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CIGARETTE SMUGGLING: AN EMPIRICAL ANALYSIS

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Abstract

Cigarette Smuggling: An Empirical Analysis

Daniel A. Sumner

Large differences in state excise taxes imply incentives for interstate cigarette smuggling. A simple framework for estimation of parameters of the demand for consumption and the net demand for smuggling is developed and applied to cross-section time series data.

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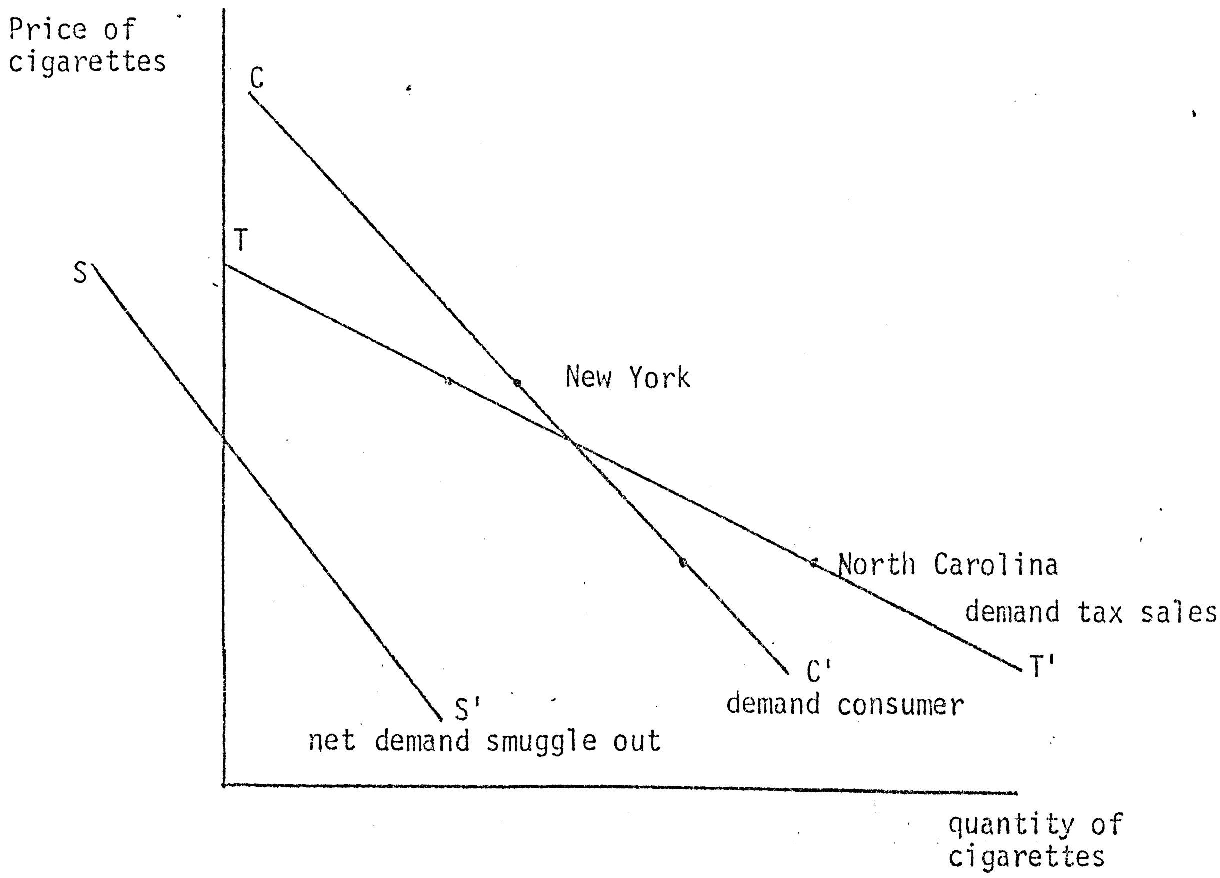
I. Introduction

There is some evidence and much speculation that transporting cigarettes across state lines in order to reduce payment of taxes has become a large illegal industry in the U. S. Since there are no direct measures of the quantities involved, it has been hard to calculate the magnitude of the problem or the effects of proposals to reduce the flow. Several states have become aware of potential tax revenues lost and have been vocal proponents of federal and state anti-smuggling legislation. A federal law that became effective this year supplements the effort of states on the receiving end who have attempted to enforce their tax laws to avoid losing state revenue. Federal laws have also been proposed which would force equality in state and local cigarette excise taxes. The most prominent plan would raise the tax rate in low tax states to near the level in high tax states.

The basic issues are that, given widely different cigarette taxes, there exist large incentives to buy cigarettes in low price states for consumption by residents of high price states. Data on quantity of cigarettes sold in each state come from taxing authorities so it is the quantity legally sold and taxed in a state that are recorded as the quantity for that state. The result is that per capita taxed sales are high in states <u>from</u> which cigarettes are smuggled and per capita taxed sales are low in states <u>to</u> which cigarettes are smuggled. No direct information is available on the per capita quantities of cigarettes actually consumed by the residents of any state.

A simple graph illustrates the situation. In Figure 1 quantity of cigarettes is on the horizontal axis, the prices of cigarettes is on the vertical axis and the units of observation are states. The flattest curve labeled TT' represents the demand to buy cigarettes legally in a state.



This demand is the sum of the two distinct demands facing sellers in that state. The first is the demand to consume cigarettes by the residents of a state labeled CC'. The second is the demand to smuggle cigarettes out of a state labeled SS'. Note that the smuggle demand will be negative for high priced states and that the sum of all smuggling is zero. The problem in estimating these elasticities of demand and thus the effect of tax proposals and other issues is that only the quantities on TT' are observable. Neither consumption nor smuggling are directly measured.

The purpose of this paper is to propose a method of estimating all three demand curves and further to present some empirical estimates of these elasticities of demand and of other shifters of the demand curves from cross-section time-series data. Also some predictions of the quantitities of smuggled cigarettes are possible using the demand equation as are predictions of some of the effect of changes in tax legislation. The methodology of this paper is an extension of Pugh's idea to use aggregate time series estimates of the price elasticities of demand to adjust naive projections of smuggling. (Schoenberg, Pugh, Maier, Manchester, Wiseman)

Model

Let Q^T be the observed quantity of cigarettes purchased in a state. This is the quantity taxed by state authorities. Let Q^C be the quantity of cigarettes actually purchased by residents of the state and let Q^S be the net quantity of cigarettes smuggled out of the state. So,

$$Q^T = Q^C + Q^S \qquad (1)$$

and

$$Q^S = Q^{TS} - Q^{CS} \qquad (2)$$

where Q^{TS} is the quantity taxed in the state but consumed by residents of other states and Q^{CS} is the quantity consumed in the state but not taxed there. Finally, defining Q^{TC} as the quantity taxed and consumed in the same state,

$$Q^C = Q^{TC} + Q^{CS} \qquad (3)$$

and so,

$$Q^T = Q^{TS} + Q^{TC}. \qquad (4)$$

In this section the demand to consume cigarettes will be modeled first and then the demand for net out-smuggling.

The Demand to Consume

Let the demand for consumption of cigarettes for year t in state i be,

$$Q^C_{it} = Q^C(P_{it}, I_{it}, Z_{it}, \varepsilon^C_{it}), \quad (5)$$

where P_{it} is the price of cigarettes, I_{it} is income, Z_{it} is a set of observable variables shifting the demand curve--mainly demographic characteristics of the state-- and ε^C_{it} is a set of unobservable variables affecting demand.

The price of cigarettes consumed by residents of a state will tend to vary across time and space and by the characteristics of the individual. It is often assumed that this variation may be ignored for aggregate analysis and this paper follows suit. An added dimension here is that consumers in state i may buy either legally taxed cigarettes, or they may buy cigarettes untaxed in this state. Competition in the market will tend to force the prices for smuggled and unsmuggled cigarettes to be equal. This equality is between the full cost per unit on the margin. The costs of transaction in illegally sold or transported cigarettes may be higher than for illegal cigarettes. The "full" price includes this transaction cost but it is not a part of the price data. Given heterogeneity in the cost of transacting, some buyers may face a lower total price for legal cigarettes whereas others may face a lower price for smuggled cigarettes. The average reported market price will not be the actual price for either buyer. Individual buyers may also face a price that varies over the year period. The assumption in this paper is that the aggregate price on which we have data adequately represents the marginal purchase price relevant to buying decisions. No attempt is made to model individual heterogeneity in the costs of buying or heterogeneity in price over the year.

The Demand to Smuggle

Total smuggling in a state is the sum of purchases taxed in other states, "in-smuggling," Q_i^{CS}, and taxed sales consumed by residents of other states, "out-smuggling," Q_i^{TS}. The gains from smuggling from state i to state j, is the difference in the tax rates in the two states. Although price net of taxes has some variation, this is mainly related to cost of distribution and sales and so may be considered an equilibrium differential that does not leave gains for arbitrage.

The costs of smuggling are related to the enforcement and severity of tax payment laws and transportation expenses. If costs of smuggling were very small, all cigarettes would be bought in the area with the lowest tax rates and the tax system would be unstable. Obviously this has not occurred, implying that costs are not trivial. As an approximation to modeling these costs in detail, I include the incentives for smuggling between nearby states and for long distance smuggling between states with very low and very high tax rates. Small tax differences that might not equal the costs per pack of smuggling over long distances for distribution might still encourage persons to buy in nearby states when passing through. Therefore, the tax differences between geographically close states affect the demand to buy in a state. The assumption is that the costs of smuggling are smaller between neighboring states. If costs are expected to growth with distance (or with the number of state borders that are to be crossed) then long distance smuggling would require a somewhat larger tax differential to be profitable. Costs of smuggling are also expected to be an increasing function of per capita illegal sales to residents of a state. Therefore, smuggling is expected to occur between more than just the lowest tax and highest tax states.

The net out-smuggling equation is written as,

$$Q^S_{it} = Q^S[(R_{it}-R_{i't}), (R_{it}-R^m_t), (R_{it}-R^n_t), Y_{it}, \varepsilon^S_{it}] , \qquad (6)$$

where the R variables represent tax rates in various states. The variables Y_{it} and ε^S_{it} represent observed and unobserved factors that affect the net smuggling. The first argument in the Q^S function is a vector of tax rate differences between state i and its nearby states, i'. These variables represent the gains from local smuggling.

R^m_t is the maximum state tax rate in year t and R^n_t is the minimum state tax rate in year t. The arguments in (6) that include these variables represent the gains from long-distance smuggling out of or into state i in year t. Legal barriers to smuggling are represented by the variables Y_{it} or, more realistically, by ε^S_{it}. Finally, note that since Q^S_{it} represents net smuggling from state i, the coefficients on each of the tax difference variables should be negative. The greater the tax in i relative to other states, the fewer cigarettes bought in i for consumption elsewhere and the more bought elsewhere for consumption in i.

The Observed Demand

Combining (5) and (6) allows rewriting equation (1) in more detail. That is,

$$Q^T_{it} = Q^C_{it} + Q^S_{it} = Q^T(P_{it}, I_{it}, Z_{it}, \varepsilon^C_{it}, DR_{it}, Y_{it}, \varepsilon^S_{it}) , \qquad (7)$$

where the notation is familiar except that DR_{it} now represents all the tax difference arguments in (6). Since neither Q^C nor Q^S are observed separately, equation (7), rather than (5) or (6), represents the basis for an empirical specification. The structure in (7) implies that the parameters in (5) and (6) may be inferred from estimating (7). Further, estimated parameters in (7) can yield predictions not only of Q^T_{it} but also of Q^C_{it} and Q^S_{it} separately. These results follow from the facts that variables in (5) do not appear in (6) and variables in (6) are not in (5). For example, $\partial Q^T/\partial P$ from (7) is equal to $\partial Q^C/\partial P$ in (5). Note that tax rate differences are correlated with the price in each state so $\partial Q^T/\partial P$ from an equation without including these variables would not measure price responsiveness in consumption.

It should be explicitly recognized here that the separability of consumption demand from net smuggling demand is not axiomatic. This assumption is an empirical approximation that seems necessary to proceed with the estimation suggested. The value of this approach depends on the degree to which this maintained hypothesis is satisfied.

Writing (7) in linear form yields,

$$Q^T_{it} = \alpha_p P_{it} + \alpha_I I_{it} + Z_{it}\alpha_z + DR_{it}\beta_R + Y_{it}\beta_y + \varepsilon^T_{it} \qquad (8)$$

where the α_j coefficients are attached to consumption demand variables and the β_j coefficients are attached to smuggling variables. Other functional forms are feasible, linearity is assumed for illustration.

While it is equation (8) that is of main interest a reduced form price equation should be specified to complete the model and account for simultaneity. This is,

$$P_{it} = \gamma_R R_{it} + X_{it}\gamma_x + \gamma_I I_{it} + Z_{it}\gamma_z + DR_{it}\gamma_D + Y_{it}\gamma_y + \varepsilon^p_{it}, \qquad (9)$$

where the γ_j are reduced form price equation coefficients, X_{it} is a vector of variables affecting costs of production of cigarettes and the other variables are in (8). Equations (8) and (9) may be estimated as a system using simultaneous equations techniques. It is explicitly assumed that right side variables in (9) are exogenous to the model.

A total demand for cigarettes, not separating smugging from consumption, may be written as,

$$Q^T_{it} = \alpha^*_p P_{it} + \alpha^*_I I_{it} + Z_{it} \alpha^*_z + \varepsilon^T_{it}{}^* \qquad (10)$$

where the "*" indicates that no smuggling variables are in the equation. Comparing (9) and (10) suggest some tests on the specification. In (10) a change in the price in state i affects both local consumption and, if it results from a tax rate change, affects the net amount of smuggling out of state i. Thus $|\alpha^*_p| > |\alpha_p|$ is expected along with the usual $\alpha_p \leq 0$ restriction.

Prediction of quantities smuggled or consumed may be generated through the estimates of equation (9). Define,

$$\hat{Q}^c_{it} = \hat{\alpha}_p P_{it} + \hat{\alpha}_I I_{it} + Z_{it} \hat{\alpha}_z \qquad \text{and}$$

$$\hat{Q}^s_{it} = DR_{it} \hat{\beta}_R + Y_{it} \hat{\beta}_y .$$

These prediction equations may be used to simulate the effects on consumption or smuggling of changes in the explanatory variable. And also the amount of tax revenue redistribution due to smuggling of cigarettes.

Data

The information used in this study is a time series of observations for each state in the United States (including the District of Columbia). Variables used include average retail prices of cigarettes, tax rates, per capita retail sales, personal incomes, a price index of states by years and a series of demographic variables. For most of these demographic variables (including percent black, percent male, percent metropolitan, and an age distribution) complete information for each year for each state is not available. However, it is also true that very little change has occurred over short periods of time in the levels of these variables in each state. Most of this demographic variation is across state observations. For this study, I chose to impute the missing observations for some years for some states by taking linear regressions based on the data for that variable for the years available for the state. A few other imputations of missing values were made for occasional missing observations on a particular variable for these background variables.

Because of the secondary importance of the variables for which missing values were imputed and because of the very slight variations in these variables over time for each state, no adjustments are made in estimation of coefficients or the variance-covariance matrices or in tests of hypotheses. I proceed in the body of the paper as though a complete set of observations were available for each variable.

Data Analysis

An appendix contains the definitions and descriptive statistics for the variables used in the regressions in the table. All monetary variables have been deflated by a national consumer price index.

In the models of Table 1 LOG(PRICE) was considered an endogenous variable. In addition to all the exogenous variables listed in the tables the instruments for predicting the price of cigarettes included:

the retail wage rate across states and years, the wage of tobacco workers, the import and export prices of flue-cured tobacco, the flue-cured tobacco allotment, the support price for flue-cured tobacco, the yield of the flue-cured tobacco and the average weight of cigarettes.

The first column of Table 1 shows the total demand for cigarettes. The price elasticity measures $\partial Q^T/\partial P$ (in log form) without holding constant incentives to smuggle. Thus, -1.138 measures the effect of a change in price on the total legal sales of cigarettes including the net effect of smuggling. The next two columns add explanatory variables which hold constant the incentive to smuggle cigarettes. In the second column the tax rate on cigarettes is an explanatory variable. If the incentive to smuggle is the differencein state tax rates, changes in the price holding tax rate constant will not affect the quantity smuggled. Therefore -0.545 is a measure of the price elasticity of demand to consume. This interpretation also holds for the price elasticity -0.624 reported in column 3.

Several of the other parameter estimates may be noted. The estimated income elasticity for cigarettes, approximately 1.0, is higher than most past estimates. However, note that several of the demographic variables that are usually left out would affect the size of the income effect. For example education is positively correlated with income and itself has a strong negative effect on cigarette demand. Two variables of particular interest are MILITARYPC and TOURISTPC. The first measures the number of military personnel in a state relative to state population. Cigarettes bought on military bases are not subject to state taxes so the more military the lower the per capita sales of cigarettes that pay the state tax.

TOURISTPC is a proxy variable for the number of days out-of-state tourists spend in the state relative to the states' population. The more tourists the greater the sales of cigarettes per capita. For low tax states part of this effect is due to tourists buying cigarettes for consumption at home.

The variables indicating the incentive to smuggle are differences between a states tax rate and those of selected other states. All these coefficients are negative as expected and the neighboring states effects are large relative to their standard errors. However, the long distance smuggling variables do not perform well and this suggests some refinement is in order in this specification.

Table 1. Estimates of the demand for cigarettes on cross-section time-series data. Two stage least square 459 observations.

Variable	Coefficient (Standard error)	Coefficient (Standard error)	Coefficient (Standard error)
INTERCEPT	0.413 (0.789)	1.982 (1.259)	3.845 (1.464)
LOG(PRICE)	-1.138 (0.069)	-0.545 (0.380)	-0.624 (0.193)
LOG(INCOME)	0.983 (0.079)	0.946 (0.082)	1.040 (0.080)
POPPC18	-0.005 (0.076)	-0.150 (0.119)	0.013 (0.080)
POPPC65	0.861 (0.514)	1.111 (0.532)	0.853 (0.545)
METROPC	-0.150 (0.041)	-0.149 (0.041)	-0.167 (0.040)
BLACKPC	0.042 (0.075)	-0.017 (0.083)	0.024 (0.075)
MILITARYPC	-3.232 (0.724)	-3.560 (0.745)	-3.448 (0.714)
EDUCATION	-0.331 (0.036)	-0.323 (0.036)	-0.297 (0.036)
LOG(TOURISTPC)	0.101 (0.012)	0.101 (0.012)	0.093 (0.011)
MALEPC	-4.357 (1.413)	-4.713 (1.417)	-6.317 (1.481)
LOG(TAXRATE)		-0.323 (0.204)	
TAXDIF1			-102.326 (27.601)
TAXDIF2			-41.673 (29.140)
TAXDIFMAX			-11.583 (64.853)
TAXDIFMIN			-76.178 (118.785)

The means for the log values are LOG(QUANTITYPC) - 4.856, LOG(PRICE) = -5.823, LOG(INCOME) = 3.520, LOG(TOURISTPC) = 5.993, LOG(TAXRATE) = -6.608.

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Appendix: Means and standard deviations of variables used in the empirical analysis

Variable name	Brief definition	Mean (standard deviation)
QUANTITYPC	Per capita sales of cigarettes (derived from tax receipts and tax rate)	132.0 (40.0)
PRICE*	Average price of cigarettes inclusive of taxes, cents per pack	0.298 (0.036)
INCOMEPC*	Per capital, personal income (thousands)	3,378.4 (1,688.2)
POPPC18	Percent of the population over 18	0.409 (0.107)
POPPC65	Percent of the population over 65	0.101 (0.021)
METROPC	Percent of the population in metropolitan areas	0.592 (0.266)
BLACKPC	Percent Black	0.101 (0.126)
MILITARYPC	Percent military population	0.011 (0.014)
EDUCATION	Average years of schooling completed	12.3 (0.33)
TOURISTPC*	Receipts of the hotel-motel industry per capita	654.75 (1480.42)
MALESPC	Percent male	0.489 (0.009)
TAXRATE*	Tax rate on cigarettes including federal, state, city and sales taxes (cents/pack)	0.139 (0.032)
TAXDIF1*	$TAXRATE_{it} - TAXRATE_{i't}$ where i' is the neighboring state for which |TAXDIF| largest	0.005 (0.043)
TAXDIF2*	$TAXRATE_{it} - TAXRATE_{i''t}$ where i" is the neighboring state for which |TAXDIF| is second largest	-0.0003 (0.037)

Appendix: con't.

Variable name	Brief definition	Mean (standard deviation)
TAXDIFMAX*	$TAXRATE_{it}$ - $TAXRATE_{jt}$ where j is the state with the highest tax in year t	-0.054 (0.028)
TAXDIFMXN*	$TAXRATE_{it}$ - $TAXRATE_{kt}$ where k is the state with the lowest taxrate in year t (North Carolina)	0.065 (0.028)

*These variables have been deflated by the National Consumer Price Index with 1967 = 100.