ECON 470 HW3

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1 Instructions

In this assignment, you'll recreate the CDC Tax Burden on Tobacco data and answer a few questions along the way. As with the last assignment, the first step is to make sure you've got the CDC Tax Burden on Tobacco repository and downloaded all of the raw data sources. Be sure to get the CPI data from the BLS as well, since we'll be working with real dollar values. Once you have the data downloaded and the code running, answer the following questions:

2 Summarize the data

2.0.1 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.

Figure 1 displays the proportion of states with a change in their cigarette tax in each year from 1970 to 1985.

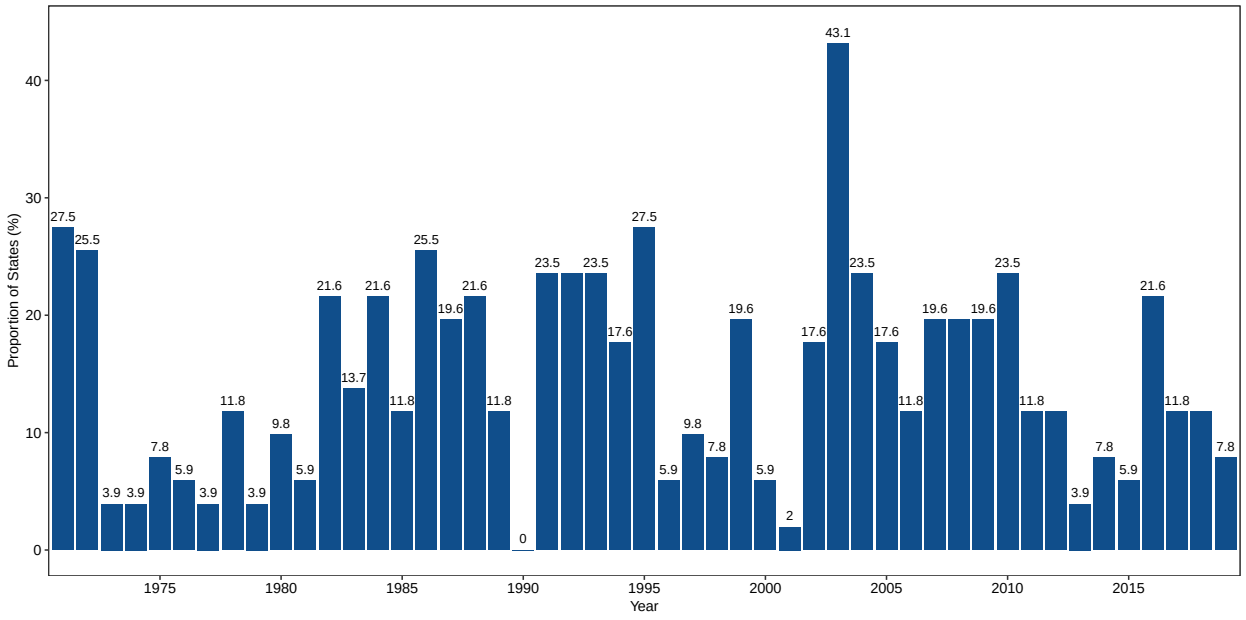

Figure 1: Average Tax (in 2012 dollars) on Cigarettes and Average Price of a Pack of Cigarettes from 1970 to 2019 in Each Year from 1970 to 2019

2.0.2 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 2019.

Figure 2 displays the average tax (in 2012 dollars) on cigarettes and the average price of a pack of cigarettes from 1970 to 2019. Both average tax on cigarettes and average price of a pack of cigarettes has been increasing from 1970 to 2019, after adjusted for inflation using 2012 dollars.

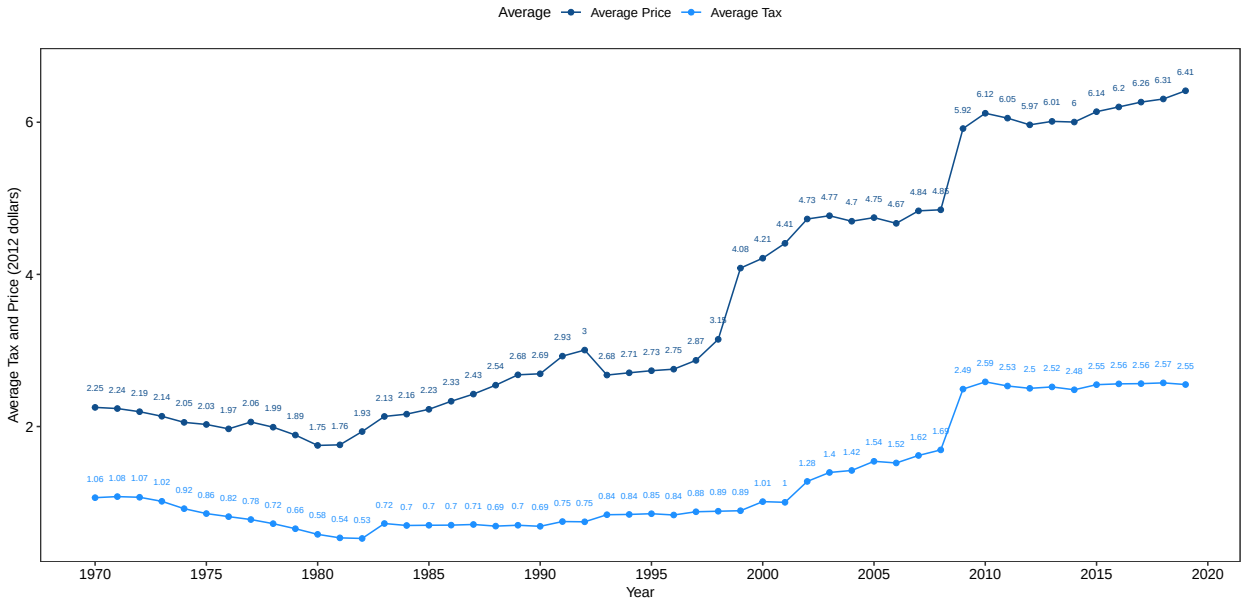

Figure 2: Average Tax (in 2012 dollars) on Cigarettes and Average Price of a Pack of Cigarettes in Each Year from 1970 to 2019

2.0.3 Question 3. Identify the 5 states with the highest increases in cigarette prices (in 2012 dollars) over the time period. Plot the average number of packs sold per capita for those states from 1970 to 2019.

District of Columbia, New York, Rhode Island, Massachusetts, Connecticut are the five states with the highest increases in cigarette prices (in 2012 dollars) over the time period from 1970 to 2019 (Table 1). Figure 3 displays the average number of packs sold per capita for those states from 1970 to 2019. The average number of packs sold per capita for those states has been decreasing from 1970 to 2019.

Table 1: Five States With the Highest Increases in Cigarette Prices (in 2012 dollars) from 1970 to 2019

State	Increases in Cigarette Prices
District of Columbia	7.43
New York	6.99
Rhode Island	6.49
Massachusetts	6.34
Connecticut	6.33

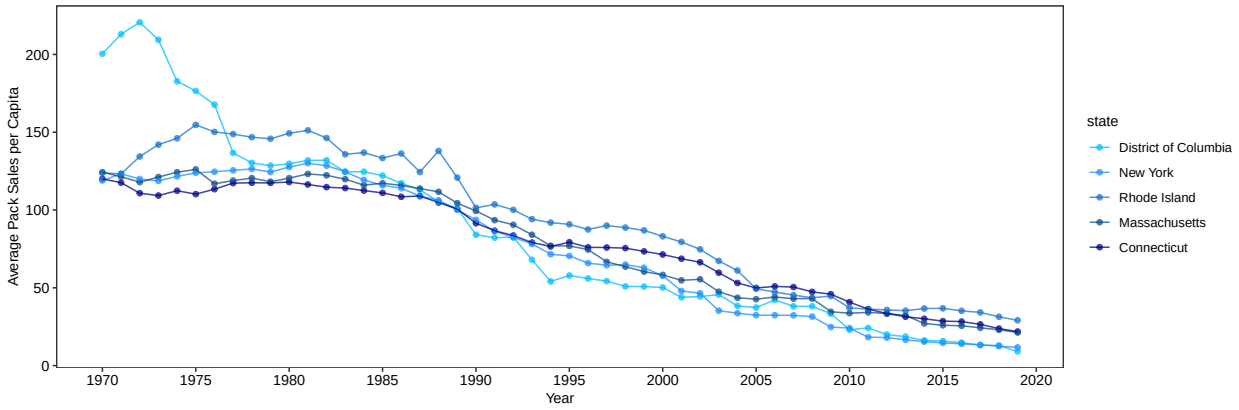

Figure 3: Average Number of Packs Sold per Capita for District of Columbia, New York, Rhode Island, Massachusetts, Connecticut from 1970 to 2019

2.0.4 Question 4. Identify the 5 states with the lowest increases in cigarette prices (in 2012 dollars) over the time period. Plot the average number of packs sold per capita for those states from 1970 to 2018.

Missouri, Tennessee, North Dakota, Alabama, Georgia are the five states with the lowest increases in cigarette prices (in 2012 dollars) over the time period from 1970 to 2019 (Table 2). Figure 4 displays the average number of packs sold per capita for those states from 1970 to 2019. The average number of packs sold per capita for those states has been increasing slightly until around 1982 and then decreasing ever since.

Table 2: Five States With the Lowest Increases in Cigarette Prices (in 2012 dollars) from 1970 to 2019

State	Increases in Cigarette Prices
Missouri	2.50
Tennessee	2.52
North Dakota	2.58
Alabama	2.67
Georgia	2.69

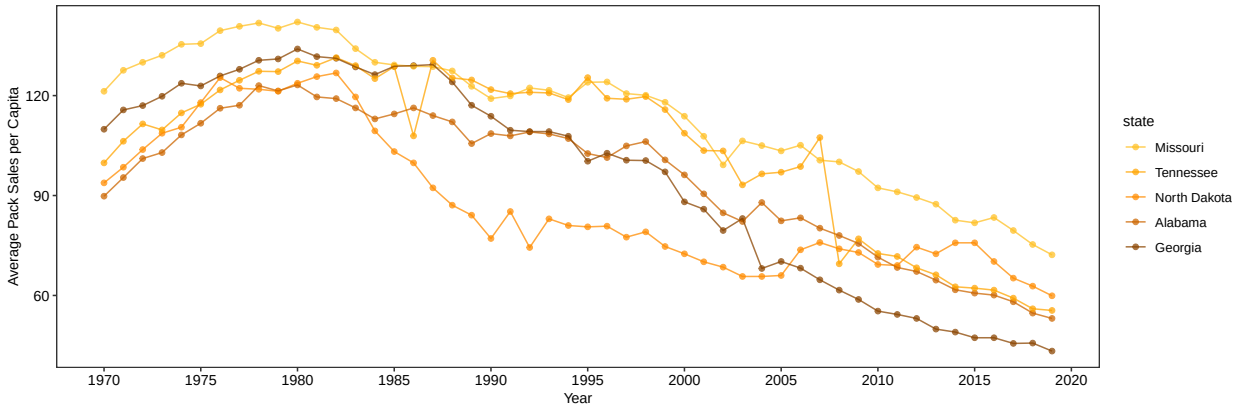

Figure 4: Average Number of Packs Sold per Capita for Missouri, Tennessee, North Dakota, Alabama, Georgia from 1970 to 2019

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

Figure 5 shows that the overall trend for the average sales from the 5 states with the highest price increases is decreasing from 1970 to 2019, while that from the 5 states with the lowest price increases is increasing slightly until around 1982 and then decreasing ever since.

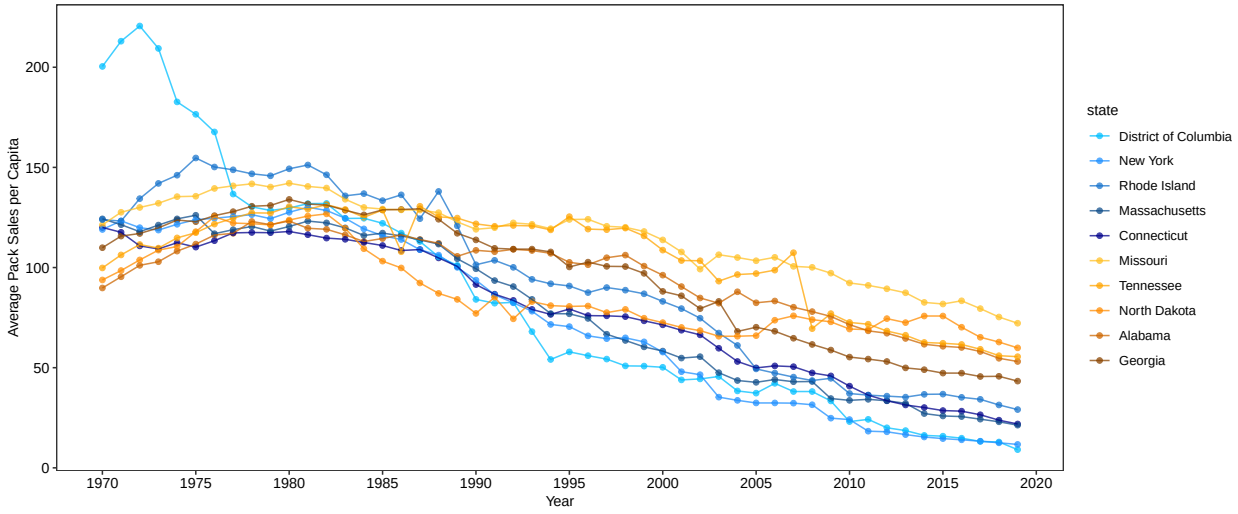

Figure 5: Average Number of Packs Sold per Capita For Selected States from 1970 to 2019 (Linear Fit)

Figure 6 shows that the linear best fit lines for the average sales from the 5 states with the highest price increases have relatively steeper slopes, which means that the average sales decrease relatively faster, while those from the 5 states with the lowest price increases have relatively smaller slopes.

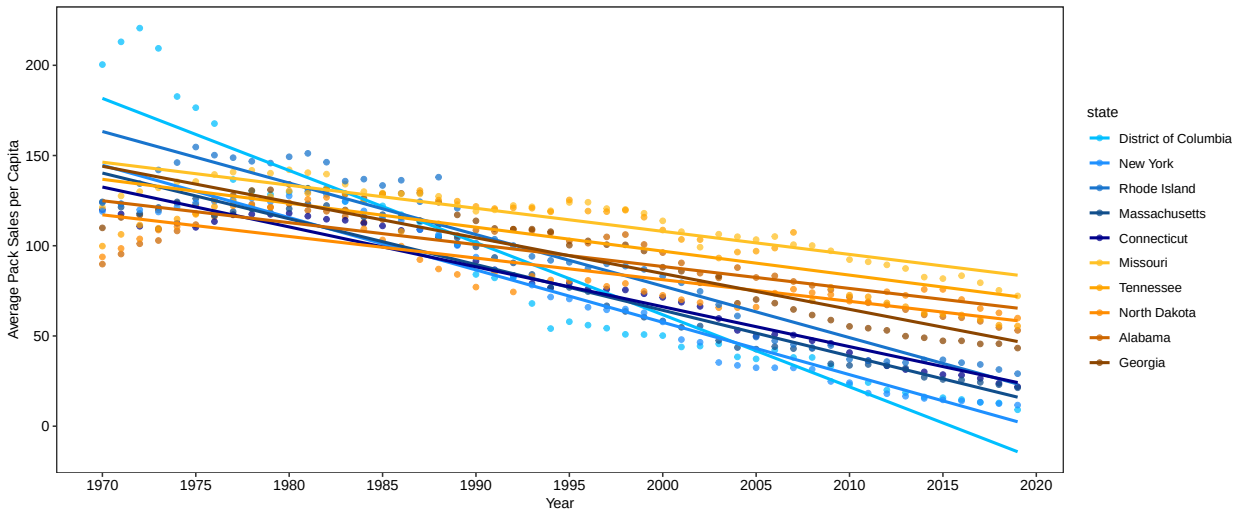

Figure 6: Average Number of Packs Sold per Capita for Selected States from 1970 to 2019 (Linear Fit)

3 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.

3.0.1 Question 1. 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.

Table 3 displays the output of regressing log sales on log prices. The regression coefficient for log prices is -0.80944, which means that for every 1% increase in the prices (average cost per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 0.80944%. Thus, the estimate of the price elasticity of demand from 1970 to 1990 is -0.80944, the absolute value of which is smaller than 1, meaning that the demand for cigarettes over this period is inelastic.

Table 3: Log-Log Regression of Sales and Prices (1970-1990)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	5.42738	0.02975	182.42376	0
ln_price	-0.80944	0.03837	-21.09805	0

3.0.2 Question 2. Again limiting to 1970 to 1990, regress log sales on log prices using the total (federal and state) cigarette tax (in 2012 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?

Table 4 displays the output of regressing log sales on log prices, with cigarette tax as an instrument for log prices. The regression coefficient for log prices is -0.736, which means that for every 1% increase in the prices (average cost per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 0.736%. Thus, the estimate of the price elasticity of demand from 1970 to 1990 is -0.736, the absolute value of which is smaller than 1, meaning that the demand for cigarettes over this period is inelastic. Comparing to those without an instrument, the absolute values of the estimates with an instrument are smaller, since some variation in log prices is now explained by cigarette tax. The smaller absolute value of the estimate of the price elasticity of demand means that the demand for cigarettes over this period is more inelastic controlling for changes in cigarette tax.

Table 4: Log-Log Regression of Sales and Prices, Cigarette Tax as Instrument for Log Prices (1970-1990)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	5.37152	0.05745	93.49861	0
fit_ln_price	-0.73600	0.07514	-9.79490	0

3.0.3 Question 3. Show the first stage and reduced-form results from the instrument.

Table 5 displays the first stage and reduced-form results from the cigarette tax instrument.

The regression coefficient for log prices in the first stage model is 0.32718, which means that for every 1% increase in the cigarette tax (federal and state tax per pack in 2012 dollars), the prices (average cost per pack in 2012 dollars) increases by 0.32718%.

The regression coefficient for log sales in the reduced-form model is -0.2408, which means that for every 1% increase in the cigarette tax (federal and state tax per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 0.2408%.

Table 5: First Stage and Reduced-Form Results from Cigarette Tax Instrument (1970-1990)

	Log Prices	Log Sales
	First Stage	Reduced Form
Constant	0.508***	4.998***
	(0.014)	(0.023)
Tax per Pack	0.327***	−0.241***
	(0.017)	(0.028)
Num.Obs.	1071	1071
F	378.696	72.582

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

3.0.4 Question 4. Repeat questions 1-3 focusing on the period from 1991 to 2015.

Table 6 displays the output of regressing log sales on log prices. The regression coefficient for log prices is -0.99681, which means that for every 1% increase in the prices (average cost per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 0.99681%. Thus, the estimate of the price elasticity of demand from 1991 to 2015 is -0.99681, the absolute value of which is slightly smaller than 1, meaning that the demand for cigarettes over this period is slightly inelastic.

Table 6: Log-Log Regression of Sales and Prices (1991-2015)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	5.65996	0.03638	155.56014	0
ln_price	-0.99681	0.02469	-40.36973	0

Table 7 displays the output of regressing log sales on log prices, with cigarette tax as an instrument for log prices. The regression coefficient for log prices is -1.16354, which means that for every 1% increase in the prices (average cost per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 1.16354%. Thus, the estimate of the price elasticity of demand from 1991 to 2015 is -1.16354, the absolute value of which is greater than 1, meaning that the demand for cigarettes over this period is elastic. Comparing to those without an instrument, the absolute values of the estimates with an instrument are larger, since some variation in log prices is now explained by cigarette tax. The larger absolute value of the estimate of the price elasticity of demand means that the demand for cigarettes over this period is more elastic controlling for changes in cigarette tax.

Table 7: Log-Log Regression of Sales and Prices, Cigarette Tax as Instrument for Log Prices (1991-2015)

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	5.89917	0.04210	140.13825	0
fit_ln_price	-1.16354	0.02874	-40.47909	0

Table 8 displays the first stage and reduced-form results from the cigarette tax instrument.

The regression coefficient for log prices in the first stage model is 0.30755, which means that for every 1% increase in the cigarette tax (federal and state tax per pack in 2012 dollars), the prices (average cost per pack in 2012 dollars) increases by 0.30755%.

The regression coefficient for log sales in the reduced-form model is -0.35784, which means that for every 1% increase in the cigarette tax (federal and state tax per pack in 2012 dollars), the quantity of sales (pack sales per capita) decreases by 0.35784%.

Table 8: First Stage and Reduced-Form Results from Cigarette Tax Instrument (1991-2015)

	Log Prices	Log Sales
	First Stage	Reduced Form
Constant	0.971***	4.769***
	(0.009)	(0.015)
Tax per Pack	0.308***	−0.358***
	(0.005)	(0.008)
Num.Obs.	1275	1275
F	4129.312	1792.312

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

3.0.5 Question 5. Compare your elasticity estimates from 1970-1990 versus those from 1991-2015. Are they different? If so, why?

Table 9 displays the regression outputs of elasticity estimates from 1970-1990 versus those from 1991-2015.

The price elasticity of demand estimates from 1970-1990 versus those from 1991-2015 are different. The absolute values of estimates from 1970-1990 are smaller than one, while those from 1991-2015 are closer to one or greater to one. The regression outputs mean that the demand of cigarette is inelastic from 1970-1990 and becomes elastic from 1991-2015. This means that consumers become more responsive to the increase in cigarette prices over time, which reflects a shift in consumer preferences. As consumers become more aware of the negative impact of cigarette consumption on personal health and have more alternative options, the demand becomes more elastic despite the addictive nature of cigarettes.

Table 9: Elasticity Estimates from 1970-1990 versus Those from 1991-2015

	1970-1990		1991-2015	
	OLS	IV	OLS	IV
Constant	5.427***	5.372***	5.660***	5.899***
	(0.030)	(0.057)	(0.036)	(0.042)
Log Prices	−0.809***		−0.997***	
	(0.038)		(0.025)	
Fitted Log Prices		−0.736***		−1.164***
		(0.075)		(0.029)
Num.Obs.	1071	1071	1275	1275
F	445.128		1629.715	
Std.Errors		IID		IID

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

3.0.6 Addition: Fixed Effects

Table 10 and table 11 display the first stage and reduced-form results from the cigarette tax instrument from 1970-1990 and from 1991-2015 respectively, considering the fixed effects of year and state.

Table 10: First Stage and Reduced-Form Results from Tax Instrument, incl. Fixed Effects (1970-1990)

	Log Prices				Log Sales			
	Step One				Reduced Form			
	No FE	FE Year	FE State	FE Both	No FE	FE Year	FE State	FE Both
Constant	0.508***				4.998***			
	(0.014)				(0.023)			
Tax per Pack	0.327***	0.505***	0.202***	0.459***	−0.241***	−0.481***	−0.068*	−0.404***
	(0.017)	(0.006)	(0.019)	(0.014)	(0.028)	(0.023)	(0.027)	(0.027)
Num.Obs.	1071	1071	1071	1071	1071	1071	1071	1071
F	378.696				72.582			
Std.Errors		by: Year	by: state	by: Year		by: Year	by: state	by: Year
FE: state			X	X			X	X
FE: Year		X		X		X		X

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 11: First Stage and Reduced-Form Results from Tax Instrument, incl. Fixed Effects (1991-2015)

	Log Prices				Log Sales			
	Step One				Reduced Form			
	No FE	FE Year	FE State	FE Both	No FE	FE Year	FE State	FE Both
Constant	0.971***				4.769***			
	(0.009)				(0.015)			
Tax per Pack	0.308***	0.224***	0.330***	0.159***	−0.358***	−0.319***	−0.343***	−0.185***
	(0.005)	(0.009)	(0.013)	(0.006)	(0.008)	(0.012)	(0.015)	(0.012)
Num.Obs.	1275	1275	1275	1275	1275	1275	1275	1275
F	4129.312				1792.312			
Std.Errors		by: Year	by: state	by: Year		by: Year	by: state	by: Year
FE: state			X	X			X	X
FE: Year		X		X		X		X

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 12 displays the regression outputs of elasticity estimates from 1970-1990 versus those from 1991-2015, considering the fixed effects of year and state. The regression outputs mean that the demand of cigarette is inelastic from 1970-1990 and becomes elastic from 1991-2015.

Table 12: Elasticity Estimates from 1970-1990 versus Those from 1991-2015, incl. Fixed Effects

	1970-1990					1991-2015				
	OLS	IV	FE Year	FE State	FE Both	OLS	IV	FE Year	FE State	FE Both
Constant	5.427***	5.372***				5.660***	5.899***			
	(0.030)	(0.057)				(0.036)	(0.042)			
Log Prices	−0.809***					−0.997***				
	(0.038)					(0.025)				
Fitted Log Prices		−0.736***	−0.952***	−0.338*	−0.878***		−1.164***	−1.427***	−1.040***	−1.164***
		(0.075)	(0.040)	(0.128)	(0.051)		(0.029)	(0.034)	(0.041)	(0.082)
Num.Obs.	1071	1071	1071	1071	1071	1275	1275	1275	1275	1275
F	445.128					1629.715				
Std.Errors		IID	by: Year	by: state	by: Year		IID	by: Year	by: state	by: Year
FE: state				X	X				X	X
FE: Year			X		X			X		X

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001