

The Impact of Sub-State Tax Changes on State Cigarette Tax Revenues in Illinois

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Outline

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Background

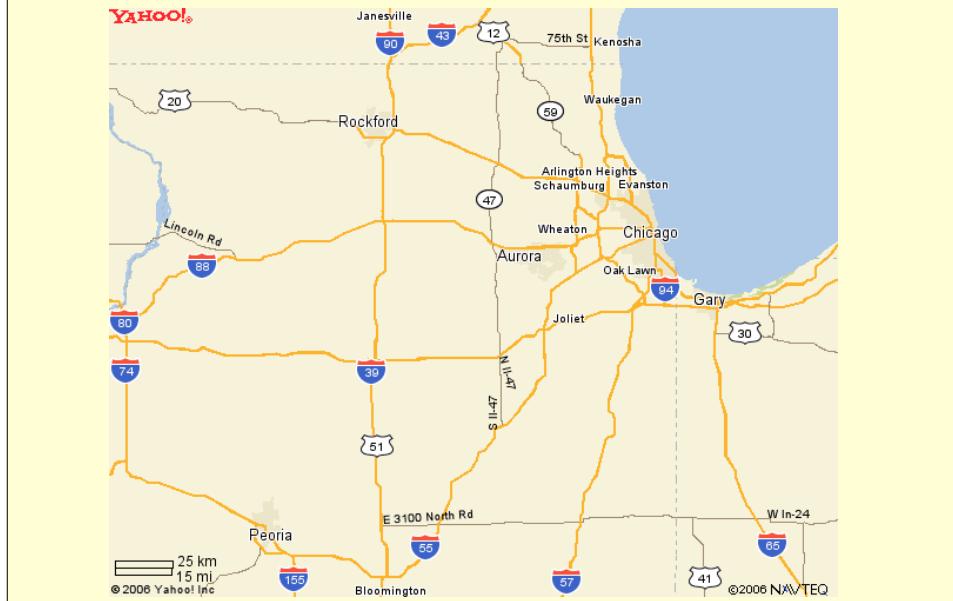
Taxing Body	Tax Rate Increase	Effective Date
State of Illinois	40 Cents	July 1, 2002
Cook County	82 Cents	April 1, 2004
City of Chicago	32 Cents	January 1, 2005
City of Chicago	20 Cents	January 1, 2006
Cook County	\$1.00	March 1, 2006

- Cigarette Taxes were originally instituted in Illinois with the Cigarette Tax Act in 1947.
- In July 2002 the price of a cigarette stamp increased from 58 cents to 98 cents per pack.
- In 2001, excise tax rates were 58 cents, 16 cents and 15 cents in Illinois, Cook County and Chicago respectively.

Leading up to the Research Question

- In fiscal year 2006 the Illinois Department of Revenues in anticipation of coming tax changes at the sub-state level, adjusted it's own excise tax receipt expectations.
- Revenue estimates applied U.S. Treasury cigarette elasticity -0.4 to an estimated proportion of sales within Cook County.
- It was thought that the price of cigarettes in metro Chicago were sufficient to cause an exodus of consumers to purchase cigarettes in Indiana.

Northern Illinois



Purpose of the Research



- Illinois revenue estimates were later adjusted up by \$15 million (2.5%) because revenues did not decline as much as expected.
- Missing the revenue estimate gave us the opportunity to look for reasons why and look for ways to make better forecasts in the future.

Research Questions



- Does an increase in the price of cigarette stamps sold by sub-state governments cause the number of cigarette stamps sold by the state of Illinois to decline?
- Will Illinois retailers hoard state stamps if sub-state governments increase their tax rates.

Limitations of this Research

- With a small dataset ($n = 52$) regression analysis is limited in the number of explanatory variables it can use.
- This research does not assess the impact of the following effects.
 - Outside of state cross border effects.
 - Impact of spending on anti-smoking campaigns.
 - Income or level of education.
 - Seasonality in sales.

Hypothesis 1

Null Hypothesis

H_0 : There is no difference in the mean cigarette stamps sold per month by the State of Illinois after City of Chicago increased the price of its cigarette stamp.

$$H_0: \mu_d = 0$$

Alternative Hypothesis

H_1 : There is a difference between the mean cigarette stamps sold per month by the State of Illinois after City of Chicago increased the price of its cigarette stamp.

$$H_1: \mu_d \neq 0$$

Hypothesis 2

Null Hypothesis

H_0 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does not explain hoarding of State Cigarette Stamps the month prior to the tax change.

$$H_0: \beta_1 = 0$$

$$H_0: \beta_2 = 0$$

$$H_0: \beta_3 = 0$$

Alternative Hypothesis

H_1 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does explain hoarding of State Cigarette Stamps the month prior to the tax change.

$$H_1: \beta_1 \neq 0$$

$$H_1: \beta_2 \neq 0$$

$$H_1: \beta_3 \neq 0$$

Hypothesis 3

Null Hypothesis

H_0 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does not explain variation in the number of state cigarette stamps sold.

$H_0: \beta_1 = 0$

$H_0: \beta_2 = 0$

$H_0: \beta_3 = 0$

Alternative Hypothesis

H_1 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does explain variation in the number of state cigarette stamps sold.

$H_1: \beta_1 \neq 0$

$H_1: \beta_2 \neq 0$

$H_1: \beta_3 \neq 0$

Data Collection

- Stamp data was collected from the Illinois Department of Revenue Monthly Cigarette Stamp Sales Reports.
- The monthly data (n=52) was compiled over the time period beginning January 1, 2002 and ending April 30, 2006.
- This range of dates was selected because it captures all recent tax increases at all three levels of local and state government.
- Tax rates were provided by the Illinois Department of Revenue, Cook County Department of Revenue and the City of Chicago.

Methods of Analysis

- Paired Sample T-Test
 - Checks to see if the mean number of stamps sold is significantly different after a tax change.
- Regression Analysis
 - Model 1: Dummy variables for tax changes
 - Model 2: Regress natural log of stamps sold on the natural log of the tax rates.

Purpose of the Paired Sample T-Test

- The t-test will confirm what is apparent upon visual inspection of the data, that cigarette stamp sales in Illinois decline after increases in sub state tax rates.
- Inspection of the results will also give us the opportunity to discuss why this statistical tool will not lead to a proper inference in this case.

Purpose of Two Regression Models

- The first regression model is intended to check for hoarding behavior. History shows retailers will hoard stamps prior to State tax changes. Will they hoard state stamps when the county or city changes their tax rates?
- The first model also includes a first order autoregressive process. This is intended to explain myopic addiction behavior.
- The linear time trend variable in the first model is intended as a proxy for the general cessation rates over time.

Purpose of Two Regression Models

- The second model examines the effect of each tax rate on the state stamp sales. Natural logs of the tax rates are used to easily derive elasticity coefficients from the regression betas.
- The first order autoregressive term is dropped in the second regression because it lacks explanatory value in the Illinois case.
- The state tax change hoarding variable is carried over from the first model because of its strong explanatory value.

Regression Model 1

$$Y' = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Y' = Number of State Cigarette Stamps Sold

X_1 = Dummy Variable for State Tax Change

X_2 = Dummy Variable for City Tax Change

X_3 = Dummy Variable for County Tax Change

X_4 = Linear Time Trend Variable

X_5 = First Order Autoregressive Process AR(1)

Regression Model 2

$$\ln Y' = \beta_0 + \ln \beta_1 X_1 + \ln \beta_2 X_2 + \ln \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

$\ln Y'$ = Natural Log of number of State Stamps Sold

$\ln X_1$ = Natural Log of State Tax Rate

$\ln X_2$ = Natural Log of City Tax Rate

$\ln X_3$ = Natural Log of County Tax Rate

X_4 = State Tax Change Dummy

Results of T - Test

Pre City Tax $\mu = 61.9$ million stamps

Post City Tax $\mu = 54.6$ million stamps

T – statistic = 2.009

P – value = 0.056

η^2 statistic = 0.13

n = 25

Results of T - Test

A paired sample t-test was conducted to evaluate the impact of a change in the City of Chicago cigarette tax on State Cigarette Stamp sales. There was a statistically significant decrease in the number of cigarette stamps sold by the state from time period one ($\mu = 61.9$ million, $\sigma = 19.8$ million) to time period two ($\mu = 54.6$ million, $\sigma = 5.3$ million), $t(25) = 2.009$, $p = 0.056$. The η^2 statistic (0.13) indicates a moderate effect size.

Not so fast with your inference

- The t-Test results reject the null hypothesis that the mean number of stamps sold in period two is equal to the mean number of stamps sold in period one. The test is of little explanatory value.
- All this test really says is that there was indeed a moderate decline in the number of stamps sold in the second period versus the first. That does not mean that the tax change caused the decline.

Results of Regression Model 1

Null Hypothesis

H_0 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does not explain hoarding of State Cigarette Stamps the month prior to the tax change.

H_0 : $\beta_1 = 0$ – Reject ($\beta = 82940729$, $t = 9.27$, $p < 0.0005$)

H_0 : $\beta_2 = 0$ – Fail to Reject ($\beta = 4350927$, $t = 0.687$, $p = .496$)

H_0 : $\beta_3 = 0$ – Fail to Reject ($\beta = 5031276$, $t = 0.799$, $p = .428$)

Alternative Hypothesis

H_1 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does explain hoarding of State Cigarette Stamps the month prior to the tax change.

H_1 : $\beta_1 \neq 0$ – Fail to Reject

H_1 : $\beta_2 \neq 0$ – Reject

H_1 : $\beta_3 \neq 0$ – Reject

Results of Regression Model 1

- The regression model explains 65.7 percent of the variation in Illinois state stamps sold ($R^2 = .657$, $F = 20.157$, $p = < 0.0005$)
- The State Tax Dummy is suggests that an increase in the state cigarette tax rate explains an increase in Illinois cigarette stamp sales the month prior to the tax increase taking effect. ($\beta = 82940729$, $t = 9.27$, $p < 0.0005$)
- Cook County and City of Chicago Tax Dummy variables were not statistically significant.

Results of Regression Model 2

Null Hypothesis

H_0 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does not explain variation in the number of state cigarette stamps sold.

H_0 : $\beta_1 = 0$ – Reject ($\beta = -0.338$, $t = -2.632$, $p < 0.0005$)

H_0 : $\beta_2 = 0$ – Fail to Reject ($\beta = -.088$, $t = -1.319$, $p = 0.194$)

H_0 : $\beta_3 = 0$ – Fail to Reject ($\beta = -0.009$, $t = -0.251$, $p = 0.803$)

Alternative Hypothesis

H_1 : A change in the State of Illinois, City of Chicago, or Cook County cigarette stamp tax rate does explain variation in the number of state cigarette stamps sold.

H_1 : $\beta_1 \neq 0$ – Fail to Reject

H_1 : $\beta_2 \neq 0$ – Reject

H_1 : $\beta_3 \neq 0$ – Reject

Results of Regression Model 2

- The regression model explains 51.2 percent of the variation in Illinois state stamps sold ($R^2 = .512$, $F = 20.157$, $p = < 0.0005$)
- The natural log State tax rate variable suggests that an increase in the state cigarette stamp tax explains a statistically significant decline in the number of stamps sold after the tax increase. ($\beta = -0.338$, $t = -2.632$, $p < 0.0005$)
- Natural logs of Cook County and City of Chicago Tax rates were not statistically significant.

Regression Results Summary

Variable	Model 1			Model 2		
	Beta Coefficient	t-statistic	p-value	Beta Coefficient	t-statistic	p-value
State Dummy	82940729.63	9.27	< 0.0005	0.749	5.019	< 0.0005
City Dummy	4350927.179	0.687	0.496			
County Dummy	5031276.077	0.799	0.428			
Linear Trend	-162989.093	-1.835	0.073			
AR(1)	-0.037	-0.423	0.674			
In State Tax Rate				-0.338	-2.632	< 0.0005
In City Tax Rate				0.088	-1.319	0.194
In County Tax Rate				0.009	0.251	0.803
Constant	64609948.9	9.297	< 0.0005	17.685	200.987	< 0.0005
Adjusted R ²	0.657			0.512		
F-Statistic	20.157			14.377		
P-Value	< 0.0005			< 0.0005		
S.E.E	8570440.268			0.136240389		
Durbin Watson	1.791			2.05		

Conclusions

- Annual state cigarette tax revenue estimates in Illinois should not be changed when large sub-state governments increase the tax on cigarettes only when the state itself increase the tax rate.
- Monthly cigarette tax revenue estimates in Illinois should not be changed to expect hoarding on stamps prior to the increase of a sub-state tax rate.

Conclusions

- State stamp tax increases in Illinois may cause the number of stamps sold to decline. The regression (state tax elasticity -0.338) is close to and consistent with the U.S. Treasury -0.4 elasticity.
- State stamp tax increases in Illinois may cause an increase in the number of stamps sold in the month prior to the tax increase.

Future Research and Opportunities

- Assemble a larger data set and expand the regression model to include seasonal dummies, cross border effects, and anti-smoking campaign spending.
- Broader research should be conducted from which results can be generalized.

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