Modeling Cigarette Consumption

Joe Fitz
Chief Economist
California Board of Equalization
Herbert Jew, Research Analyst

Federation of Tax Administrators
Revenue Estimating and Tax Research Conference
September 26, 2000
Background -- California Cigarette Excise Tax Allocations (Cents Per Pack)

- General Fund 10 cents
- Breast Cancer Fund 2 cents
- Cigarette and Tobacco Products Surtax Fund (Proposition 99, passed in 1988) 25 cents
- California Children and Families First Trust Fund (Proposition 10, passed in 1998) 50 cents

TOTAL 87 cents
Background -- Proposition 10

• Proposition 10, passed in November 1998:
  – $0.50 per pack increase in California cigarette tax, effective January 1, 1999.
  – BOE required to determine the effect of the new tax on cigarette consumption.
  – Purpose: To “backfill’ revenue losses for existing programs funded by previously enacted cigarette taxes.
Modeling Challenges

• Another nearly concurrent external factor: Cigarette manufacturers’ price increases resulting from the tobacco settlement announced late 1998, a wholesale price increase of $0.45 / pack.

• Together, these two events increased retail cigarette prices by approximately 50%.

• Research task: Develop an econometric model to predict consumption without the Proposition 10 tax increase of $0.50 / pack.
Methodology -- Nonlinear Regression Model

- **Background**: previous regression estimation work and literature review.
  - Price Elasticities estimated in most studies ranged from -0.3 to -0.5.
  - Such a large percentage price/tax increase outside of historical experience.

- Nonlinear Regression model

- SAS Nonlinear (NLIN) procedure
Model Structure -- Functional Form and Specification

• Functional form: Multiplicative, annual percentage change
• Specification:
  – Expressed in packs per capita, real 1997 prices.
  – Dependent variable: (apparent consumption per capita, year t) / (apparent consumption per capita, year t-1).
  – Independent variables: All expressed in same mathematical form as dependent variable (i.e. annual percent changes).
Mathematical Specification

- \( \frac{(cig2/pop2)}{(cig1/pop1)} = \)
- \( B_0 \)
- \( (catax2/catax1)^{B_1} \)
- \( (fedtax2/fedtax1)^{B_2} \)
- \( (retail\ price2/retail\ price1)^{B_3} \)
- \( (wage2/wage1)^{B_4} \)
- \( (CaEmployRt2/CaEmployRt1)^{B_5} \)
- \( (Pre-1966\ indicator)^{B_6} \)
- + error term
Independent Variables

- Where:
  - B-0  Constant (trend multiplier)
  - B-1  CA excise tax per pack
  - B-2  Federal excise tax per pack
  - B-3  Product price per pack
    \(\text{(Retail price - CA tax - Federal tax)}\)
  - B-4  CA wage and salary income per capita
  - B-5  CA employment rate
    \(\text{(Inverse of unemployment rate)}\)
  - B-6  Pre-1966 Surgeon General Report dummy variable (Equals 1 after 1965)
Results -- Overall Model

- All variables except product price significant at the 95% confidence level.

- R-Squared = 0.63

- Autocorrelation coefficient = -0.36
Results -- Coefficients

- $B_0 = 0.965$ i.e. 3.5% per year decline, all other conditions constant.
- $B_1 = -0.089$
- $B_2 = -0.155$
- $B_3 = -0.009$
- $B_4 = 0.503$
- $B_5 = -1.125$
- $B_6 = 0.010$
Results -- Example of Interpretation of B1 Coefficient

- **B1** - Suppose the CA excise tax increases by 10%:
  - predicted % change = \((1.10)^{-0.08955}\)
  - i.e. - 0.85%
  - i.e. An elasticity close to -0.1 for CA excise taxes (- 0.85 / 0.10 = - 0.085)

- **Other coefficients interpreted similarly**
Results -- Hypothetical Example of Interpretation of Assumed Changes

- Suppose: CA excise taxes, Federal excise taxes, and retail prices each increase 10 %, real wages and salaries increase 2%, and the employment rate increases 0.5%.

- Given these conditions, the product of these ratios is 0.946, i.e. A 5.4% decline in apparent cigarette consumption.