ADVERTISING RESTRICTIONS AND CIGARETTE SMOKING:
EVIDENCE FROM MYOPIC AND RATIONAL ADDICTION MODELS

NATSUKO IWASAKI, CAROL HORTON TREMBLAY, and VICTOR J. TREMBLAY*

Because of the high social cost of cigarette smoking, many countries impose
advertising restrictions to reduce cigarette consumption. Yet previous studies conclude
that advertising constraints have been ineffective at reducing cigarette smoking. This
conclusion is incorrect because it ignores the fact that advertising restrictions have
supply as well as demand effects. The authors extend existing research by showing
that advertising regulations, especially those found in the recent National Tobacco
Settlement, have decreased the equilibrium level of cigarette consumption in the
United States, a result that holds for both myopic and rational addiction models.

I. INTRODUCTION

As the leading cause of preventable mortality
in the United States, cigarette smoking imposes a tremendous cost on society. Sloan
et al. (2004) estimate that each year smoking causes approximately 400,000 deaths and
$104 billion in social costs. Of this amount, $35 billion is external to individual cigarette
smokers. In spite of these known private and external costs associated with cigarette
smoking, approximately 17% of U.S. adults continue to smoke cigarettes (Centers for
Disease Control and Prevention 2002). 1

To reduce cigarette smoking, many countries have imposed various advertising restric-
tions. For example, the United States enacted the Fairness Doctrine Act, effective 1968–70,
which required that one antismoking advertisement be aired for every four prosmoking
advertisements on television and radio. In 1971 the U.S. Broadcast Advertising Ban
abolishing all cigarette (pro- and antismoking) advertising from TV and radio. At the end
of 1998, the U.S. tobacco industry and 46 states forged an agreement, the National
Tobacco Settlement, that prohibits outdoor advertising, bans tobacco companies from
using cartoon characters to market their products, and provides funding for antismok-
ing advertising (Nader 1998; Shapiro 1998; Teinowitz 1998).

A growing body of evidence has shown, however, that advertising bans have no sig-
nificant effect on cigarette demand. 2 For example, in a study of 22 Organisation for
Economic Co-operation and Development countries, Stewart (1993) finds that advertis-
ing bans may actually stimulate cigarette smoking. Schneider et al. (1981) find that
the Broadcast Advertising Ban increased cigarette smoking in the United States, arguing
that this was due to the elimination of both pro- and antismoking advertising. In a review
article of international studies concerning the relationship between advertising and cigarette
smoking, Duffy (1996, p. 20) concludes: “Taken as a whole, these studies, American
and otherwise, provide very little support for those who believe that a broadcast adver-
tising ban is a potent way of achieving significant changes in smoking behavior.”

*The authors thank Bruce McGough, Robert Michaels, and an anonymous referee for helpful com-
ments on an earlier version of the article.

Iwasaki: Ph.D. candidate, Department of Economics,
Oregon State University, Corvallis, OR. E-mail
iwasaki@onid.orst.edu

C. H. Tremblay: Associate Professor of Economics,
Oregon State University, Corvallis, OR. E-mail
ctremblay@oregonstate.edu

V. J. Tremblay: Professor of Economics, Oregon State
University, Corvallis, OR. E-mail v.tremblay@
oregonstate.edu

1. For a discussion of the history of public health
research on cigarette smoking, see Hammerle (1992)

doi:10.1093/cep/byj024
© Western Economic Association International 2006
No Claim to Original U.S. Government Works
Given the high cost and the subsequent social goal of deterring smoking, understanding the consequences of advertising restrictions is critical to establishing appropriate public policy. Tremblay and Tremblay (1999) argue that the counterintuitive conclusion of Duffy (1996) and others may be incorrect because it ignores the supply side effects of advertising. Their model shows that even when advertising has no effect on market demand, an advertising ban can still cause a dramatic fall in the equilibrium level of cigarette smoking if advertising has procompetitive supply effects. Farr et al. (2001) find empirical support for this hypothesis in the short run using a myopic addiction model.

In contrast to previous work, the authors compare the short-run and long-run effects of advertising restrictions on cigarette smoking for both myopic and rational addiction models. In myopic addiction models consumers have no foresight, so previous consumption affects current consumption, but future consumption bears no influence. When consumers are rationally addicted (Becker and Murphy 1988), they also look forward so that current consumption may depend on expected future as well as past consumption. Although there has been empirical support for the rational addiction model (Chaloupka 1991; Becker et al. 1994; Olekalns and Bardsley 1996; Fenn et al. 2001; Sloan et al. 2002), it has not gone unchallenged. For example, Akerlof (1991) shows that procrastination can negate foresight. In Akerlof’s model, consumers ignore the future because the present is unduly salient. A consumer who wants to quit smoking because of an increase in expected future prices, for example, may find it optimal to postpone quitting for a day, as the benefit of smoking now is high relative to the cost of waiting one day to quit. Day-by-day optimization leads the consumer to continue smoking despite the intention to quit. In addition, cigarette smokers may suffer from cognitive dissonance (Akerlof and Dickens 1982). That is, consumers who smoke and value health face an inconsistency that creates internal conflict. One response is to ignore the future and downplay public health warnings concerning smoking cigarettes. If cognitive dissonance and procrastination are important, then the effect of expected future consumption on current consumption will be small, and the myopic and rational addiction models will yield similar results.

To see if this is the case, the authors develop two models of the cigarette market, one with myopic addiction and one with rational addiction, to examine the effect of advertising restrictions on the equilibrium level of cigarette consumption. That is, the authors estimate the change in equilibrium consumption from an unregulated to a regulated environment where the Fairness Doctrine Act, the Broadcast Advertising Ban, and the National Tobacco Settlement are in effect. As well as shedding light on these policy issues, the results will expose any differences in estimates for the rational addiction model and the myopic addiction model.

II. THE THEORETICAL AND EMPirical MODEL

Because cigarette smoking is addictive, cigarette demand is dynamic. The market demand price at time $t$ is a function of current consumption ($Q_t$), the level of addiction ($\phi$), and a vector of other relevant demand variables such as advertising and consumer income ($x_t$). For addictive commodities, an increase in current consumption increases the degree of addiction and therefore market demand in next period. If people are rationally addicted, an expected increase in the future price would decrease future consumption and therefore current market demand. Future effects would be discounted, however, given the degree of consumer foresight and rate of time preference, which are captured by the discount factor, $\delta$ ($0 \leq \delta < 1$). When $\delta = 0$, consumers ignore the future and are myopically addicted. In this case the authors can say that consumers are infinitely impatient. Consumers are rationally addicted when they have at least some patience and foresight (i.e., $\delta > 0$), and current

4. Even when consumers are not rationally addicted, however, supply forces like learning-by-doing may also cause the optimal path of current consumption to be influenced by expected future effects (Pindyck 1985; Showalter 1999).

5. That is, $\delta = 1/(1 + r)$, where $r$ is the rate of time preference. For example, a value of $\delta = 0.6$ implies that a smoker would be willing to give up no more than 60 cigarettes today to receive 100 cigarettes in the next period. A lower discount factor implies greater impatience. It may also imply greater uncertainty about the future, causing consumers to place less weight on expected future events.

3. This is consistent with Schoenbaum (1997, p. 755), who finds that “heavy smokers significantly underestimate their risk of premature mortality.”
demand will depend on consumption in the previous period, \(\phi(Q_{t-1})\), and on expected consumption in the future, \(\delta\phi(Q_{t+1})\) (Becker et al. 1994; Fenn et al. 2001). This produces the following inverse demand function:

(1) \[ p_t = p_t(Q_t, \phi(Q_{t-1}), \delta\phi(Q_{t+1}), \Sigma), \]

where \(p_t\) is the demand price in period \(t\).

Given the addictive nature of cigarettes, current sales affect a firm’s current and future profits. In this setting, the firm’s problem in the current period \((t = 0)\) is to choose the sequence of firm output levels \((q)\) that maximizes its discounted stream of current and future profit \((\Pi)\). More formally, the firm’s problem is:

(2) \[ \max_{\Pi_0} = \sum_{t=0}^{\infty} \delta^t \left[ (p_t(\cdot) - mc_t)q_t - F_t \right] \]

s.t. \(\phi(t + 1) = f(t, \phi(t), q(t))\)

\(\phi(0) = \phi_0\)

\(q(t) \in \Omega_t\)

where \(mc_t\) is marginal cost, and \(F_t\) is fixed cost. The objective function is maximized, subject to the dynamic updating rule that links addiction in period \(t + 1\) with addiction and consumption in period \(t\), given an initial value of addiction \((\phi_0)\) and that the choice of output is an element of the feasible set \(\Omega_t\).

When faced with a dynamic setting such as this, the firm’s economic problem can be solved recursively using dynamic programming methods.\(^6\) Let the value function, \(V_{k+1}\), be the maximized value of the objective function of the subproblem in period \(k + 1\). Assuming a solution exists, the Bellman equation or value function in period \(k\) \((0 \leq k < \infty)\) can be written as

(3) \[ V_k = \max_{q \in \Omega_k} \{ p_k(\cdot) - mc_k \} q_k - F_k + V_{k+1} \]

subject to the constraints described. Because of addiction, an output change in period \(k\) will affect future as well as current profit. This trade-off can be seen from the firm’s first order condition:

(4) \[ p_k - \theta q_k - mc_k + \frac{\partial V_{k+1}}{\partial q_k} = 0 \]

The term in brackets is the standard first-order condition of the firm’s static problem in the absence of addiction, where \(\theta\) is a markup or market power index. That is, the equilibrium price exceeds marginal cost in the static model when \(\theta\) exceeds 0. With addiction, however, it may be optimal for a firm to substantially lower price today, even setting it below marginal cost, because this will increase addiction and future profits. As a result, the price-cost margins or Lerner index underestimates the degree of market power in markets with addiction (Pindyck 1985). Solving equation (4) for price produces a dynamic version of the supply relation found in the new empirical industrial organization (Bresnahan 1989; Kadiyali et al. 2001). Assuming constant marginal cost in period \(k\) and aggregating over all firms produces the supply relation at the industry level:

(5) \[ p_k = mc_k + \theta Q_k - V_{k+1}, \]

where \(Q\) is industry output and \(V’\) is the effect of a change in current output on the aggregate value function in the future.

In addition to the variables affecting smoking in equations (1) and (5), advertising enters the model in the demand equation and may also affect the supply relation. For example, advertising that is primarily informative will raise competition and lower markups (Bagwell 2003; Carlton and Perloff 2005). Eckard’s (1991) and Farr et al.’s (2001) empirical results suggest that antismoking advertising and the Broadcast Advertising Ban have increased price-cost margins in the U.S. cigarette industry. The present authors estimate how advertising affects cigarette consumption when unregulated and when regulated by the Fairness Doctrine Act, the Broadcast Advertising Ban, and the National Tobacco Settlement. Estimates are obtained from a reduced-form model of the equilibrium level of consumption, which derives from the structural demand function and supply relation. The advantage of using the reduced form is that it places limited structure on demand and supply and allows the authors to directly estimate

---

6. See Novshek (1993), for example, for a more complete description of dynamic programming.
the effect of a change in advertising policy on the equilibrium level of consumption (Griffiths et al. 1993; Kadiyali et al. 2001). The authors model the industry supply relation in period $t$ as follows.\footnote{Following Roberts and Samuelson (1988), Jarmin (1994), and Genesove and Mullin (1998), the authors use a constant term and a variable parameter for marginal cost to capture dynamic effects and increase model flexibility.}

\begin{equation}
    p_t = f_t(m_{c_t}, Q_t, A_t D_{55-67}, A_t D_{68-70}, A_t D_{71-97}, A_t D_{98-02}).
\end{equation}

In this specification, $A_t$ is industry advertising. The influence advertising on supply under the Fairness Doctrine Act is captured by interacting $A_t$ with $D_{68-70}$, a dummy variable that equals 1 when the Fairness Doctrine was in effect (1968–70) and 0 otherwise. Likewise, the model also includes advertising interaction terms for the Broadcast Advertising Ban ($A_t D_{71-97}$), and the National Tobacco Settlement $A_t D_{98-02}$. Because the Broadcast Advertising Ban is still in force, the $D_{98-02}$ dummy variable represents the regulatory states of the Ban and the Settlement. Finally, cigarette advertising was unregulated prior to 1968, and the effect of advertising during this period is captured by the advertising interaction term, $A_t D_{55-67}$.

Specification of the market demand for cigarettes in equation (1) follows previous research. Because the marginal effect of advertising on demand may vary by marketing medium (Porter 1976), the authors also allow the effect of advertising to differ by policy regime in the demand function.\footnote{One might also be concerned that past advertising affects current demand, but Boyd and Seldon (1990) find that cigarette advertising dissipates within one year. Thus, has little effect on goodwill, and current advertising would primarily affect current consumption. See Bagwell (2003) for a review of this issue.} Information about the health risks of smoking will affect the smoking behavior of rational consumers. This effect is captured by a dummy variable ($D_{64}$) that coincides with the U.S. Surgeon General’s 1964 report, the first to conclude that cigarette smoking causes lung cancer. $D_{64}$ equals 1 from 1964 on, and 0 otherwise.

Furthermore, Chaloupka (1991, 1992) finds that the clean indoor air laws have a significant negative impact on average cigarette consumption. As a result, the authors construct a variable that accounts for the increasing strictness of indoor smoking, $LAW_t$.\footnote{This variable also reflects other demand forces that vary with time, such as the growing evidence and concern with the social costs of cigarette smoking. See Appendix A for the definition of this variable.} From demand theory, consumer income may also be an important demand determinant. Consequently, per capita cigarette demand in period $t$ ($pcq_t$) is defined as

\begin{equation}
    pcq_t = f_0(p_t, pcy_t, pcq_{t-1}, pcq_{t-1}, D_{64}, LAW_t, A_t D_{55-67}, A_t D_{68-70}, A_t D_{71-97}, A_t D_{98-02}),
\end{equation}

where $pcy_t$ is per capita disposable income. The reduced form of this system is obtained by solving equations (6) and (7) simultaneously for $pcq_t$. Assuming it can be accurately approximated by a linear specification, the statistical model of the reduced form is

\begin{equation}
    pcq_t = \pi_0 + \pi_1 m_{c_t} + \pi_2 pcy_t + \pi_3 pcq_{t-1} + \pi_4 pcq_{t-1} + \pi_5 D_{64} + \pi_6 LAW_t + \pi_7 AD_{55-67} + \pi_8 AD_{68-70} + \pi_9 AD_{71-97} + \pi_{10} AD_{98-02} + \epsilon_t,
\end{equation}

where the $\pi$’s are reduced form parameters and $\epsilon_t$ is an additive error term. The model is myopic when $\delta$ and, therefore, $\pi_\delta$ equals 0. Estimates of the model can be used to predict how a change in advertising policy will affect equilibrium consumption in the short run and the long run. Because the reduced-form parameters capture the net effect of relevant demand and supply effects on consumption, they should be interpreted as such. For example, an increase in persuasive advertising may increase demand and reduce price competition. The increase in demand would increase equilibrium consumption, whereas the decrease in competition would lead to a higher price and lower equilibrium consumption. Thus, the net effect of advertising on consumption, which depend on the relative
magnitudes of these effects, is ambiguous but can be obtained directly from the reduced-form results. Methods used to obtain the short-run and long-run effects of an advertising policy on cigarette smoking are described in Appendix B.

### III. EMPIRICAL RESULTS

The rational and myopic addiction models are estimated using annual industry data, 1955–2002. The data are described in Appendix A and in Table 1. As in previous studies (Becker et al. 1994; Fenn et al. 2001; Sloan et al. 2002), the rational addiction model is estimated by two-stage least squares. The myopic model is estimated by ordinary least squares because lagged output is predetermined.

The empirical results are reported in Table 2. All parameter estimates have expected signs and many are significantly different from 0 at conventional levels of significance. In both the rational and myopic models, the marginal cost has a negative effect and disposable income has a positive effect on consumption. Public health information and antismoking restrictions, captured by $D_{64}$ and $\text{LAW}_t$, inhibit cigarette smoking.

Addiction plays an important role as evidenced by the positive, significant, and relatively large coefficient estimate on lagged consumption. The large and significant

### TABLE 1


<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q$</td>
<td>Quantity of cigarettes domestically consumed (in millions) [8]</td>
<td>523,762.5 (71,797.79)</td>
</tr>
<tr>
<td>$pcq$</td>
<td>Per capita quantity (in thousands) $= q/(\text{population 18 years and older})$ [2, 8]</td>
<td>3.46134 (0.7725)</td>
</tr>
<tr>
<td>$p$</td>
<td>Retail price per cigarette including tax in cents per cigarette; 1982 $\dagger$ [1, 6]</td>
<td>5.1294 (1.4174)</td>
</tr>
<tr>
<td>$pcy$</td>
<td>Per capita disposable income [3, 6]</td>
<td>10281 (2545.91)</td>
</tr>
<tr>
<td>$mc$</td>
<td>Marginal cost proxy (in cents per cigarette) $= \frac{\text{total cost of cigarette materials + payroll for cigarette employees + (gross value of fixed assets in cigarette industry} \times \text{Moody's AAA corporate bond rate) + federal and weighted average state taxes}}{q}$ [1, 3, 5, 6, 8]</td>
<td>3.0103 (0.6307)</td>
</tr>
<tr>
<td>$D_{64}$</td>
<td>Dummy variable for the Surgeon General’s 1964 Report $= 1$ for 1964–2002; $= 0$ otherwise</td>
<td>0.8125 (0.3944)</td>
</tr>
<tr>
<td>$\text{LAW}$</td>
<td>Control for clean indoor air $\dagger$ [2, 7]</td>
<td>33.98 (29.02)</td>
</tr>
<tr>
<td>$A$</td>
<td>Advertising expenditures (millions of 1982 $\dagger$) [4, 9]</td>
<td>1264.22 (705.27)</td>
</tr>
<tr>
<td>$D_{55-67}$</td>
<td>Pre-Fairness Doctrine Act dummy variable $= 1$ for 1955–67; $= 0$ otherwise</td>
<td>0.2708 (0.4491)</td>
</tr>
<tr>
<td>$D_{68-70}$</td>
<td>Fairness Doctrine Act dummy variable $= 1$ for 1968–70; $= 0$ otherwise</td>
<td>0.0625 (0.2446)</td>
</tr>
<tr>
<td>$D_{71-97}$</td>
<td>Broadcast Advertising Ban dummy variable $= 1$ for 1971–97; $= 0$ otherwise</td>
<td>0.5625 (0.5013)</td>
</tr>
<tr>
<td>$D_{98-02}$</td>
<td>National Tobacco Settlement dummy variable $= 1$ for 1998–2002; $= 0$ otherwise</td>
<td>0.1042 (0.3087)</td>
</tr>
</tbody>
</table>

Notes: Price and income are deflated by the Consumer Price Index, costs are deflated by the Producer Price Index, and advertising expenditures are deflated by the Media Price Index (1982 = 100).


10. Output instruments include all current exogenous variables and all lagged and future values of all exogenous variables, U.S. tobacco growers’ acreage allotment, and price.

11. The authors also test for autocorrelation, using a modified Breusch-Godfrey test for the rational addiction model (Greene 2002). No autocorrelation is detected in the rational or myopic models.
parameter estimate of expected future consumption suggests that the rational addiction model provides a better representation of the cigarette market than the myopic addiction model. In the rational model, the coefficient on lagged consumption is greater than on future consumption, a result that is consistent with previous empirical studies (Becker et al. 1994; Fenn et al. 2001; Sloan et al. 2002). Becker et al. (1994) show that the parameter on future consumption will equal the parameter on past consumption times the discount factor. Results from Table 2 suggest a discount factor of 0.78, for a rate of time preference of about 27%. A rate above the real interest rate or a risk-free investment implies that the representative smoker is relatively impatient, an expected outcome for a commodity like cigarettes, where physical dependence, procrastination, and cognitive dissonance would lead to a higher rate of time preference.12

The advertising variables capture consumption effects through both the demand and the supply sides of the market. Although only one parameter is significantly different from 0, they exhibit a consistent pattern and imply that advertising restrictions negatively impact cigarette smoking. Focusing on the more relevant rational addiction results, advertising has a negligible effect on consumption when there are no advertising restrictions (1955–67). This suggests that the demand and supply effects of advertising are negligible or offsetting. For each succeeding regime of policy restrictions, however, advertising has a decreasing effect on consumption. The current advertising restrictions under the National Tobacco Settlement and the Broadcast Advertising Ban have the greatest effect, an effect that is negative and significantly different from 0. This suggests that the Advertising Ban and the National Tobacco Settlement diminish price competition and consumption, a result consistent with Eckard (1991) and Farr et al. (2001). The evidence indicates that these advertising restrictions reduce consumption, even if advertising has little or no effect on market demand as in earlier studies.

Table 3 provides estimates of the effect of the different advertising regimes on consumption, based on the parameter estimates in Table 2. The authors use actual consumption in 2002 as the reference point for the analysis. This is the most recent year of the sample, a year when both the Broadcast Advertising Ban and the provisions of the National

---

### TABLE 2

Rational and Myopic Model Estimates of the Equilibrium Level of Cigarette Smoking

<table>
<thead>
<tr>
<th>Variable</th>
<th>Rational Addiction Model</th>
<th>Myopic Addiction Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.0375085 (0.75164)</td>
<td>1.148731* (2.96274)</td>
</tr>
<tr>
<td>mct</td>
<td>-0.086742 (01.61045)</td>
<td>-0.104510* (1.9791)</td>
</tr>
<tr>
<td>pcy</td>
<td>0.053878 (1.529872)</td>
<td>0.02654 (0.68102)</td>
</tr>
<tr>
<td>pq−1</td>
<td>0.494288* (3.99084)</td>
<td>0.770911* (10.3651)</td>
</tr>
<tr>
<td>pq+1</td>
<td>0.387939b (2.4911)</td>
<td>—</td>
</tr>
<tr>
<td>D64</td>
<td>-0.119833b (2.05459)</td>
<td>-0.058779 (0.821730)</td>
</tr>
<tr>
<td>LAW</td>
<td>-0.004273 (1.47067)</td>
<td>-0.006712b (2.31597)</td>
</tr>
<tr>
<td>A65–67</td>
<td>0.046610 (0.541345)</td>
<td>-0.005656 (0.064456)</td>
</tr>
<tr>
<td>A68–71</td>
<td>0.019510 (0.228403)</td>
<td>-0.059587 (0.75022)</td>
</tr>
<tr>
<td>A71–97</td>
<td>-0.065145 (1.43408)</td>
<td>-0.052583 (1.11833)</td>
</tr>
<tr>
<td>A98–02</td>
<td>-0.09164c (1.84096)</td>
<td>-0.107740b (2.2036)</td>
</tr>
<tr>
<td>R²</td>
<td>0.995217</td>
<td>0.992137</td>
</tr>
<tr>
<td>N</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Discount factor (δ)</td>
<td>0.7848</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: The absolute values of t-statistics are in parentheses.
*Significant at 0.01 level (two-tailed test, critical t value = 2.690).
*Significant at 0.05 level (two-tailed test, critical t value = 2.014).
*Significant at 0.10 level (two-tailed test, critical t value = 1.679).

12. Gruber and Koszegi (2000) make a similar argument, suggesting that there is additional discounting for addictive bads.
Tobacco Settlement were in effect. The authors then predict 2002 levels of consumption that would result under three alternative policy settings: no advertising restrictions, the Fairness Doctrine Act, and the Broadcast Advertising Ban (apart from the tobacco settlement). Table 3 shows that advertising restrictions substantially reduce the equilibrium level of consumption in the short run and the long run. It also shows that the dynamic nature of addiction models produces greater long-term effects than short-term effects in both myopic and rational specifications.

Each advertising restriction becomes more effective at reducing the impact of advertising on cigarette smoking, with the current policy regime that includes the National Tobacco Settlement and the Broadcast Advertising Ban being most effective. This result is consistent with Keeler et al. (2004), who find that the price increase resulting from the National Tobacco Settlement reduced per capita consumption even though advertising expenditures rose substantially immediately after the settlement.

The magnitude of the impact of advertising regulations differs for the rational and myopic models. The difference in short-run predictions reflects differences in the parameter estimates between models. In the long run, policy changes are greater in the rational addiction model, because the lag and lead effects of addiction in the rational model exceed the single lagged effect in the myopic model. Consistent with the rational addiction model where consumers have foresight, long-run consumption falls when a policy is expected to lead to less competition and higher prices in the future. Although there is empirical support for the rational addiction model, the lessons from the myopic and rational addiction models are the same: Advertising restrictions result in less smoking, particularly under the Broadcast Advertising Ban and the National Tobacco Settlement.

### IV. CONCLUSION

Many countries have imposed advertising restrictions to curtail the social cost associated with cigarette smoking. Previous research indicates, however, that advertising bans generally have no significant effect on demand.
Unfortunately, this is interpreted to mean that such bans have no effect on the equilibrium level of consumption. This interpretation may be incorrect, however, because it ignores the fact that advertising can have supply as well as demand effects. Even if an advertising ban had no effect on demand, it could still reduce the equilibrium level of consumption if it reduced price competition.

To address this issue directly, the authors estimate a reduced-form output equation for the U.S. cigarette industry. Unlike previous research, the model allows the effectiveness of advertising to vary with the Fairness Doctrine Act, the Broadcast Advertising Ban, and the National Tobacco Settlement. As expected, the empirical results indicate that the equilibrium level of cigarette smoking declines with higher marginal costs, more accurate health information, and with more restrictive clean indoor air regulations. Consistent with the rational addiction model, both past and expected future levels of consumption positively and significantly affect current consumption.

Advertising restrictions, especially the current policy that includes a ban on broadcast advertising and the provisions of the National Advertising Settlement, reduce the equilibrium level of consumption. Because previous studies show that cigarette advertising has little or no effect on market demand, it appears that advertising restrictions lower consumption by reducing price competition. This provides one explanation for the observation that cigarette profits have risen in spite of public policies to decrease demand (Becker et al. 1994; Bulow and Klemperer 1998; Farr et al. 2001) and may explain why the leading U.S. cigarette producers have not been strongly opposed to advertising restrictions.

This is not to imply, however, that advertising restrictions are a first-best policy for cutting cigarette consumption. For example, one could design an equally effective tax policy, as Keeler et al. (1993) and Evans and Farrelly (1998) suggest, that has the same effect on consumption without profiting cigarette producers.

Finally, estimates from the rational addiction model reveal that cigarette smokers have a high rate of time preference when considering the influence of future price changes on current behavior. This high rate is consistent with the addictive nature of smoking, the tendency to procrastinate a decision to quit, and the cognitive dissonance associated with consuming unhealthy commodities.

**APPENDIX A**

Annual U.S. cigarette industry data from 1955 through 2002 are used to estimate the reduced-form cigarette consumption model. Data sources, variable descriptions, means, and standard deviations for the primary data are listed in Table 1. Price and income data are deflated by the Consumer Price Index, advertising expenditures are deflated by media price index, and marginal cost is deflated by the Producer Price Index. Advertising is segmented into different regimes by interacting advertising expenditures (\(A_t\)) with appropriate dummy variables for the four different periods of advertising regulations: \(A_{t1968–70}, A_{t1971–97},\) and \(A_{t1998–02}\). The dummy variable \(D_{t1968–70}(\text{representing the period with no advertising restrictions})\) equals 1 from 1955 through 1967 and 0 otherwise. \(D_{t1971–97}(\text{Fairness Doctrine Act})\) equals 1 for 1968 through 1970 and 0 otherwise. \(D_{t1998–02}(\text{Broadcast Advertising Ban})\) equals 1 from 1971 through 1997 and 0 otherwise. \(D_{t1998–02}(\text{National Tobacco Settlement and the Broadcast Advertising Ban})\) equals 1 from 1998 through 2002 and 0 otherwise. In addition, effective marginal cost is measured as unit cost plus federal and average state taxes per cigarette.

The authors also construct the variable \(LAW_t\) to control for the influence of clean indoor air laws and the influence of health information on cigarette demand. \(LAW_t\) is defined as the sum of each state’s share of the U.S. population times a measure of restrictiveness of each states clean indoor air laws. The authors use the U.S. Department of Health and Human Services (1989) definition of overall antismoking restrictiveness, which equals 0 if there are no statewide antismoking restrictions, 1 if the state regulates smoking in one to three public places (excluding restaurant and private work sites), 2 if the state regulates smoking in four or more public places (excluding restaurant and private work sites), 3 if the state regulates smoking in restaurants (but not private work sites), and 4 if the state regulates smoking in private work sites. States with restaurant and private work site restrictions typically have several other antismoking restrictions. Historical facts regarding these restrictions are obtained from the U.S. Department of Health and Human Services (1989 and 1993), Chaloupka and Saffer (1992), Shelton et al. (1995), Kluger (1996), and the National Center for Chronic Disease Prevention and Health Promotion (2005).

**APPENDIX B**

For the rational addiction model, the short-run and long-run effects of an advertising policy change on consumption are derived from equation (8). The short-term effects of each policy change are:

\[
\frac{\Delta q_t}{\Delta D_{t1998–70}} = A_t \cdot \text{pop}_t(\pi_0 - \pi_t)
\]

\[
\frac{\Delta q_t}{\Delta D_{t1971–97}} = A_t \cdot \text{pop}_t(\pi_0 - \pi_t)
\]

\[
\frac{\Delta q_t}{\Delta D_{t1998–02}} = A_t \cdot \text{pop}_t(\pi_0 - \pi_t)
\]
where \( p_{op} \) is the population aged 18 and older. Each corresponds to the change in consumption in year \( t \) when the regime changes from being unregulated (1955–67) to each advertising regulation: the Fairness Doctrine Act (1968–70), the Broadcast Advertising Ban (1971–present), and the National Tobacco Settlement (1998–present). Other variables are held constant at their 2002 levels, the most recent year of the data set.

Given the addictive nature of cigarette smoking, however, a change in policy today will affect future as well as current consumption. Thus, short-run and long-run effects will differ. To estimate the long-run effects of a policy change, the authors use the equilibrium multipliers described in Greene (2002, pp. 415–17). To do this, the authors solve equation (8) for \( p_{ct,1} \) and multiply through by \( p_{op} \).

\[
(B2) \quad q_{t+1} = \frac{1}{\pi_d} p_{op} \left( \pi_0 + \pi_1 m c_t + \pi_2 p_{cy} + \pi_3 p_{ct-1} - p_{c} q_{t} + \pi_D D_{t4} + \pi_L A W_{t} + \pi_A D_{25–67} + \pi_E D_{68–70} + \pi_P D_{71–97} + \pi_M D_{88–92} + \pi_1 \right)
\]

Next, the authors reparameterize and write equation (B2) in terms of \( q_{t+1}, q_t, q_{t-1} \), and \( \pi_0 \).

\[
(B3) \quad q_{t+1} = \Pi_0 q_0 + \Theta_1 q_t + \Theta_2 q_{t-1} + \varepsilon_t
\]

where \( \Pi_0 \) is a vector of parameters that corresponds to \( \gamma_2 \).

Because there are two lagged variables, the authors add one more equation as follows:

\[
(B4) \quad [q_{t+1}, q_t] = \gamma_1 [\Pi_{0}, [\Theta_1, \Theta_2] + [\varepsilon_t, 0] + [q_{t-1}, q_t]
\]

or

\[
(q_{t+1}) = \gamma_1 [\Pi_{0}, [\Theta_1, \Theta_2] + [\varepsilon_t, 0] + [q_{t-1}, q_t]
\]

\[
\hat{q}_{t+1} = \hat{y}_1 A_{t+2} + \hat{y}_1 B_{t+2} + \varepsilon_t
\]

where

\[
\hat{q} = \begin{bmatrix} q_{t+1} \\ \pi_1 \end{bmatrix}, \quad \hat{y}_1 = \begin{bmatrix} q_{t+1} \\ \pi_1 \end{bmatrix}
\]

\[
A = \begin{bmatrix} \Pi_{0} \end{bmatrix}
\]

\[
B = \begin{bmatrix} \Theta_1 & \Theta_2 \\ 1 & 0 \end{bmatrix}
\]

and \( \varepsilon_t = \begin{bmatrix} \varepsilon_t, 0 \end{bmatrix} \)

Taking a lag of equation (B4), \( \hat{q} = \hat{y}_1 A_{t+2} + \hat{y}_1 B_{t+2} + \varepsilon_t \), and substituting for \( \hat{q} \) in (B2) yields

\[
(B5) \quad q_{t+1} = \gamma_1 A_{t+2} + (\gamma_1 A_{t+2} + \hat{y}_1 B_{t+2} + \varepsilon_t) B + \varepsilon_t
\]

Subsequent substitution yields

\[
(B6) \quad \hat{q}_{t+1} = \sum_{\rho = 0}^{\infty} \gamma_1 A_{t+2} + \sum_{\rho = 0}^{\infty} \hat{y}_1 B_{t+2}
\]

Assume that \( \lim_{t \to \infty} A B^t = 0 \). Then

\[
(B7) \quad \hat{q}_{t+1} = \gamma_1 A + B + B^2 + B^3 + \cdots
\]

Summing the geometric series in equation (B7) to infinity reveals a simpler formula for the long-run consumption of cigarettes:

\[
(B8) \quad \hat{q}_{t+1} = \gamma_1 A \left[ 1 - B^{-1} \right]^{-1}
\]

or

\[
(B9) \quad \hat{q}_{t+1} = \gamma_1 A \left[ 1 - \Theta_1 - \Theta_2 \right]^{-1}
\]

\[
(B10) \quad \left[ q_{t+1} - q_t \right] = \gamma_1 \left[ \frac{1}{\pi_1} \begin{bmatrix} \pi_0 & \pi_1 \\ \pi_2 & \pi_3 \end{bmatrix} \right]
\]

The first element of the vector on the right-hand side of the equation is the long-run equilibrium multiplier. Fixing \( \gamma_1 \) at previous year values (2001), the effect of lifting the Fairness Doctrine Act and replacing it with no advertising restrictions in the long run is therefore:

\[
(B11) \quad \frac{\Delta q_{LR}}{\Delta D_{88–70}} = A_{2001} \cdot p_{2001} \left( \left( \frac{\pi_0}{\pi_1} - \frac{\pi_3}{\pi_1} \right) \left( 1 - \frac{1}{\pi_1} \right) \right)
\]

so

\[
(B12) \quad \frac{\Delta q_{LR}}{\Delta D_{71–97}} = A_{2001} \cdot p_{2001} \left( \left( \frac{\pi_0}{\pi_4} + \frac{\pi_1}{\pi_4} \right) \left( 1 - \frac{1}{\pi_4} \right) \right)
\]

The long-run effect of replacing the ban with no advertising restrictions is

\[
(B13) \quad \frac{\Delta q_{LR}}{\Delta D_{88–92}} = A_{2001} \cdot p_{2001} \left( \left( \frac{\pi_0}{\pi_4} + \frac{\pi_1}{\pi_4} \right) \left( 1 - \frac{1}{\pi_4} \right) \right)
\]

Moving from the current regime, the ban and settlement, to a setting with no restrictions has a long-run effect given by:

\[
(B14) \quad \frac{\Delta q_{LR}}{\Delta D_{88–92}} = A_{2001} \cdot p_{2001} \left( \left( \frac{\pi_0}{\pi_4} + \frac{\pi_1}{\pi_4} \right) \left( 1 - \frac{1}{\pi_4} \right) \right)
\]

For the myopic addiction model, the authors follow the specification in Farr et al. (2001). The myopic version of equation (8) is obtained by setting \( \pi_4 \) equal to 0 and reparameterizing as follows

\[
(B15) \quad \phi_{ct} = \psi_0 + \psi_1 m c_t + \psi_2 p_{cy} + \psi_3 p_{ct-1} + \psi_4 A D_{t4} + \psi_5 A W_{t} + \psi_6 D_{25–67} + \psi_7 D_{68–70} + \psi_8 D_{71–97} + \psi_9 D_{88–92} + \psi_t
\]

To derive the effect of a policy regime change, rewrite the equation as

\[
(B16) \quad \phi_{ct} = X_1 \psi + \lambda \phi_{ct-1} + \psi_t
\]
In the myopic addiction model, the changes in short-run consumption for the different policy regimes are:

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-70}} = A_1 \cdot p_0 \cdot (\psi_1 - \psi_0)
\]

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-97}} = A_2 \cdot p_0 \cdot (\psi_2 - \psi_0)
\]

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-42}} = A_3 \cdot p_0 \cdot (\psi_0 - \psi_0).
\]

Evaluating the term at 2002 values is

\[
q^L_{2002} = X^L_{2002} \Psi [1 - \lambda]^{-1}
\]

Hence, the corresponding changes in consumption are

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-70}} = A_2 \cdot p_0 \cdot p_0 \cdot (\psi_2 - \psi_0) [1 - \lambda]^{-1}
\]

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-97}} = A_2 \cdot p_0 \cdot q^L_{2002} \cdot (\psi_2 - \psi_0) [1 - \lambda]^{-1}
\]

\[
\frac{\Delta q^L_{2002}}{\Delta D_{2002-42}} = A_2 \cdot q^L_{2002} \cdot (\psi_0 - \psi_0) [1 - \lambda]^{-1}
\]

### REFERENCES


