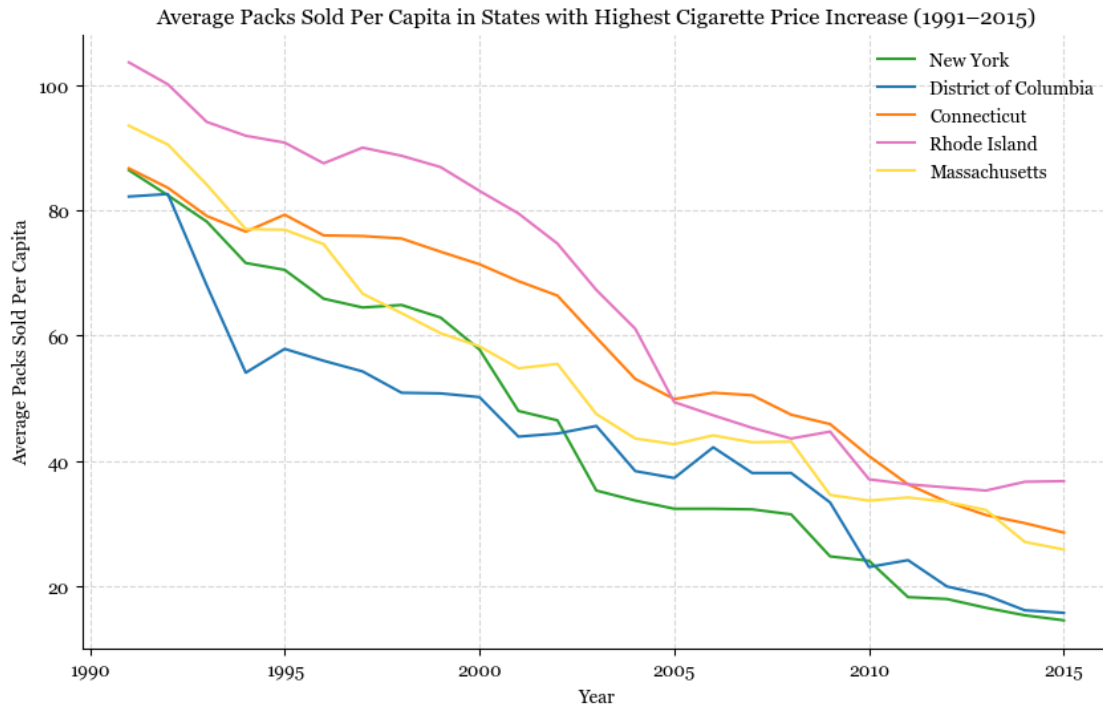
Question 9B

Plot on a single graph the average tax (in 2012 dollars) on cigarettes and the average price of a pack of cigarettes from 1991 to 2015.



Question 9C

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 1991 to 2015.



Question 10

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

The decrease in price elasticity over time suggests that non-price factors (e.g., regulations, health awareness, smoking bans) played a growing role in reducing cigarette consumption, making smokers less sensitive to price changes.