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Abstract

The economic incidence of cigarette excise taxes in the United States is estimated for 1955-1989. The analysis simultaneously considers consumer demand and the reactions of manufacturers and the distribution industry, and contrasts the incidence of federal with state and local taxes.

A cost function was estimated, and found that cigarette manufacture is subject to increasing returns to scale. The model of the market found a mean price elasticity of demand of -1.08. Price elasticity has been decreasing. The elimination of simultaneity bias may explain why this estimate is higher than that of other studies.

The industry was found to be less competitive than a Cournot industry. Competition among manufacturers has decreased substantially since 1980. This may be because manufacturers have become less concerned about anti-trust scrutiny or the prospect of new competitors.

A simulation shows that an increase in the federal excise tax causes a greater increase in price, and a greater decrease in consumption, than does the same increase in the average of state and local tax rates. This is consistent with the view that in the face of an increase in a state or local tax, some demand shifts to neighboring jurisdictions with lower taxes.

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Cigarette smoking is regarded as the single most important cause of preventable illness in the United States. Public health officials are advocating increases in excise taxes as a means of discouraging smoking.

Tobacco taxes are levied by the Federal government and all 50 states, and by some 400 local governments. Total revenue exceeded $10 billion in 1990, representing 25.6% of the retail price of cigarettes. Nominal tax rates have not kept pace with inflation over the last 30 years, but recent rate increases have begun to restore real tax rates to former levels.

The degree to which excise taxes reduce cigarette consumption depends on the elasticities of demand and supply. An estimate of these elasticities must correct for simultaneous equations bias. An especially challenging aspect to such estimates is the need to account for the imperfect competition in cigarette manufacture, and for the possible difference in responses to state and federal tax increases.

The cigarette industry is a 6-firm oligopoly which has become increasingly concentrated. In recent years price changes have been initiated by one of the two largest firms, R.J. Reynolds or Philip Morris. As documented by Harris (1987), these changes are quickly followed by the remaining manufacturers, usually within 48 hours. This suggests a high degree of price coordination in the industry.

Sumner (1981) considered the variation in excise taxes across states as a marginal cost subject to markup by the oligopoly of manufacturers. With the assumption that manufacturers charge different prices in different states, he estimated the market power of the oligopoly, which he found to be negligible. This suggests that manufacturers find it difficult to pass on excise taxes. This analysis

is flawed, however, because manufacturers do not price discriminate between states.

Manufacturers set a single national price for each product category. Cigarettes are sold to wholesalers, who then distribute them to retail firms. Since a wholesaler may distribute to retailers in several states, any attempt by manufacturers to price discriminate among the states would inspire arbitrage by wholesalers. Indeed, economic theory says that competition in distribution, regardless of monopoly power in manufacturing, would require them to do so.

While manufacturers bear the legal incidence of federal taxes, and wholesale distributors bear the legal incidence of state and local taxes, the economic incidence of these taxes depends on the degree to which they affect wholesale and retail prices.

This paper examines the incidence of these taxes, and whether the incidence of state and federal taxes differs. Part 1 of this paper develops a model of the cigarette market. Part 2 estimates parameters for the model, and evaluates its effectiveness in simulating the market. Part 3 presents the results of simulated increases in state and federal taxes. Part 4 discusses these results.

1. A Simultaneous Equations Model of the Cigarette Industry

This paper describes the cigarette market as six simultaneously generated endogenous variables: quantity, retail price, wholesale price, manufacturers' marginal costs and advertising expenses, and the implicit costs of wholesale and retail distribution.

Demand. Aggregate demand for cigarettes (Q) is modeled as a linear function of retail price (P), consumer income (INC), population (POP), expenditures on cigarette advertising (ADV) and variables representing policy interventions and the growing awareness of the detrimental health effects

of cigarettes.

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 INC + \alpha_3 POP + \alpha_4 SURGEN + \alpha_5 FAIRDOC + \alpha_6 BRDBAN + \alpha_7 LAWS + \alpha_8 ADV + \alpha_9 FILTER + \alpha_{10} LOWTAR + u_1 \quad (1)$$

Policy variables include an index of state laws regulating smoking in public places (LAWS) and dummy variables for the 1964 warning by the U.S. surgeon general (SURGEN), the era of the fairness doctrine, when the Federal Communications Commission required broadcasters to air anti-smoking commercials (FAIRDOC), and the eventual banning of broadcast advertising in 1970 (BRDBAN). Finally, the share of sales made up of filter (FILTER) and low-tar (LOWTAR) cigarettes are included in the model. These shares are necessary because smokers increase consumption to compensate for the low levels of nicotine in filter and low tar cigarettes. If they are excluded, the estimate of price response will be biased, for it may ascribe to price the increase in consumption that occurred with the increased popularity of these types of cigarettes.

Retail price. The pricing behavior of the retail and wholesale distributors of cigarettes is taken as a linear function of the wholesale price of cigarettes (P_W), the federal excise tax rate (FT), the consumption weighted average of the state and local excise tax rates (ST), and distribution costs (DISTR).

$$P = \beta_0 + \beta_1 P_W + \beta_2 FT + \beta_3 ST + \beta_4 DISTR + u_2 \quad (2)$$

Wholesale price. A third, non-linear, equation estimates the wholesale price as a function of marginal costs and industry structure. A manufacturer maximizes profits by its choice of quantity of production. For any quantity of production chosen (q_i), the remaining firms chose their levels of

production, yielding a total industry supply (Q). The profit function for firm i is thus:

$$\pi_i = P_w(Q(q_i))q_i - c_i(q_i)$$

The first order condition for profit maximization is:

$$P_w = MC_i - \frac{dP_w}{dQ}\frac{dQ}{dq_i}q_i$$

If firms share identical conjectures about their rivals' response, their first order conditions may be multiplied by market shares and summed:

$$P_w = MC_{AVG} - \frac{\theta HQ}{\left[\frac{dQ}{dP_w}\right]}$$

MC_{AVG} is the output weighted average marginal cost of the industry, H is the Herfindahl index of industry concentration, and θ is a parameter representing the firms' conjectures about their rivals' response, their conjectural variation. The derivative of quantity with respect to wholesale price may be decomposed by the chain rule:

$$\frac{dQ}{dPw} = \frac{dQ}{dP}\frac{dP}{dP_w}$$

Thus we can impose the cross equation constraints that the derivatives of quantity with respect to wholesale price is equal to the product of the derivatives represented by α_1 and β_1 in equations 1 and 2, yielding the following equation for estimation:

$$P_w = MC_{AVG} - \frac{\theta HQ}{\alpha_1\beta_1} + u_3 \qquad (3)$$

Under the Cournot assumption, rivals do not respond to changes in output, and θ=1. Cournot behavior may be tested by discovering whether this parameter is significantly different from 1.

The model is refined by allowing conjectural variation parameter, θ, to vary with policy and health

information shocks, and with time.

Marginal Cost of Manufacture. The translog functional form allows estimation of a cost function without imposing on economies of scale or the rate of substitution between factors of production (Christensen, Jorgenson & Lau, 1971). The total cost of manufacture (C) is a function of the quantity manufactured (Q_M), factor prices (W_i), time in years from the outset (T), and product attributes, in this case, the share of production made up of filter cigarettes (F) :

$$\begin{aligned}\ln C = {} & a_o + \sum_i a_i \ln W_i + a_Q \ln Q_M + a_F \ln F + a_T \ln T \\ & + \frac{1}{2}\sum_i \sum_j a_{ij} \ln W_i \ln W_j + \sum_i a_{iQ} \ln W_i \ln Q_M + \sum_i a_{iF} \ln F \ln W_i \\ & + \sum_i a_{iT} \ln T \ln W_i + \frac{1}{2} a_{Q^2}(\ln Q_M)^2 + a_{QF} \ln Q_M \ln F + a_{QT} \ln Q_M \ln T \\ & + \frac{1}{2} a_{F^2}(\ln F)^2 + a_{FT} \ln F \ln T + \frac{1}{2} a_{T^2}(\ln T)^2\end{aligned}$$

Given this total cost equation, demand for factors can be computed using Shephard's lemma:

$$X_i = \frac{\partial C}{\partial W_i}$$

Demand for each factor is multiplied by its price and divided by the total costs to yield a set of cost share equations which have parameters in common with the cost equation, giving additional degrees of freedom for estimation:

$$\frac{W_i X_i}{C} = \frac{\partial \ln C}{\partial \ln W_i} = a_i + \sum_j a_{ij} \ln W_j + a_{iQ} \ln Q_M + a_{iF} \ln F + a_{iT} \ln T$$

The parameters are further restricted by the fact that a well behaved cost function must be homogenous of degree one in factor prices. Marginal cost can be estimated by taking the derivative

of the cost function with respect to the quantity manufactured:

$$\frac{dC}{dQ_M} = \left[a_Q + \sum a_{iQ} LnW_i + a_{Q^2} LnQ_M + a_{QF} LnF + a_{QT} LnT\right]\frac{C}{Q_M}$$

Advertising. A manufacturer chooses a level of advertising (a_i) to maximize profit, given a conjecture about the level of advertising which will be chosen by rival firms (a_j). At any given wholesale price the profit is:

$$\pi_i = P_W\, q_i(a_i, a_j(a_i), P_W) - c(q_i(a_i, a_j(a_i), P_W)) - a_i$$

And the profit maximizing condition is:

$$\frac{d\pi_i}{da_i} = \left(P_W - \frac{dc}{dq_i}\right)\left(\frac{\partial q_i}{\partial a_i} + \frac{\partial q_i}{\partial a_j}\frac{\partial a_j}{\partial a_i}\right) - 1 = 0$$

This may be restated as:

$$\frac{a_i}{P_W q_i} = \left(\frac{P_W - MC_i}{P_W}\right)\left[\left(\frac{\partial q_i}{\partial a_i}\frac{a_i}{q_i}\right) + \left(\frac{\partial q_i}{\partial a_j}\frac{a_j}{q_i}\right)\left(\frac{\partial a_j}{\partial a_i}\frac{a_i}{a_j}\right)\right]$$

The terms within brackets on the right side of this equation are the elasticity of the response to the firm's own advertising, its rivals' advertising, and the elasticity of conjectured response. If these elasticities do not vary by firm, and if the marginal costs of firms are also the same, then industry advertising expenditures are a function of an advertising response parameter (ADRESP), wholesale price, marginal costs, and sales:

$$ADV = ADRESP \cdot (P_W - MC_{AVG})Q + u_4 \qquad (4)$$

The model is refined by allowing the advertising response parameter to vary with the policy and health information shocks.

Implicit Distribution Costs. The cost of distributing cigarettes is given implicitly as the difference between retail and wholesale price (inclusive of excise taxes). Since the retail price may be

observed with some error, the simple difference would yield a variable which is correlated with the error term. To avoid the bias in estimates which would result, an instrument representing distribution costs (DISTR) is created by regressing retail price on all of the exogenous variables in the system. The implicit cost of distribution is the difference between the fitted value for retail price, less taxes and the wholesale price.

The cost of distributing cigarettes depends on the cost and productivity of factors in the wholesale and retail industries, and partly on the direct costs of cigarettes. The cost of maintaining an inventory of tax-stamped cigarettes varies with the value of the inventory. Since distributors pay manufacturers a price which is the sum of the wholesale price and the federal tax, the parameters for wholesale price and federal tax may be constrained to be equal:

$$DISTR = \gamma_0 + \gamma_1(P_W+FEDTAX) + \gamma_2 STATETAX + \gamma_3 DISTRCOSTS + u_5 \quad (5)$$

Data limitations preclude estimation of a cost function for the distribution sector. The non-product costs of tobacco wholesalers is used to represent the indirect costs of cigarette distribution (DISTRCOSTS).

2. Parameter Estimates and Accuracy of Simulation

Cost Estimate. Variables used to estimate the cost function are listed in Table 1. Appendix A provides details on the sources of these data. The system of constrained equations was estimated with a seemingly unrelated regression. Each variable was divided by its mean value before logs were taken. In this way, the log of each variable represents a deviation from zero, and the parameters of terms which are neither squared nor interactive represent the elasticity of costs with respect to that variable at its mean value.

Parameter estimates for the cost equation are found in Table 2. In real terms, the average manufacturing cost remained essentially unchanged throughout the time series. It averaged 15.2 cents

per pack (in 1981 dollars). Marginal costs have been declining with time. Thus the cost function finds that cigarette manufacturing is subject to increasing returns to scale which are growing with time. Real marginal cost were an average of 12.3 cents per pack, but dropped to less than 10 cents a pack after 1983.

The cost function provides estimate of marginal cost for each given period which is a function of the quantity of production. A linear approximation of the marginal cost was used to include marginal cost in the wholesale price equation. This approximation was made via a first-order Taylor series which allowed marginal costs to vary with domestic cigarette consumption, taking export production and factor prices as exogenous.

Model of Cigarette Market. The variables used to estimate the market for cigarettes are described in Table 3, and in the Appendix. The system was estimated via three stage least squares. Two different models were estimated and the results are presented in table 2. In system 1, the conjectural variation (the intercept in the wholesale price equation) and advertising response parameter (ADRESP) are assumed to be constant throughout the period. System 2 allows both conjectural variation and the advertising response parameter to be influenced by health information and policy shocks. It also allows conjectural variation to shift in 1981 (NEWCV), and to vary with time after this shift (TIMENEW). This model resulted in a substantial improvement in the fit. The Clarke and Davies (1984) model of constant elasticity of conjectural variation was tested and rejected because of extremely poor fit.

The mean elasticity of demand was calculated for each models (Table 5). These price elasticities are at the higher end of the range of those reported in the literature. To ascertain the role of simultaneity bias, the demand equation (equation 1) was estimated via ordinary least squares. The resulting elasticity was more inelastic than the estimate generated by either model. Thus the observed high demand elasticity is at least in part due to a specification which corrects for simultaneous

equations bias.

Elasticity was also calculated for three different eras: the period prior to the surgeon general's report, the time between the release of that report and 1980, and the last decade. Both models, and the single equation estimate, show price elasticity to be decreasing. The more inelastic demand of the 1980's reflects the high prices of that decade.* The decreased elasticity of demand is consistent with a shift in consumer tastes. Those people most sensitive to price may have already quit smoking, leaving only the most strongly addicted consumers in the market.

Income elasticities are also higher than reported in the literature, and this too appears to be at least partly due to the elimination of simultaneity bias.

The models also allows for an analysis of how the industry deviates from competitive behavior. Model 1 allows the hypothesis that the industry exhibits Cournot behavior (i.e., that conjectural variation equals 1) to be rejected (t=10.33).

Model 2 finds that the cigarette manufacturing industry was more competitive than Cournot prior to 1964, and that it has become much less competitive since 1980. This may be quantified by several measures. Equation 3 may be restated as:

$$\frac{P_W - MC}{P_W} = \frac{\theta H}{\left(\frac{dQ}{dP}\frac{P}{Q}\right)\left(\frac{dP}{dP_W}\frac{P_W}{P}\right)}$$

The left hand side of the equation is the Lerner Index, the right hand side of the equation includes the conjectural variation and Herfindahl index in the numerator, and the retail price elasticity and wholesale price elasticity in the denominator. Table 6 presents the estimates of these measures of competition, as estimated by Model 2. Also presented is the elasticity of conjectural variation. With

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* The trend towards inelastic demand was even more apparent when the model was re-estimated to allow the price parameter in the demand equation to vary with time. However, the effect was so strong that the elasticity estimates were no longer plausible.

the assumption that all firms have the same conjectural variation, it is equal to the product of the conjectural variation and Herfindahl index. A perfectly collusive oligopoly would have a value of 1.

3. Simulation of the Effect of Tax Increases

The parameters from the models were used in simulations which yielded reasonably good estimates of the endogenous variables. Theil's inequality coefficient for the endogenous variables generated in the simulations are presented in table 7.

The models were used to simulate the impact of a 1 cent increase in real federal tax, holding all other exogenous variables at their observed values for the 1955-89 period. A corresponding simulation was performed with a 1 cent increase in state tax. Table 8 presents the mean effect of these simulated tax increases on prices and quantity.

In both simulations, the retail price increased more under a federal tax increase than under a state tax increase. Thus federal taxes were more successful in discouraging smoking. Distributors passed on more of the federal tax increase and absorbed more of a state and local tax increase. Manufacturers were forced to absorb more of the federal tax, and less of the state tax increase, but these effects were outweighed by the distributors' role.

The change in consumer and producer surplus was calculated for each model. Results are presented in Table 9. Producer surplus represents the loss in revenues to producers, less the reduced cost of advertising, manufacture, and distribution.

The loss of producer surplus exceeds the lost consumer surplus. To the extent that there are variable costs not accounted for by manufacturing, advertising, or distribution (e.g., manufacturers administrative and sales staff), the effect on producer surplus may be overstated. The deadweight loss and loss of consumer surplus are larger with a federal tax increase, which is consistent with the larger effect on quantity.

The change in producer surplus can be divided between manufacturers and the retail and

distribution industry. This reveals that the distribution industry bears more of the burden of a state tax than do manufacturers, while the relative burden of federal taxes is equal.

4. Discussion of Results

There are two principal results. First, competition among manufacturers declined during the 1980's. Second, consumers bears a greater burden under a federal tax than they do under a state or local excise tax.

There are various hypothesis for the increasing coordination of the cigarette oligopoly. A theory expressed in the business press is that the price increase represents "making a dying horse run hard."[#] With the knowledge that cigarette smoking is on the decline, high prices represent a strategy of extracting the maximum possible consumer surplus in the long-term. Under this scenario, manufacturers are taking the best advantage possible of the addiction of current consumers, and care little about the loss of future consumers caused by high prices.

Price increases may represent the demise of a limit pricing strategy. According to this hypothesis, manufacturers' realized that it was no longer necessary to deter the entry of new competitors with low prices. Deterrence may stem from the specter of product liability lawsuits. Firms may perceive that there is a relaxation of anti-trust scrutiny, as federal authorities assign little priority to the socially undesirable goal of lower cigarette prices. An alternate explanation is that the oligopoly was no longer fearful of entry, but expecting the exit of the smallest firm, which was suffering extreme financial problems in 1980.

Harris (1987) believes that manufacturers used the 1983 federal excise tax increase as a signalling device to coordinate a series price increases. This signaling theory may be true, but it cannot explain the entire trend of price increases, as it predates the enactment of the federal excise tax

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Where there's smoke, there's trouble. Business Week 1/18/88 3034:88-8

increase. An additional explanation is the advent of discount cigarette brands in 1981. Under this story, manufacturers felt they could raise prices to higher levels because there were now discount brands which would keep price sensitive smokers in the market.

Increased coordination is consistent with the increasing concentration in the industry. Phillip Morris has been steadily gaining market share at the expense of its competitors. In 1983, its became the industry leader with 34.3% market share. Since then, its market share has grown to 42.9%

The model shows that federal excise taxes have a greater effect on the price of cigarettes than state excise taxes. An intuitive analysis suggests why prices may increase more in response to federal taxes than to state and local taxes. Some consumers will respond to an increase in a state or local excise tax by shopping in neighboring areas where there is a lower excise tax rate. Such activity, dubbed "bootlegging" or "smuggling" by some analysts, can be a perfectly legal. The consumer merely incurs travel costs to avoid taxation. There are fewer opportunities for bootlegging to circumvent a federal tax increase.

This result must be placed in context. The increase in state tax which was evaluated represents an increase in the weighted average state excise tax rate, given the difference in state taxes which existed during the period under study. If every state increased its tax rate by exactly the same amount at exactly the same time, there is no reason to expect the response to be any different from the same size increase in federal tax. Thus the result reflects the historical differences in state tax rates. It seems likely that state tax changes which narrow the differences between states will have different effects than changes which increase the divergence. The evaluation of these effects will require a panel of consumption and distribution data for the states.

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Table 1
Variables Used to Estimate Manufacturing Cost of Cigarettes
United States, 1955-1989

Variable		Units	Mean
QMFG	Quantity manufactured	Millions of packs	28,903
COST	Costs	Millions of nominal dollars	2,526.5
R	Rental rate of capital	Percent	0.1569
W	Wage	Nominal dollars per employee	8.9185
TB	Tobacco price	Nominal dollars per pound	1.1638
F	Filter cigarette market share	Percent	65.9
T	Time	Years	20.5
K	Capital stock	Real 1972 dollars	2,720.9
L	Labor	Thousands of employees	67.8
QTOB	Tobacco	Millions lbs. processed weight	1,174.5
SHAREL	Labor cost share	Percent	0.2026
SHARET	Tobacco cost share	Percent	0.6259
SHAREK	Capital cost share	Percent	0.1715

Table 2
Aggregate Manufacturing Costs for Cigarettes
United States, 1955-1989
Seeming Unrelated Regression Estimate

	Parameter estimate	t statistic		Parameter estimate	t statistic
INT	7.8080	(696.185)	Q*TB	-0.0645	(-0.963)
W	0.2444	(45.584)	F*TB	0.0163	(1.516)
TB	0.5698	(106.353)	TB*T	-0.0681	(-2.321)
R	0.1858	(20.361)	R*TB	-0.2513	(-1.067)
Q	0.7162	(5.351)	R^2	0.3131	(1.257)
F	-0.1532	(-3.167)	R*T	0.1402	(3.323)
T	0.0245	(0.470)	Q*R	-0.0532	(-0.525)
W^2	0.1590	(6.082)	F*R	-0.0423	(-2.723)
W*TB	-0.0972	(-5.079)	Q^2	2.9137	(1.842)
R*W	-0.0618	(-1.572)	Q*F	0.3249	(2.336)
Q*W	0.1177	(2.363)	Q*T	-1.4057	(-4.338)
F*W	0.0260	(3.264)	F^2	0.0158	(0.517)
W*T	-0.0721	(-3.303)	F*T	-0.1668	(-3.832)
TB^2	0.3485	(1.517)	T^2	0.2537	(10.709)

Table 3
Variables Used to Estimate U.S. Market for Cigarettes
1955-1989

Variable		Units	Mean
Q	Quantity	Billions of cigarettes sold	26,897
P	Retail price	Real 1981 cents per pack	92.63
Y	Income	Real 1981 dollars per capita	10,553
F	Filter cigarettes	Percent market share	0.7495
L	Low-tar cigarettes	Percent market share	0.1957
LAW	State laws	Index of state legislation	0.3303
N	Adult population	Thousands of civilians over 17 years	142,029
ADV	Advertising expenditures	Millions of 1991 dollars	1179.4
BBAN	Broadcast ban	1 after 1971, 0 otherwise	0.5429
FAIR	Fairness doctrine	1 between 1967 and 1971, 0 otherwise	0.1143
SURGEN	Surgen General's report	1 after 1964, 0 otherwise	0.7429
PW	Wholesale price	Real 1981 cents per pack	35.34
ST	State and local tax rate	Real 1981 cents per pack	17.95
FT	Federal tax rate	Real 1981 cents per pack	19.47
DISTR	Implicit distribution costs	Real 1981 cents per pack	19.86
HERF	Herfindahl index	Sum of squared percent market shares	0.2289
WHCOSTP	Wholesale costs	Percent of sales	0.1472

Table 4
U.S. Market for Cigarettes
1955-1989
Three Stage Least Squares Estimate
(t-statistics in parentheses)

	1	2
Demand Equation		
Intercept	24,198.1 (7.013)	24,893.7 (7.524)
PRICE	-320.46 (-12.949)	-308.50 (-13.186)
INCOME	1.2395 (4.128)	1.1905 (4.104)
FILTER	8,663.7 (5.666)	9,216.1 (6.274)
LOWTAR	-10,778.2 (-5.251)	-10,549.3 (-5.299)
LAWS	-19,183.0 (-5.371)	-18,130.2 (-5.313)
POP	0.1119 (2.404)	0.0966 (2.176)
ADVERT	5.5193 (5.243)	5.5193 (5.476)
BRDBAN	-464.30 (-0.942)	-396.20 (-0.836)
FAIRDOC	-727.33 (-2.323)	-692.78 (-2.282)
SURGEN	-1,102.3 (-2.970)	-1,037.5 (-2.906)
Retail Price Equation		
Intercept	-0.9632 (-0.250)	-1.5697 (-0.409)
WHPRICE	0.9603 (17.478)	0.9846 (17.880)
STATETAX	0.9414 (12.090)	0.9629 (12.337)
FEDTAX	1.0175 (16.127)	1.0235 (16.293)
DISTR	1.1552 (5.545)	1.1167 (5.349)

	1	2
Wholesale Price Equation		
Intercept	1.1633 (10.334)	0.9663 (10.817)
BRDBAN		0.1477 (1.965)
FAIRDOC		0.3477 (3.650)
SURGEN		-0.1857 (-2.230)
NEWCV		0.5779 (9.486)
TIMENEW		0.1354 (8.921)
Advertising Equation		
Intercept	0.0019 (40.050)	0.0018 (9.967)
BRDBAN		-0.000458 (-1.554)
FAIRDOC		-0.000616 (-1.801)
SURGEN		0.000449 (1.305)
Distribution Equation		
Intercept	-18.7467 (-7.514)	-20.3962 (-8.035)
ST	-0.1261 (-2.947)	-0.1792 (-4.176)
PWTAX	0.1514 (6.764)	0.1517 (6.673)
WHCOST	221.49 (15.737)	238.77 (16.706)

Table 5
Estimates of Demand Elasticity

	Single Equation Estimate	1	2
Price Elasticity of Demand			
1955-89	-0.76	-1.12	-1.08
Prior to 1964	-0.87	-1.28	-1.23
1964 - 1979	-0.73	-1.08	-1.04
After 1980	-0.71	-1.05	-1.01
Income Elasticity of Demand			
1955-89	0.08	0.48	0.46
Prior to 1964	0.07	0.42	0.40
1964 - 1979	0.08	0.48	0.46
After 1980	0.09	0.55	0.53

Table 6
Estimates of Conjectural Variation in U.S.
Cigarette Manufacturing Industry

	Entire Period 1955-89	Prior to 1964	1964 to 1979	After 1980
Lerner Index	0.628	0.483	0.609	0.790
Retail Price Elasticity	-1.081	-1.232	-1.040	-1.011
Wholesale Price Elasticity	0.374	0.358	0.330	0.461
Conjectural Variation	1.097	0.966	0.951	1.448
Herfindahl Index	0.229	0.216	0.216	0.261
Conjectural Elasticity	0.251	0.209	0.206	0.377

Table 7
Static Simulation of Endogenous Variables
Theil's Inequality Coefficient

	--- 1 ---	--- 2 ---
P	0.079942	0.034116
Q	0.086101	0.069608
PW	0.17152	0.062666
ADV	0.20797	0.28899
DISTR	0.069536	0.049446

Table 8
Simulation of the Effect of a 1 cent Increase in Cigarette Excise Tax
Effect on Prices and Quantities

	1		2	
	Federal	State	Federal	State
Mean Change in Real Price (1981 cents)				
Retail Price paid by Consumers	0.748	0.499	0.732	0.467
Price Received by Retailers	-0.252	-0.501	-0.268	-0.533
Wholesale Price	-0.391	-0.262	-0.399	-0.256
Mean Change in Quantity (Billions of Packs)	-479.9	-320.8	-469.1	-300.8

Table 9
Simulation of the Effect of a 1 cent Increase in Cigarette Excise Tax
Effect on Social Welfare

	1		2	
	Federal	State	Federal	State
Mean Change in Social Welfare (1981 Dollars)				
Consumer Surplus	-197.8	-132.2	-190.4	-121.7
Producer Surplus	-328.1	-247.9	-331.9	-235.9
Total Decrease in Surplus	-525.96	-380.1	-522.4	-357.6
Dead Weight Loss	260.6	113.1	257.6	91.2
Government Revenue	265.4	267.0	264.7	266.4
Percent Shares of Change in Social Welfare				
Consumers' Share of Lost Welfare	37.8	35.0	38.5	35.9
Producers' Share of Lost Welfare	62.2	65.0	61.5	64.1
Deadweight Loss as Percent of Lost Welfare	49.6	29.9	49.0	25.1
Mean Change in Social Welfare (1981 Dollars)				
Producer Surplus	-328.1	-247.9	-331.9	-235.9
Manufacturers	-163.7	-109.9	-170.7	-110.0
Distributors	-164.4	-138.0	-161.3	-125.8
Percent Shares of Change in Producers' Surplus				
Manufacturers	49.3	43.7	47.1	42.5
Distributors	50.7	56.3	52.9	57.5
Change in Costs				
Manufacturing	-72.0	-48.1	-70.6	-45.3
Advertising	-43.5	-29.2	-44.1	-28.4
Distribution	-72.7	-109.2	-72.0	-119.8

Appendix A
Data Sources and Analysis

Quantity. The quantity of cigarettes produced, consumed and exported are from the excise tax data of the U.S. Bureau of Alcohol, Tobacco and Firearms. These are published by the United States Dept. of Agriculture (Grise and Griffin, 1988) and updated by it in the periodical Tobacco Situation and Outlook Report.

Cigarette Type. The same U.S.D.A. sources provide the market share of filter cigarettes. The domestic market share of low-tar cigarettes is from the U.S. Federal Trade Commission (1991).

Personal Income. Average personal income is from the U.S. Bureau of Economic Analysis (1989), as updated in the Survey of Current Business.

Price. Retail price is the quantity weighted average of state prices obtained in the annual survey of the Tobacco Institute (1990). Wholesale price is a weighted average of wholesale prices published in Table 4 of the April issues of the Tobacco Situation and Outlook Report. Wholesale prices of each category of cigarette (standard, king size, filter, and 100 mm.) are weighted by each product's share of total quantity manufactured. That share was obtained from Table 3 of the same publication. Price weighting was also by the number of days out of the year that a given price prevailed.

Advertising Expenditures. Advertising expenditures for 1963 through 1989 were obtained from the United States Federal Trade Commission (1991). Data for 1955 through 1963 were from Schmalensee's The Economics of Advertising (1972).

Population. Population is the civilian U.S. population at least 17 years of age. The source is the annual estimates of the Bureau of Census, published in the Current Population Report Series P-25. All data reflect post-census corrections made to intercensal estimates.

State Smoking Laws. An index was created to represent state laws. Each state law contributed to the index in proportion to that state's share of the population. Additional weighting

depended on the restrictiveness of the law, measured on 4 step scale, as published in Table 19 of the Surgeon General's Report (U.S. Office on Smoking and Health, 1989). The index was normalized to take on a value between 0 and 1.

Herfindahl Statistic. The share of market for each domestic manufacture for the period 1955-1985 is from Maxwell (1986). More recent data are Maxwell's figures, as published in various issues of Business Week, Advertising Age, and Tobacco Reporter.

Tax Rates. The average state and local tax rate is a quantity weighted average of taxes prevailing in all state and local jurisdictions. Quantity and tax rates were obtained from the Tobacco Institute (1989).

Distribution Costs. The distribution costs are the percentage of the total revenues of tobacco wholesalers which are accounted for by non-product costs, as reported in the Census of Wholesale Trade for 1954, 1958, 1963, 1967, 1972, 1977, 1982, 1987. Intercensus years were interpolated with an assumption that costs change logarithmically.

Manufacturing Wages and Labor. The number of employees and total compensation paid to employees in the cigarette manufacturing industry (SIC 2111) was obtained from the Annual Survey of Manufactures.

Capital Cost. Capital cost is the rental cost of the stock of capital used in cigarette manufacturing. The cost was estimated as the product of a quantity-- the real capital stock employed, and a factor price-- the rental rate for capital.

Three types of capital were considered-- equipment, inventory, and structures. The rental rate in any year was the weighted average nominal rental rate for each capital type, with the weighting by the quantity of the stock of that type in that year. The rental rate for capital of the capital type i, (R_i), was calculated as:

$$R_i = \frac{r}{\left(1 - e^{-rL_i}\right)} P_i$$

where r is the corporate rate of return on capital, L_i is the lifetime of that capital type, and P_i is its price deflator.

The return to corporate capital was assumed to be 11.5% throughout the period, the average rate of return reported by Feldstein et al (1983). Price deflators were the producers' price indexes in the National Income and Product Accounts. These were the fixed-weighted price index for non-residential structures and the fixed-weighted price index for private purchases of general industrial equipment. The rental rate for inventories was simply the corporate return times the general GNP price deflator (i.e., an infinite lifetime-- some level of inventories is always maintained).

Capital lifetimes were those used by the Bureau of Labor Statistics (1979), 14 years for industrial machinery and 36 years for industrial buildings. The capital stock of the cigarette manufacturing industry was estimated with the assumption of straight-line depreciation. Inventories and capital expenditures on equipment and buildings between 1950 and 1989 were obtained from the Annual Survey of Manufactures. For the years 1950-59, 1966, 1981, 1983, and 1984, the Survey reported only total capital expenditures, and did not distinguish between equipment and structures. For these years it was assumed that the share of total capital invested in equipment was the same as the average of years in which the separate expenditures of each type were reported.

Since there were no data on capital expenditures prior to 1950, the capital stock estimates of the Bureau of Labor Statistics were used to estimate the value of pre-1950 capital stock remaining in each year. This value was calculated from the implicit depreciation in the BLS estimates.

Once the nominal stock of capital was calculated, it was divided by the appropriate price index to yield real capital stock.

Tobacco Quantity and Price. The price of tobacco was a weighted average of various tobacco types. The quantity of each type of tobacco used in cigarette manufacture is from Grise and Griffin (1988) and the Tobacco Situation and Outlook Report.

The quantity of each domestic type was converted to green weight, and multiplied times the

average farm price for that type to generate a total expenditure on raw tobacco. The share of the cigarette tobacco used in domestic manufacture was used to determine the share of the non-tobacco costs of the domestic tobacco and stemming and drying industry (SIC 2141) which were added to the cost of tobacco used in cigarette manufacture. The costs of stemming and drying were obtained from the Annual Survey of Manufacturers.

The quantity of each foreign type was multiplied by the average price for that type to estimate expenditures on imported tobaccos used in domestic cigarette manufacture. Import prices and quantities were obtained from the Tobacco Situation and Outlook Report. Imported tobacco is already stemmed and dried.

These tobacco costs were divided by the total dried weight of tobacco used in the industry to develop the average weighted price.

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