CIGARETTE ADVERTISING REGULATION: A META-ANALYSIS

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Abstract.

This paper presents a synthesis of cigarette advertising elasticities derived from econometric studies for the U.S. and other countries. Summaries are presented using fixed- and random-effects weighted means and weighted regressions. The regressions account for heteroscedasticity, non-homogeneity, independence, and random effects. After accounting for random effects, the meta-analysis indicates that advertising elasticities are very small and not statistically significant regardless of the time period. The paper also reviews fifty years of regulation of cigarettes by the Federal Trade Commission and conducts a meta-analysis of four important regulatory events: the 1953 health scare; 1964 Surgeon General's Report; 1967-70 Fairness Doctrine; and the 1971 ban of broadcast advertising. The effect of the 1971 broadcast ban, which directly affected advertising, is not statistically significant.

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1. Introduction

Advertising is often singled out as an important causal determinant of cigarette consumption (U.S. Surgeon General, 1989, 1994, 2000). This view rests on the assumption that brand advertising has an important spillover effect on smoking behaviors and aggregate consumption. For example, the U.S. tobacco industry spends more than $1 billion annually on brand advertising and non-price promotions (FTC Report, 2004), and critics argue that this fact alone demonstrates that cigarette advertising must be important for smoking behaviors – otherwise the industry would not spend so much on advertising.[1] This negative view of advertising is reflected in tobacco policies in the United States and other countries, including bans of broadcast and billboard advertising; restrictions on advertising messages and placements; public reporting requirements for advertising expenditures; requirements for package warning labels; and attempts to further limit promotions or packaging that might appeal to adolescents and young adults (DOJ, 2005; FDA, 1996; Kessler et al., 1997; State Attorneys General, 1998; WHO, 2003). Little systematic analysis exists, however, on the effectiveness of many of these policies.

This paper provides cumulative evidence on the size and significance of the advertising elasticity of demand for cigarettes and associated federal regulations. For several reasons, estimation of demand elasticities for cigarettes is a frequent application of econometrics: for example, the policy issues are important; aggregate consumption and advertising data are readily available; and several important regulatory events have occurred, including the 1971 ban of broadcast advertising. As a result, numerous econometric studies estimate elasticities for cigarette advertising and other factors that might affect consumption, such as price and income effects, "health hazard" events, and package labeling laws. However, empirical estimates vary by time period, country, data interval, model specification, and econometric methods. As a consequence, considerable uncertainty exists regarding the significance and magnitude of the advertising elasticity. Reducing this uncertainty is important for public policy and provides information that might guide future research efforts. Similar uncertainly exists regarding the possible effects of regulation – a topic that previous literature summaries largely ignored. The objective of this paper is to use meta-analysis to synthesize available information on cigarette advertising elasticities and four associated regulatory events: the 1953 health scare; 1964 Surgeon General's Report; 1967-70 Fairness Doctrine anti-smoking ads; and the 1971 broadcast ban. Advertising elasticities are obtained from 25 U.S. studies and 13 non-U.S. studies. Regulatory impacts for the U.S. are obtained from 19 studies. These estimates are combined or synthesized using weighted means and generalized least-squares regression analysis.

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[1] I have stated this proposition in the manner that it has appeared in the public health literature. A study by Tye et al. (1987) attempts to demonstrate a causal connection based on the magnitude of cigarette advertising expenditures; see also Saffer (2000), Sullum (1998, pp. 102-03), and Boddewyn (1986).

The technique of meta-analysis has been widely used to obtain formal combinations of research results from multiple studies (Farley & Lehmann, 1986; Stanley, 2001; Stanley & Jarrell, 1989). A meta-analysis proceeds as follows (Lipsey & Wilson, 2001): first, the problem is stated such that it can be studied using a common quantitative "effect size" (e.g., scale-free advertising elasticities). Second, all available studies that provide *comparable* estimates are collected. Third, each study is evaluated and samples of estimated effect sizes and standard errors are obtained. Fourth, other relevant information is obtained on each study's sample and methods, such as time span, data interval, explanatory variables, and econometric methods. Potentially, this information can be used to explain the variation in the sample of elasticities. Fifth, the elasticities are synthesized or combined, and a single best "cumulative estimate" may be presented. This step is often controversial because the sample of observations may lack statistical independence or homogeneity. Hence, it is important to constrain the sample so as to produce relatively independent and homogeneous observations of a common phenomenon. The present study uses fixed- and random-effects methods to obtain weighted means and weighted regressions for separate samples for the U.S. and non-U.S. countries.

In many econometric studies, a researcher will present several estimates of a given demand parameter that reflect different model specification, estimation methods, and samples. This procedure has been criticized by Leamer (1978) and others. Meta-analysis is potentially valuable as a tool to assess the robustness and magnitude of results, but the use of multiple estimates from the same study can violate the assumption of statistical independence. For example, some cigarette demand studies report a dozen or more elasticities from the same data set (Kao & Tremblay, 1988; Porter, 1986; Schmalensee, 1972), while other studies report only one or two estimates (Doron, 1979; Schneider et al., 1981; Simonich, 1991). In meta-analysis, several different procedures have been used to deal with the independence problem, including selection of a single best estimate, random selection, and calculation of a mean value for each study (Lipsey & Wilson, 2001). Further, in order to assess homogeneity across estimates, econometric applications of meta-analysis employ regression analysis. However, it is important to weight the observations to account for inherent heteroscedasticity and the precision of each elasticity (Hedges & Olkin, 1985; Saxonhouse, 1976). I report generalized least-squares regressions, using as weights the inverse standard errors of the elasticities.

Two previous meta-analyses have examined cigarette advertising elasticities. In the context of a broad summary of empirical results for cigarette demand functions, a meta-analysis by Andrews and Franke (1991) summarized 147 advertising elasticities from 24 econometric studies covering the U.S. (17 studies), United Kingdom, and West Germany. A second study by Gallet and List (2003) summarized 137 advertising elasticities from 22 studies covering the U.S. (15 studies), New Zealand, Spain, United Kingdom, and West Germany. On average, each analysis used about six elasticity observations per

sampled study, which violates the independence assumption. Both analyses used fixed-effects methods, and each dealt differently with the problems presented by homogeneity and heteroscedasticity. I comment on these procedures in Sections 3 and 4, and propose alternative procedures. The present study also expands the sample of studies considered in the analysis.

The procedures used in the present study are as follows: first, statistical independence is handled by selecting a single best estimate for a given study or, where appropriate, by calculating a weighted mean using inverse variance weights (Hedges & Olkin, 1985). Second, the homogeneity problem is addressed by using meta-regression analysis for separate U.S. and non-U.S samples. I report results for fixed-effects and mixed-effects regressions, reflecting the inherent uncertainty about the data-generating process. Third, heteroskedasticity is treated by using regression weights based on the inverse standard error of each elasticity. Fourth, reflecting the policy concerns, the focus in the present study is the variation over time in the significance and magnitude of the advertising elasticity. In particular, it may be that the advertising elasticity has decreased importantly as smoking prevalence declined and restrictions were imposed on smoking and advertising (Andrews & Franke, 1991). Hence, the study also applies meta-analysis to four regulatory events: (1) "health scares" during 1952-53; (2) 1964 Surgeon General's report; (3) anti-smoking ads under the Fairness Doctrine during 1967-1970; and (4) the 1971 ban of broadcast advertising. The two previous meta-analyses ignored regulatory events, and focused exclusively on advertising and price elasticities. Because the available estimates are smaller in number, weighted means are used in the analysis of regulations. As background, a review is presented of federal regulation of smoking, with emphasis on actions taken by the Federal Trade Commission (FTC). The FTC's regulatory involvement over the past fifty years is underappreciated, despite its past importance.

The remainder of the paper is organized as follows: Section 2 reviews the history of cigarette advertising regulation by the FTC and briefly summarizes trends in advertising and U.S. cigarette consumption for 1947-2002. The rise in price and non-price promotional expenditures is documented as well as the decline since 1973 of cigarette consumption per capita. Section 3 reviews meta-analysis procedures, including fixed- and random-effects models, and presents a preliminary analysis of weighted-mean estimates for the advertising elasticities obtained from 38 studies. I arrange the studies into three groups according to the median sample year, reflecting several regulatory regimes. Section 4 contains a meta-regression analysis of the advertising elasticity estimates. Fixed- and mixed-effects regressions are reported. Section 5 presents the meta-analysis of the effects of regulatory events. Section 6 contains the conclusions.

2. Background on Cigarette Advertising Regulation

Cigarette advertising has been controversial since the early 1950s, reflecting the health risks due to

smoking and the belief that advertising is a causal factor in smoking behaviors.[2] A bill to ban all interstate advertising of tobacco and alcohol products was introduced in 1954 by Rep. John Dingell, Sr. (D, MI). A bill requiring labeling of cigarette packages was first introduced in Congress in 1955, following new reports of health risks in 1952-54 by the American Cancer Society, British Medical Research Council, *British Medical Journal*, and *Reader's Digest* (1952, 1954). Following these early events, Federal regulation of cigarette advertising and marketing grew markedly over time, and thus might be reflected in advertising elasticities or regulatory impacts. As background to the meta-analysis, this section reviews federal regulation of cigarette advertising and labeling.

2.1 Federal Advertising and Labeling Regulation

Beginning in 1938, the Federal Trade Commission (FTC) used its broad regulatory authority under the Wheeler-Lea Act to issue "unfair and deceptive" advertising complaints against the six major cigarette companies and several minor firms. During the 1940s and early 1950s, these actions, known collectively as the "health claims cases," resulted in consent decrees and cease-and-desist orders against several major brands. However, each order or settlement affected only a single brand, and a firm could easily replace the old advertisement with a new one. In September 1954, as several major cases neared the final judgment phase, the FTC sent a letter to all companies proposing a seven-point list of advertising standards in light of "scientific developments with regard to the [health] effects of cigarette smoking." A year later, it issued its *Cigarette Advertising Guides* (16 *CFR* 15; *Trade Regulation Reports* 41,602), which forbade any reference to physical effects of smoking (e.g., reduced throat irritation) and representations that a brand of cigarette was low in nicotine or tars that "has not been established by a competent scientific proof." Thus, industry-wide regulation of cigarette advertising began in 1955 and the FTC's Annual Report (FTC, 1956) claimed this helped "eliminate much objectionable advertising."

Following several articles in *Reader's Digest* (1957a, 1957b) on the effectiveness of filters, advertising shifted to emphasis on tar and nicotine reduction during the 1957-59 "tar derby." The FTC initially tolerated these ads if based on test results from *Reader's Digest* or *Consumer Reports*. In 1958, the FTC hosted a two-day conference on tar and nicotine testing and, in 1960, it negotiated a trade practice agreement with the industry that "all representations of low or reduced tar or nicotine, whether by filtration

[2] This section is based on independent research by the author, including primary sources from the tobacco documents web sites; see, for example, http://legacy.library.ucsf.edu/index.html. Important secondary sources include Calfee (1985), Fritschler and Hoefler (1996), FTC (1981), Institute of Medicine (2001), Kluger (1996), and U.S. Surgeon General (1989).

or otherwise will be construed as health claims."[3] This action was blamed for halting a trend toward increased consumption of lower-tar cigarettes (Calfee, 1985; Neuberger, 1963, p. 97; *Reader's Digest*, 1961). The FTC vacated this agreement when in 1966 it informed the companies that it would no longer consider labels and advertising that contain "a factual statement of the tar and nicotine content" a violation of the *Advertising Guides* (FTC Document, 1966).

In March 1962, the British Royal College of Physicians reported that lung cancer was prevalent among smokers, which resulted in a decline in U.S. stock prices (Scherega & Calfee, 1996). Shortly thereafter a similar investigation was begun in the United States, and on January 11, 1964, the U.S. Surgeon General's Advisory Committee on Smoking and Health issued its famous report on *Smoking and Health* (U.S. Surgeon General, 1964), which concluded that cigarettes were a health hazard of sufficient magnitude to warrant remedial action. The report was in part a response to an FTC request for guidance on labeling and advertising of cigarettes. Along with four other federal agencies, an FTC observer was privy to the Committee's formal meetings and deliberations during 1962-63.[4] One week after the report's release, the FTC announced initiation of proceedings "for promulgation of trade regulation rules regarding unfair and deceptive acts or practices in the advertising and labeling of cigarettes" (notice, 29 *Fed Reg* 530, January 22, 1964; final rule, 29 *Fed Reg* 8325, July 2, 1964; vacated, 30 *Fed Reg* 9484, July 29, 1965).[5] The Proposed Rule required that all packages and advertisements disclose prominently the statement, "Caution: Cigarette smoking is dangerous to health [and] may cause death from cancer and other diseases." Failure to include the warning would be regarded as a violation of the FTC Act. The FTC also issued the first of several staff reports on cigarette advertising and marketing (FTC, 1964b).

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[3] The FTC's cover letter to the agreement stated that "non-compliance with this request by a current user of health claims will result in referral of the matter to other Bureaus of the Commission looking forward to mandatory procedures where indicated in the public interest" (FTC Document, 1960).

[4] At the time, the FTC was the only federal agency represented with control over the use and sale of tobacco products. The Food and Drug Administration (FDA) has jurisdiction over cigarettes as drugs in cases involving health claims for tobacco, additives, and devices. Under Dr. David Kessler, the FDA in 1996 unsuccessfully attempted to regulate cigarettes as addictive drugs and impose restrictions designed to reduce the use of tobacco products by children, including advertising bans (final rule, 61 *Fed Reg* 44395, August 28, 1996; vacated by *FDA v. Brown & Williamson Tobacco Corp., et al.*, 529 U.S. 120, March 21, 2000).

[5] The 1964 Proposed Rule characterized cigarette advertising as unfair and deceptive "in view of the evident attractiveness of cigarette smoking to children and teenagers, and the fact that it is habit-forming." The Rule defined unfair acts and practices as those that either (1) cause "substantial injury to consumers;" (2) are "immoral, unethical, oppressive, or unscrupulous;" or (3) otherwise "offend public policy." In 1980, the FTC revised its definition of unfairness to emphasize objective evidence of substantial net harm to consumers, and to limit somewhat the role of public policy as a primary basis for an action; see http://www.ftc.gov/bcp/policystmt/ad-unfair.htm. From 1980 to 1994, the FTC did not have the authority to issue rules governing commercial advertising on the basis of a determination that such advertising constitutes an unfair act or practice, but it could bring individual cases.

The industry challenged the Rule on grounds that the FTC lacked the statutory authority to issue industry-wide trade rules, absent congressional guidance (Fritschler & Hoefler, 1996, p. 77; FTC, 1964a). The major companies also responded by establishing an industry *Cigarette Advertising Code*, which prohibited advertising aimed at minors, health-related claims, and celebrity endorsements. The FTC's actions lead to several congressional bills and hearings that culminated in the *Federal Cigarette Labeling and Advertising Act of 1965* (P.L. 89-92, effective January 1, 1966). The Labeling Act required each cigarette package to contain the statement, "Caution: Cigarette Smoking May Be Hazardous to Your Health." According to the Act's declaration of policy, the warning was required so that "the public may be adequately informed" about the health hazards of smoking. The Act also required the FTC to report annually to Congress concerning (a) the effectiveness of cigarette labels, (b) current methods of cigarette advertising and promotion, and (c) such recommendations for legislation as it may deem appropriate. A four-year moratorium was placed on FTC rulemaking with regard to cigarette advertising, and the Act also preempted state and local regulation of cigarette package warnings.[6]

In June of 1967, the FTC commenced its annual reporting to Congress on advertising and regulation of cigarettes. It recommended that health warning be extended to advertising and strengthened to conform to its original proposal, and it called for research on less-hazardous cigarettes (FTC Report, 1967). These recommendations were repeated in 1968 and 1969, and a recommendation was added that advertising on television and radio should be banned. Three other important regulatory actions took place during 1967-1969. First, the FTC established a laboratory to conduct standardized testing of tar and nicotine content for each brand. In November 1967, the FTC commenced public reporting of tar and nicotine levels by brand, together with reports of overall trends in smoking behaviors (e.g., sales of filtered cigarettes). Second, in June 1967, the Federal Communication Commission (FCC) ruled that the "fairness doctrine" was applicable to cigarette advertising, which lead to numerous free anti-smoking commercials by the American Cancer Society and other groups during July 1967 to December 1970. Third, in 1969, the FCC issued a notice of proposed rulemaking to ban broadcast advertising of cigarettes (34 *Fed Reg* 1959, February 11, 1969). The proposal was endorsed by the National Association of Broadcasters and enactment was anticipated by industry observers (Drew, 1969; Lazarus, 1969).

As the end of the four-year moratorium approached, the FTC issued a notice of proposed rulemaking (34 *Fed Reg* 7917, May 20, 1969) to require more forceful statements on packages and extend the warnings to all advertising as a modification of its 1964 Rule in the "absence of contrary congressional

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[6] Although Congress had asserted authority over the package labels, it had not, according to the FTC, rejected the basis for the Trade Regulation Rule, meaning that "any cigarette advertising which contains any representation, express or implied, that tends to undermine the warning placed on the package would be unfair and deceptive, and could be ordered to be stopped" (30 *Fed Reg* 9485). According to annual fiscal year reports issued by the FTC, cigarette advertising was and remained under "continuous monitoring" (FTC, 1965, 1967).

direction." However, Congress again asserted its authority over the FTC and FCC by enacting the *Public Health Smoking Act of 1969* (P.L. 91-222, effective November 1, 1970), which banned broadcast advertising after January 1, 1971 and modified the package label to read, "Warning: The Surgeon General Has Determined that Cigarette Smoking is Dangerous to Your Health." In 1970, the FTC negotiated voluntary agreements with the major companies to (a) disclose tar and nicotine levels in cigarette advertising using the FTC's test results; and (b) include health warning in advertising through displays of cigarette packs. Hence, by 1972, the FTC believed that it had achieved the recommendations contained in its initial reports to Congress (FTC Report, 1972, p. 1).

During the early 1970s, the FTC concentrated on enforcement of its advertising regulations. It issued consent orders for false and deceptive advertising in order to force companies to include health warnings "clearly and conspicuously in all cigarette advertising." It required 260 newspapers and 40 magazines to submit information on cigarette advertisements, and established a task force with the Department of Health, Education and Welfare to determine if newspaper ads were deceptive. In 1976, the FTC announced that it was again investigating "whether there may be deception and unfairness in the advertising and promotion of cigarettes" (FTC Report, 1976). It subpoenaed documents from cigarette manufacturers, advertising agencies, and other organizations, including copy tests, consumer surveys, and marketing plans. Five years later, the FTC submitted to Congress the results of this investigation in its *Staff Report on the Cigarette Investigation* (FTC, 1981). The report proposed a system of stronger rotating warnings and covered issues that had emerged regarding low-tar "light" cigarettes, including compensatory behaviors by smokers and the adequacy of the FTC's Test Method.[7] In 1984, President Reagan signed the *Comprehensive Smoking Education Act* (P.L. 98-474, effective October 12, 1985), which required four rotating health warnings for packages and advertising.

More recently, during the "Barclay filter" controversy of 1981-83, the FTC was immersed in issues associated with the accuracy of its Test Method (48 *Fed Reg* 15953, April 13, 1983). Eventually, several major changes in the method were proposed (U.S. National Cancer Institute, 1996), but these changes have yet to materialize.[8] In April 1985, the Coalition on Smoking or Health (CSORH) petitioned the FTC to ban an advertisement by R.J. Reynolds, entitled "Of Cigarettes and Science." Eventually,

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[7] "Compensation" refers to changes in smoking behaviors associated with filtered and low-nicotine "light" cigarettes, whereby smokers self-regulate their nicotine intake by smoking more, inhaling deeper, etc. This practice was noticed or predicted following the introduction of filtered cigarettes; see FTC (1958, 1964a), Neuberger (1963), U.S. Public Health Service (1966), and U.S. Surgeon General (1964).

[8] In 1967, the cigarette companies issued a public statement that was critical of the FTC's proposed test method, noting that it "will be misleading and deceptive to the public [because] . . . not all smokers smoke the same way . . . yet the FTC plans to report as though they do" (Tobacco Institute, 1967). Despite more than 30 years of testing experience and defense of its methods, the FTC in 2000 finally conceded that "it's impossible to tell from the ratings the amount of tar and nicotine a smoker will get from any cigarette" (FTC, 2000).

Reynolds signed a consent order prohibiting the advertisement (111 *FTC* 584, March 24, 1989). Federal bans on smoking on airplane flights and interstate buses took effect in 1988 and 1990. In December 1991, the CSORH filed a petition requesting an FTC investigation of Reynolds' "Joe Camel" advertising campaign, alleging that the ads unfairly and deceptively targeted children and youth. In 1994, the FTC Commission voted 3-2 against issuing a complaint. At the request of several members of Congress, the case was reopened in 1997 and a complaint was issued against Reynolds, seeking to bar the use of Joe Camel as a violation of the FTC Act (Calfee, 2000; Cohen, 2000). Because the 1998 Master Settlement Agreement between the state attorneys general and the major companies banned the use of cartoon characters, the FTC dropped the Camel complaint in early 1999. The MSA also banned most outdoor and transit advertising, brand-name sponsorship of events, free samples, and sale of apparel and merchandise with brand-name logos.

In summary, the FTC has engaged in continuous surveillance of advertising and marketing practices for cigarettes. Directly or indirectly, the FTC either initiated or influenced many regulatory developments in the cigarette industry. These industry-wide efforts began in 1955 and have continued to the present day. As a result, the advertising of cigarettes in the U.S. is more restricted than other lawful consumer products. Some regulations are primarily informational in nature (e.g., warning labels), but others affect advertising directly, such as the 1971 broadcast ban. As an independent regulatory agency, the FTC has used its legal powers in several ways, including cease and desist orders, direct court actions, consent decrees, and trade regulation rules. It also used informal means to obtain compliance with the FTC Act, such as advertising guides, trade practice conferences and rules, stipulations and voluntary agreements, corrective advertising, advisory opinions, special report orders, surveillance, consumer education, and policy advocacy. During a fifty-year period, the FTC regulated the overall direction of cigarette marketing, including advertising and product development. Through its testing program, it influenced the types of cigarettes produced and consumed (FTC Report, 1968, p. 18). The FTC also engaged in continuous monitoring of advertising practices (FTC, 1965, p. xx; FTC, 1967, p. 3); published in-depth reports on these practices (FTC, 1964b, 1977, 1979, 1981); held hearings on cigarette testing, advertising, and labeling (FTC, 1958, 1964a, 1966, 1969); and issued consumer advisories (FTC, 2000).

However, it remains to be shown that these actions had an important or noticeable effect on cigarette consumption or industry advertising expenditures. In light of FTC and Congressional regulation, has the cigarette advertising elasticity declined importantly over time? Is there empirical evidence that federal regulation has materially affected aggregate cigarette consumption? If the answers are affirmative, the FTC's persistent use of its multiple powers has been rewarded. However, if the answers are negative or the effects are limited in magnitude or time duration, it suggests that regulatory actions after 1964 did not add materially to new information in the marketplace or were otherwise misguided. The application of

meta-analysis in this paper seeks to provide insight into these questions.

2.2 Advertising and Cigarette Consumption Trends, 1947-2002

In its reports to Congress, the FTC presents data on annual expenditures on media advertising and promotion of cigarettes (FTC Report, 2004). These data are obtained from the tobacco companies and date back to 1963. In particular, the FTC collects data on (a) *media expenditures* (TV, radio, newspapers, magazines, outdoor and transit); (b) *non-price promotions* (point-of-sale, direct mail, specialty items, sample distribution, event sponsorship, product placements); and (c) *price promotions* (retail and wholesale allowances, price discounts, redemption coupons). The latter category has expanded significantly over time, but does not generally represent the type of promotion regulated by the FTC, except possibly under the Robinson-Patman Act. Advertising expenditure data for the years 1947-1962 were obtained from Schmalensee (1972). Cigarette shipments are reported by the FTC, but these data fail to account for changes in inventory holdings by wholesalers and retailers (FTC Report, 1998). The cigarette consumption series reported by the U.S. Department of Agriculture (USDA, 1996) provides estimates of the number of cigarettes sold to consumers after adjusting for inventory changes.

Table 1 shows selected annual data for 1947-2002 for seven series: (1) USDA total sales; (2) USDA per capita sales for ages 16 and over; (3) nominal advertising expenditures for five major media; (4) nominal expenditures on non-price promotions; (5) real expenditures on advertising and non-price promotions; (6) nominal expenditures on price promotions; and (7) real expenditures on price promotions. Figure 1 shows USDA per capita cigarette sales and real expenditures on media and non-price promotions. For purposes of Figure 1, I assumed that promotional expenditures were negligible prior to 1970 (see Table 1). Promotional expenditures for the years 1971-1974 have been interpolated.

The time span depicted in Figure 1 can be divided into four periods: (1) *pre-1964*, during which there were few restraints on marketing and advertising, but which includes the FTC's *Advertising Guides* and the shift toward filtered cigarettes following the 1952-53 "health scare"; (2) *1964-1970*, which covers the Surgeon General's 1964 report, 1965 warning labels, and the Fairness Doctrine's anti-smoking ads; (3) *1971-1997*, which includes the ban of broadcast advertising, package labels added in 1971 and 1985, warning messages in print advertising, FTC's tar and nicotine ratings in advertisements, bans on smoking on airplanes, and the shift toward non-price promotions; and (4) *1998-present*, which includes the MSA advertising bans, increased litigation and settlement costs, state and local clear air laws, competition from generic and deep-discount brands, and increased emphasis on price promotions. Table 1 and Figure 1 show that per capita consumption peaked in 1963 during the first time period, slowed for about a decade, and then declined continually after 1973. Between 1982 and 2002, cigarette consumption declined annually at a rate of -3.24% due in part to the sharp increase in real cigarette prices, which rose by 88%

between 1980 and 1992 (Grossman, 2004). Nominal media advertising declined during 1971-1973, rose by 12.7% per annum between 1973 and 1985, and then declined sharply after 1989. Real media and non-price promotions rose by 7.0% per annum between 1985 and 1994, and declined after 1994 as price promotions increased rapidly. Overall, cigarette consumption has declined importantly and smoking prevalence fell from about 53% of the male population in 1964 to 43% in 1974 and 27% in 1995 (Forey et al., 2002). Hence, despite rising real expenditures on promotions, the picture is one of a steadily declining market. It is unclear if advertising has had any effect on the overall size of the market. Lastly, the data in Table 1 demonstrate the importance of price promotions after 1994 as producers attempted to offset the effects of tax hikes on cigarette prices. This marketing trend has not been analyzed importantly in recent econometric studies of cigarette demand.

3. Meta-Analysis: Preliminary Results

Meta-analysis was developed to address the problem of research synthesis. A meta-analysis combines the empirical findings of several studies to assess the magnitude and significance of a quantitative effect or outcome.[9] Among the hallmarks of high quality meta-analyses are completeness, transparency, and comparability. A thorough literature search is conducted, and methods and results are reported in a manner that facilitates replication. A meta-analysis compares studies to identify differences in research design or "treatment" that moderate effect sizes, such as the sample time period, data interval, model specification, and econometric method. Meta-analysis also is used to assess the consistency of research findings by determining the extent to which variation in the findings is systematic or due to inherently random factors. A key point in the present analysis is the possible "drift" of the advertising elasticity over time as might reflect increased regulatory efforts and the decline in smoking prevalence. Given the available sample of studies, three time periods are identified for the meta-analysis that represent distinct regulatory regimes: an early period with few restraints (*pre-1964*); a period of heightened regulation and surveillance (*1964-1970*); and the post-broadcast ban period (*post-1970*). Using the median sample year, each elasticity estimate is categorized according to these time periods. There are insufficient studies to cover the events after 1997.

[9] Standard references for technical aspects of meta-analysis are Cooper and Hedges (1994), Hedges (1992, 1994), Hedges and Olkin (1985), and Lipsey and Wilson (2001). A common criticism of meta-analysis is the inclusion of studies that are weak methodologically, which is one reason for conducting a meta-regression analysis. A second problem is that a literature review might tend to uncover only those studies reporting significant results, which is called the "file drawer problem." This problem is unlikely in the present study due to the large number of studies reporting insignificant results; see also Andrews and Franke (1991, p. 90).

3.1 Weighted Combinations of Estimates

Suppose there are N independent studies, each yielding an observation T_i for the advertising elasticity of demand, i = 1, 2, . . . , N. For simplicity, assume that each study yields a single observation. In meta-analysis, T_i is labeled the "effect size" estimate and the corresponding population parameters are denoted by θ_i , i = 1, . . . , N. The "fixed-effects" model assumes that $\theta_1 = \theta_2 = \ldots = \theta_N = \theta$, implying that each study in the meta-analysis is measuring the same underlying effect. That is, each study is estimating an identical, but unknown, true population parameter θ. Assume also that the study observations are normally distributed such that $T_i \sim N(\theta, s_i^2)$, where s_i is the standard error of the effect size. Following Hedges and Olkin (1985, p. 111), an asymptotically-efficient estimator of θ is a weighted mean. The optimal weight is the inverse variance of each observation given by $w_i = (1/v_i)$, where $v_i = s_i^2$ is the conditional variance. The fixed-effects weighted-mean and variance are given by

$$\bar{T} = \sum_{i=1}^{N} w_i T_i \Big/ \sum_{i=1}^{N} w_i \ , \qquad \text{var}(\bar{T}) = 1 \Big/ \sum_{i=1}^{N} w_i \tag{1}$$

where w_i are the weights, $\bar{T}$ is the cumulative weighted-mean, and var($\bar{T}$) is its variance. Fixed-effects estimates assume that variation among the observations is due to sampling error only. The research objective is to estimate the weighted-mean and test the null hypothesis that $\theta = 0$.

Do the N studies share a common population effect size? As a test of equivalence among the observations, Hedges and Olkin (1985, p. 123) suggest the following homogeneity test statistic

$$Q = \sum_{i=1}^{N} w_i \left(T_i - \bar{T}\right)^2 \tag{2}$$

which has a chi-square distribution with N –1 degrees of freedom. If Q exceeds the critical value, the null hypothesis is rejected and the basic fixed-effects model is inappropriate, i.e., each study may not be estimating the same population mean. A random-effects model relaxes the assumption of a common population parameter. Alternatively, a significant Q could reflect objective or measurable between-study differences in treatment such as data interval and estimation method. This source of heterogeneity can be addressed using a weighted-regression model with various study-level descriptor variables.

3.2 Random-Effects and Mixed-Effects Models

If homogeneity is rejected, several alternative models are available. A random-effects analysis incorporates the sampling variation due to an underlying population of effect sizes – the between-study variability – as well as the study-level sampling error. The between-study variability may be due to unobservable random differences among studies – such as investigator procedures – or it may simply

reflect the lack of a common population parameter. In these models, the random component of the effect-size variation is calculated and incorporated in the weights in (1) or used in mixed-effects regressions. Given heterogeneity, three extensions of the fixed-effects model are outlined.

First, assume that the population parameters are not identical, but rather are drawn from a hyper-population of true effects. The distribution of observations is given by $T_i \sim N(\theta_i, s_i^2)$ and the distribution of true effects is described by $\theta_i \sim N(\theta^*, \sigma_\theta^2)$, where θ^* is the mean of the hyper-population and σ_θ^2 is the between-study variance. The observed variability of effect sizes is partly due to variation in the underlying population parameters and partly due to the sampling error of a given estimate about its population value. For example, it might be that the outcomes of advertising processes are inherently random due to idiosyncratic features of the campaigns or because the sources of influence on cigarette consumption are numerous. For the i-th estimate, the unconditional variance is given by $v_i^+ = (v_i + \sigma_\theta^2)$, and calculations in (1) are based on inverse variance weights given by $w_i^+ = (1/v_i^+)$. The fixed-effects model emerges as a special case in which $\sigma_\theta^2 = 0$. Hedges (1992, p. 290) suggests the following method-of-moments estimator for the between-studies variance component

$$\hat{\sigma}_\theta^2 = \frac{Q - (N - 1)}{\sum w_i - (\sum w_i^2 / \sum w_i)} \qquad (3)$$

where Q is the value of the homogeneity test statistic from equation (2); N is the number of observations; and w_i is the study-level inverse variance-weight defined above. In the fixed-effects model, a few observations with small variances can dominate the estimates because the resulting weights are large. The random-effects model treats outliers by incorporating the between-study error, which reduces the weight and "shrinks" the estimate toward the mean. The research objective is to model the within-study sampling error and the random error, and test the null hypothesis that $\theta^* = 0$.

As a second extension, the observations can be grouped together according to one or more study-level characteristics or descriptors (e.g., time period, data interval, model specification, econometric method). The fixed-effects meta-regression model assumes that heterogeneity arises due to measurable differences in "treatment" procedures and sampling error. The true effect size is assumed to a linear function of the descriptors, i.e., each estimate T_i is an unbiased estimate of θ. The generalized least-squares meta-regression model is given by

$$T_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_p X_{ip} + e_i, \quad e_i \sim N(0, v_i), \quad i = 1, \ldots, N \qquad (4)$$

where $\mathbf{X} = (X_{i1}, X_{i2}, \ldots, X_{ip})$ is a vector of categorical dummy variables that capture the procedural differences across studies; $\boldsymbol{\beta} = (\beta_0, \beta_1, \ldots, \beta_p)$ are the unknown parameters; and e_i is the error term. In this form, the regression model is equivalent to an analysis-of-variance or ANOVA model (Kennedy, 2003). The research objective is to determine the significant differences among treatments, estimate the

expected effect size for each category, and obtain diagnostics for the regression. Hypothesis tests using (4) focus on the size and significance of the coefficients. The parameter estimates are obtained by weighted least-squares, using inverse standard errors as the programmatic weights (Lipsey & Wilson, 2001; Saxonhouse, 1976). If the effect sizes are homogeneous conditional on the descriptors, the regression coefficients provide estimates of the true effect sizes for the categories in question.

As a third extension, suppose that homogeneity is rejected even after modeling the objective between-study differences. A mixed-effects model includes the between-study variance *after* removing the systematic portion of the total variance. Let SSE represent the OLS residual sum-of-squares from (4), which has a chi-square distribution with (N - P - 1) degrees of freedom (Hedges & Olkin, 1985, p. 172). In the mixed-effects model, a three-step estimation procedure is employed (Raudenbush 1994, p. 310). First, estimate (4) by OLS and obtain the SSE. Second, calculate the following method-of-moments estimator of the random error component[10]

$$\tilde{\sigma}_{\theta}^{2} = \left[\mathrm{SSE}/(\mathrm{N} - \mathrm{P} - 1)\right] - \left(\sum \mathrm{v}_{\mathrm{i}}/\mathrm{N}\right) \qquad (5)$$

which is the mean square residual from (4) minus the mean estimation variance. Third, each effect size observation is assumed to be related to its population value according to $T_i = \theta_i + u_i$, where $u_i \sim N(0, \sigma_\theta^2)$. Substitution in (4) yields a mixed-effects regression model

$$T_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_P X_{ip} + e_i + u_i, \quad i = 1,\ldots,N \qquad (6)$$

where $(e_i + u_i) \sim N(0, v_i + \sigma_\theta^2)$. The fixed-effects are given by the coefficient vector $\boldsymbol{\beta}$ and the random effects are given by u_i, and the errors e_i and u_i are assumed to be independent. The weights in the generalized regression model are given by $w_i^{+} = [1/(s_i + \tilde{\sigma}_\theta)]$.

In summary, this paper considers four levels of meta-analysis as applied to economic data on advertising elasticities of demand for cigarettes: (1) fixed effects weighted-means using the inverse-variance weights; (2) random effects weighted-means, which incorporate the between-study variance; (3) fixed-effects meta-regressions using weights given by the inverse standard error of each observation; and (4) mixed-effects meta-regressions using weights adjusted for the between-study variance. In the analysis of regulatory events, the samples of observations are small. Hence, the regulatory analysis only uses

[10] Equation (5) is an approximation based on identical sampling variances among the observations. Raudenbush (1994) shows that the approximation can be quite accurate in practice. In order to eliminate the influence of a few large variances, the mixed-effects estimates make use of the median variance in (5).

weighted means. Overall, this is a higher level of complexity than considered in previous meta-analysis of cigarette demand (Andrews & Franke, 1991; Gallet & List, 2003) or meta-econometrics generally (Farley & Lehmann, 1986; Stanley, 2001; Stanley & Jarrell, 1989). Estimation of several models tests the robustness of meta-analysis results for different data-generating processes. Previous studies have not used independent samples and ignored the necessity to weight the observations. They also ignored random- and mixed-effects models, outlier observations, and regulatory effects.

3.3 Data Collection

The validity of a meta-analysis depends in part on the thoroughness and completeness of the literature retrieval process. Data collection in the present paper included searches of existing literature reviews and articles; searches based on *EconLit*, *Dissertation Abstracts Online*, *Social Science Citation Index*, and other Web-databases; and searches using various tobacco documents web-sites, such as the Legacy Tobacco Documents Library (http://legacy.library.ucsf.edu/index.html).[11] As a result of these methods, 25 U.S. advertising studies are used in the analysis. Thirteen non-U.S. studies also were located using these same procedures, including New Zealand (2 studies), South Africa (1), Spain (1), United Kingdom (7), and West Germany (2). For the U.S., I examined more than 45 aggregate demand studies and located 25 studies that contained advertising elasticities, but which differed in study design or treatment (see Appendix A). I have deleted cigarette demand studies that did not include advertising and studies based on brand level advertising. I deleted duplicate studies and studies based on Internal Revenue Service data. I also deleted studies or estimates where the mean sample year was earlier than 1954 for the U.S. and earlier than 1964 for other countries. Finally, some studies are deleted due to unclear procedures and lack of standard errors or confidence levels.

Some of the studies could be split by time period, allowing a sample of 33 U.S. elasticity estimates. Independence was defined at the treatment level, so that a study that estimated the same model using different time periods (subsamples) provides independent elasticity estimates (Lipsey & Wilson, 2001, p. 112). In order to avoid overrepresentation of studies that engage in specification searches on the same data set, only one elasticity estimate per subperiod was obtained from each study.[12] Hence, the selection process reflects two basic considerations: first, a "best" estimate was chosen based on the study's

[11] There are several surveys of the cigarette demand literature, including Cameron (1998), Duffy (1996), Hagan (1993), Lancaster and Lancaster (2003), and Simonich (1991). These surveys were useful as a starting point for identifying potential studies for inclusion in the meta-analysis.

[12] A few studies did not report standard errors or t-statistics, but did report information about significance levels. In these cases, the significance level was used to impute a standard error; see Andrews and Franke (1991, p. 97) for a comparable procedure. Although the selection processes are incompletely described, previous meta-analyses have included all "usable" estimates in each study. For example, Andrews and Franke (1991, p. 85) included 8-16 estimates from each of four studies, accounting for a sizable portion of their sample.

conclusions or my judgements regarding those conclusions (see Appendices A and B); and, second, subsamples were chosen to capture the effects of different regulations. For studies that used log-log functional form, the elasticity estimates were obtained directly. If a U.S. study used a linear form, comparable data on advertising and consumption were used to estimate a mean elasticity and standard error. Non-U.S. studies using linear models were excluded due to absence of comparable data required for the elasticity calculation. Compared to previous meta-analyses, these selection procedures substantially reduced the total number of estimates, but reflect better the independent information contained in each study.

Appendix B summarizes the sample of 33 advertising elasticities for the United States, along with a few descriptors of each study. The range of U.S. values is from -0.209 in Gallet (1999) to 0.106 in Tremblay and Tremblay (1995). Some of the regression analysis treats Gallet's estimate as an outlier. In Appendix B, the unweighted mean elasticity and standard error are 0.025 (s.e. = .029). Only three of 33 observations are statistically significant at the 95% confidence level and eight estimates are negative. Appendix C summarizes the sample of 16 advertising elasticities for other countries. The range of values is from -0.050 in Sinnott et al. (1979) to 0.100 in Annett (1998). Eight of 16 elasticities are significant and three estimates are negative. For the non-U.S. estimates in Appendix C, the unweighted mean elasticity and standard error are 0.040 (.050).

3.4 Weighted-Mean Advertising Elasticities

Table 2 shows the weighted means, where the elasticities are grouped according to the median year of the sample period. For the U.S. sample, the Q statistics indicate the null hypothesis of homogeneity is rejected for 1964-1970. This result is due to the large positive estimate in Porter (1986). For the other two periods, the Q statistics indicate homogeneity. In the interest of completeness, random-effects means are computed for all time periods. The preliminary estimates suggest that the advertising elasticity was statistically significant before 1964 (prior to the Surgeon General's report), but insignificant after that date. Using the fixed-effects mean, the pre-1964 confidence interval at the 95% level is about $0.024 \pm 2.20 \times (0.009)$, or 0.004 to 0.044. However, only six of the 12 estimates are within this range, indicating the need for further analysis. Further, elasticities with magnitudes in the 0.02 to 0.04 range indicate that advertising has little, if any, impact on the overall size of the market. The elasticity for the pre-1964 period also might be affected by the novelty of television advertising, adoption of filter cigarettes, and the youth culture of the baby boom generation. As shown Appendix B, only one of twelve estimates in the pre-1964 period was statistically significant.

The weighted means for other countries are summarized for two time periods as there was only one estimate available for the pre-1964 period, which is omitted from the analysis. The fixed-effects

weighted means are statistically significant for the non-U.S. countries. However, both preliminary estimates fail the homogeneity test. For the non-U.S. samples, the random-effects analysis suggests an advertising elasticity of about 0.02 to 0.04, which is very small in magnitude.

The preliminary values in Tables 2 can be compared to results reported in the two previous meta-analyses. Andrews and Franke (1991, p. 90) examined 147 advertising elasticities, ranging from -0.155 to 0.685. For a sample of U.S. and non-U.S. elasticities, the unweighted mean was 0.07 and the fixed-effects weighted-mean was 0.060 (.034). In order to account for independence, they also calculated weighted-means by study (N = 23), which yielded a sample mean of 0.085 (.026). This is a larger value than the means in Table 2. However, some studies in their sample provided as many as 12-18 observations, which increases substantially the weight given to these studies and reduces the variance. Using ANOVA methods and a U.S. sample, the weighted means by time period followed a trend similar to that displayed in Table 2. Adjusting for study design, Andrews and Franke (1991, p. 93) reported a U.S. mean elasticity of 0.142 before 1970 and -0.007 after 1970. They concluded that the small positive impact of advertising on market demand declined over time as cigarettes moved through the product life cycle from novelty to maturity. Alternative explanations are that the effect of advertising was eroded over time by regulatory restrictions on cigarette marketing or that health information after 1964 rendered consumers less responsive to advertising. This issue is examined in Section 5 of this paper. The meta-analysis by Gallet and List (2003, p. 822) reported an unweighted mean of 0.100 (.130) and an unweighted median of 0.090 (range = -0.100 to 0.690). Their regression analysis for U.S. and non-U.S. studies (N = 22) focused on study design, and they did not report coefficients for different time periods or regulatory regimes. Their unweighted regressions controlled for researcher-specific effects and independence, but not for heteroscedasticity, random effects, or regulatory time periods.

4. Meta-Regression Analysis

This section presents a meta-regression analysis of the elasticity estimates contained in Appendices B and C. A general model is developed that encompasses the three regulatory time periods, conditional on other aspects of the study design and random effects. For simplicity, I ignore author characteristics and publication quality (outlet), and focus instead on measurable features of the study design. In addition to the median year of the study time period, the study-level descriptors include several features of the data and econometric specification.

4.1 Study Descriptor Variables

The objective in this section is to obtain estimates of the effects of time that adjust for other differences among studies. A typical or modal study in the sample can be described as follows: (1) 25-30

annual observations on per capita cigarette consumption; (2) advertising measured by real total expenditures; (3) three significant explanatory variables (e.g., lagged consumption, price, and a policy variable); (4) logarithmic specification, estimated by instrumental variables (IV) or two-stage least-squares (2SLS) to correct for possible endogeneity of prices; (5) uniformly high R^2 values reflecting the presence of a lagged dependent variable as a regressor; and (6) no other corrections for serial correlation or stationarity. Dummy variables are specified that reflect the rigor of treatment in the modal study, which is the null case. In order to facilitate interpretation of the time dummies, the constant term is omitted, so that each time coefficient is the advertising elasticity of the modal study for a given time period. The other study descriptors capture the effects of differences in study design.

Because the descriptor variables tend to be correlated and the sample sizes are small, results for only a portion of the possible descriptors are reported. For each study (or subsample), data were obtained on the following study descriptors, all of which are specified as binary dummies: (1) *Sample and data characteristics* – (a) three dummies for the median sample year (pre-1964, 1964-70, or post-1970); (b) measurement of advertising, total expenditure vs. stock (total = 0, stock = 1); and (c) expenditure measure of consumption (cigarette consumption = 0, expenditure = 1); and (2) *Econometric specification and methods* – (a) OLS vs. non-OLS method, e.g., IV, 2SLS (non-OLS = 0, simple OLS = 1); (b) functional form, logarithmic vs. linear model (log model = 0, linear = 1); and (c) lagged consumption term as an explanatory variable (yes = 0, no = 1).

4.2 Meta-Regression Results

Table 3 displays the fixed- and mixed-effects meta-regressions. Due to inherent heterogeneity, separate regression results are reported for U.S. and non-U.S. samples. The large negative estimate due to Gallet (1999) is included in only regression (1). Using generalized least squares, only one of the twelve U.S. coefficient estimates by time period is statistically significant at conventional confidence levels, suggesting that advertising has little effect on the market size. In regression (3), one feature of the econometric specification is statistically positive, which is the exclusion of a lagged dependent variable. The other three descriptors (OLS estimator, linear model, advertising stock) are not significant, but do contribute to the overall explanatory power. The diagnostics for regression (3) are satisfactory as indicated by tests for overall significance, normal residual errors, homoscedasticity, and absence of specification errors. Regression (4) shows the mixed-effects regression for the U.S. sample, but it fails to yield a significant elasticity for any of the time periods. At most, the analysis provides only weak support for a significant effect of advertising during the pre-1964 period.

Regressions (5)-(8) present the results for the other countries. Only two of eight coefficient estimates by time period are statistically significant. Both time period coefficients are significant in

regression (7) and one descriptor is significantly negative, but the small sample size may play a role in these results. The mixed-effects regression again fails to support the preliminary findings using weighted means. In general, the results in regressions (1) and (5) reveal the limitations of a meta-analysis based solely on weighted means. The results in regressions (4) and (8), which use mixed-effects specifications, indicate that the data-generating process may be more complex than considered in past studies.

Previous researchers have pointed out that meta-analyses tend to find small significant effects, even when most of the underlying observations are not significantly different from zero. This "problem" is inherent in meta-analysis, and reflects concerns associated with combining studies of varying quality (Lipsey & Wilson 2001, p. 9). The results in Table 3 indicate that any spillover effect of cigarette advertising on aggregate consumption was limited in duration and negligible in magnitude. The small size of the coefficients for the pre-1964 period reveals that the primary effect of advertising is on brand shares, and the ability of advertising to expand the overall market is very limited and probably non-existent. Of course, the measured effects might reflect other factors, such as new information regarding smoking hazards and changes in regulation after 1964. Hence, a further test in this paper is to use meta-analysis to examine the effects of various regulatory events on cigarette consumption. A cumulative finding that a *direct* restriction on advertising reduced consumption would lend support to a causal connection between advertising and smoking, despite the negative results in Table 3.

5. Meta-Analysis of Regulation

This section examines the cumulative effects of regulatory events. Most empirical studies approach this issue by including one or more binary (dummy) variables that capture regulation-induced shifts in the intercept term. For example, Hamilton (1972) included regulatory variables representing the first major health report on smoking in 1953 (dummy = 1 for 1953-1970); 1964 Surgeon General's report (dummy = 1 for 1964-1970); and antismoking messages under the Fairness Doctrine (dummy = 1 for 1968-1970). Several authors, including Hamilton, recognize that regulations may not affect smoking behaviors instantaneously or that interactions with advertising can occur. Some of the resulting models are unique and the results can only be summarized in a qualitative manner. For example, Ippolito et al. (1979) included intercept dummies for 1953 and 1964, and interacted the dummies with time counters with starting values in 1953 and 1964. The meta-analysis in this section is necessarily restricted to studies that use intercept dummies and logged dependent variables. Linear models are excluded. Further, results for all regulatory events are not available or are uniquely reported in only a few studies. I first summarize the evidence for warning labels on packages and print advertising. This is followed by a meta-analysis of four major regulatory events: (1) 1953 health scare; (2) 1964 Surgeon General's report; (3) 1967-70 Fairness Doctrine; and (4) 1971 broadcast ban. The results demonstrate that the effects of regulation on cigarette

consumption were greater for the earlier informational events and the effect of the 1971 broadcast ban was statistically insignificant.

5.1 Warning Labels

Two empirical studies analyze the effects of health warnings on cigarette consumption. Abernathy and Teel (1986) included dummy variables for the first and second cigarette pack warnings in 1965 and 1970, respectively, and the print advertising warnings that began in 1972. These variables were not significant at the 5% level or better. Using quarterly data, Simonich (1991) investigated the effects of the first two warning labels, the 1971 requirement to list tar and nicotine content of each brand, and the 1972 requirement to include warning messages in print ads. In his preferred specification, none of these variables were statistically significant, leading him to conclude that warning labels are not associated with decreased consumption (Simonich, 1991, p. 147). These results are consistent with Posner's (1979) view that the FTC and Congress did not act until *after* the health hazards of smoking were well known or a consensus had emerged. At most, the early warning labels were an incremental addition to health information and public awareness.

5.2 Meta-Analysis of Regulatory Events

Table 4 displays the results for meta-analysis of the four major regulatory events obtained from 19 econometric studies of cigarette demand. Due to the limited number of studies, two estimates of the regulatory impact were drawn from some studies. The samples range from nine observations for the 1971 broadcast ban to 22 observations for the 1964 Surgeon General's report. The bottom two rows of the table report untransformed fixed- and random-effects weighted-means. For policy purposes, it is useful to translate the weighted-means for each event to the percentage change in cigarette consumption, $\%\Delta C$. The variances are small enough to ignore; hence the transformation is given by $\%\Delta C = 100 \times [1 - \exp(D_i)]$, where D_i is the weighted-mean of the i-th regulatory event.[13]

Using the random-effects means, the log-dummy transformation yields the following cumulative estimates of regulatory effect sizes for cigarette consumption:

[13] A number of studies used dummy-interaction variables to model possible changes in the advertising slope coefficient due to regulatory events. Because each study is somewhat unique with respect to specification, a quantitative summary is not possible. Collinearity also is likely to be a problem in several of these models. Overall, the results for this group of studies suggest that the effectiveness of advertising was severely reduced by regulatory actions during the 1960s. For example, the interaction model in Doroodian and Seldon (1991, p. 363) indicates that advertising was an insignificant determinate of cigarette consumption after 1963.

Regulatory Event	% Change in Consumption
1953 Health Reports	- 4.8% per annum
1964 Surgeon General Report	- 6.4% per annum
1967-1970 Fairness Doctrine	- 3.9% per annum
1971 Broadcast Ban	- 1.6% per annum (not significant)

It is important to note that the 1953 and 1964 regulatory events had little, if any, direct impact on advertising, although indirect effects may have occurred. The 1953 health reports and 1964 Surgeon General's report are more appropriately classified as informational events, rather than advertising regulations. The effect of the Fairness Doctrine is statistically significant, but about one-half the size of the Surgeon General's report. The weighted-mean for the 1971 broadcast ban is not statistically different from zero. Hence, the regulation that directly affected commercial advertising had little or no impact on consumption, which is contrary to the view that advertising is an important determinate of cigarette consumption. For example, it would require more than a 200% increase in advertising to have the opposite effect of the 1964 Surgeon General Report. The regulation results, including that for the Fairness Doctrine, suggest that the information on the hazards of smoking eliminated or severely reduced any possible spillover effect of advertising on aggregate consumption. Thus, the results of the regulatory analysis are consistent with the meta-analysis results for advertising elasticities.

6. Conclusions

Most U.S. studies of cigarette demand report small and insignificant advertising elasticities, which refutes the view that advertising has an important spillover effects on aggregate demand and smoking behaviors. Given the fragile nature of many econometric estimates, a meta-analysis of these results is revealing of the underlying population value(s). Meta-analysis is a research synthesis method that combines quantitative results in a rigorous fashion and which avoids the arbitrary judgments associated with traditional literature reviews. The application of meta-analysis in this paper employed several techniques that were ignored by two previous analyses, including random-effects weighted means, weighted regressions, and mixed-effects weighted regressions. The results of the analysis indicate that cigarette advertising elasticities for the U.S. are extremely small and insignificantly different from zero. Prior to 1964, the preliminary results suggest that advertising had a small positive influence on cigarette consumption, but this result is not robust based on a general analysis that better accounts for the complexity of the data-generating process. Further, other explanations for small effects are possible, including the influence of demographics (baby boom generation), media effects (advent of TV advertising), and adoption of filtered cigarettes following the early health scares. While the sample is small, the meta-analysis results for the non-U.S. countries also yield small elasticities, which are not

significant using mixed-effects regressions.

Given the long history of regulation and advertising controls by the FTC and Congress, a meta-analysis of regulatory effects reveals the importance of changes in health information. An early "health scare" in 1953 had a negative effect on cigarette consumption, but the effect of the well-publicized 1964 Surgeon General's Report was much larger. Counter-advertising under the Fairness Doctrine during 1967-70 had a small negative effect on cigarette consumption. The measured effect of the 1971 ban of broadcast advertising is not statistically significant, which is consistent with the regression results as well as other evidence on cigarette advertising bans (Lewitt et al., 1981; Czart et al., 2001; Nelson 2003a, 2003b). Thus, the 1971 ban, which had a direct effect on advertising, appears to have had no impact on cigarette consumption. Given the changes in health information, the regulatory efforts of the FTC and Congress after 1964 were subject to the law of diminishing marginal returns.

Lastly, it is important to note both the strengths and weaknesses of meta-analysis as an analytical procedure. Meta-analysis provides a useful discipline on the process of summarizing a body of research finding that is often missing from narrative summaries, and greatly facilitates the handling of information from a large number of studies. A weakness is that the analysis may not be sufficiently sensitive to quality differences across studies and tends to produce small significant results regardless of the underlying sample of estimates. The several levels of analysis in the present study attempt to overcome this weakness.

Appendix A
Studies used in the meta-analysis

U.S. Studies:

Abernethy, A.M. & J.E. Teel (1986). Advertising regulation's effect upon the demand for cigarettes. *Journal of Advertising* 15, 51-55.

Baltagi, B.H. & D. Levin (1986). Estimating dynamic demand for cigarettes using panel data: The effects of bootlegging, taxation and advertising reconsidered. *Review of Economics and Statistics* 68, 148-55.

Baltagi, B.H. & D. Levin (1992). Cigarette taxation: Raising revenues and reducing consumption. *Structural Change and Economic Dynamics* 3, 321-35.

Bishop, J.A. & J.H. Yoo (1985). "Health scares," excise taxes and advertising ban in the cigarette demand and supply. *Southern Economic Journal* 52, 402-11.

Cameron, S. (1997). Dynamic models of smoking behavior: A re-assessment of the U.S. time series evidence. Unpub. working paper, University of Bradford, UK.

Doron, G. (1979). *The Smoking Paradox.* Cambridge, MA, Abt Books.

Doroodian, K. & B.J. Seldon (1991). Advertising and cigarette consumption. *Eastern Economic Journal* 17, 359-66.

Farr, S.J., C.H. Tremblay, & V.J. Tremblay et al. (2001). The welfare effect of advertising restrictions in the U.S. cigarette industry. *Review of Industrial Organization* 18, 147-60.

Franke, G.R. (1994). U.S. cigarette demand, 1961-1990: Econometric issues, evidence, and implications. *Journal of Business Research* 30, 33-41.

Fujii, E.T. (1980). The demand for cigarettes: Further empirical evidence and its implications for public policy. *Applied Economics* 12, 479-89.

Gallet, C.A. (1999). The effect of the 1971 advertising ban on behavior in the cigarette industry. *Managerial and Decision Economics* 20, 299-303.

Goel, R.K. & M.J. Morey (1995). The interdependence of cigarette and liquor demand. *Southern Economic Journal* 62, 451-59.

Hamilton, J.L. (1972). The demand for cigarettes: Advertising, the health scare, and the cigarette advertising ban. *Review of Economics and Statistics* 54, 401-11.

Ippolito, P.M. & R.A. Ippolito (1984). Measuring the value of life savings from consumer reactions to new information. *Journal of Public Economics* 25, 53-81.

Ippolito, R.A., R.D. Murphy, & D. Sant (1979). *Staff Report on Consumer Responses to Cigarette Health Information.* Washington, DC, FTC.

Kao, K. & V.J. Tremblay (1988). Cigarette "health scare," excise taxes, and advertising ban: Comment. *Southern Economic Journal* 54, 770-76.

McAuliffe, R. (1988). The FTC and the effectiveness of cigarette advertising regulations. *Journal of Public Policy & Marketing* 7, 49-64.

Peles, Y. (1971). Rates of amortization of advertising expenditures. *Journal of Political Economy* 79, 1032-58.

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Porter, R.H. (1972). The impact of government policy on the U.S. cigarette industry, in: Ippolito, P. & D. Scheffman (Eds.), *Empirical Approaches to Consumer Protection Economics.* Washington, DC, FTC, pp. 447-81.

Schmalensee, R. (1972). *The Economics of Advertising.* Amsterdam, North-Holland.

Schnabel, M. (1972). An oligopoly model of the cigarette industry. *Southern Economic Journal* 38, 325-35.

Schneider, L. (1980). *The Economic Effects of the Ban on Broadcast Cigarette Advertising*. Unpub. Ph.D. dissertation, University of California at Los Angeles.

Schneider, L., B. Klein, and K.M. Murphy (1981). Government regulation of cigarette health information. *Journal of Law and Economics* 24, 575-612.

Seldon, B.J. and R. Boyd (1991). The stability of cigarette demand. *Applied Economics* 23, 319-26.

Simonich, W.L. (1991). *Government Antismoking Policies*. New York, Peter Lang.

Tegene, A. (1991). Kalman filter and the demand for cigarettes. *Applied Economics* 23, 1175-82.

Tremblay, C.H. & V.J. Tremblay (1995). The impact of cigarette advertising on surplus, profit, and social welfare. *Contemporary Economic Policy* 13, 113-24.

Yucelt, U. & E. Kaynak (1984). A study of measuring influence of advertising and forecasting cigarette sales. *Managerial and Decision Economics* 5, 213-18.

Non-U.S. Studies:

Annett, N. (1988). The effects of advertising on consumption in South Africa, in: *The Economics of Tobacco Control in Southern Africa*. Cape Town, SA, University of Cape Town, pp. 73-77.

Chetwynd, J., P. Cope, R.J. Brodie & W. Wells (1988). Impact of cigarette advertising on aggregate demand for cigarettes in New Zealand. *British Journal of Addiction* 83, 409-14.

Duffy, M. (1995). Advertising in demand systems for alcoholic drinks and tobacco. *Journal of Policy Modeling* 17, 557-77.

Duffy, M. (2003). Advertising and food, drink and tobacco consumption in the U.K. *Agricultural Economics* 28, 51-70.

Harrison, R., J. Chetwynd, & R.J. Brodie (1989). The influence of advertising on tobacco consumption. *British Journal of Addiction* 84, 1241-46.

Hofmann, V.H.J. (1987). The effect of advertising on cigarette consumption in the Federal Republic of Germany. *Jahrbucher fur Nationalokonomie und Statistik* 203, 257-73.

McGuinness, T. & K. Cowling (1975). Advertising and the aggregate demand for cigarettes. *European Economic Review* 6, 311-28.

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Reuijl, J.C. (1982). *On the Determination of Advertising Effectiveness: An Empirical Study of the German Cigarette Market*. Boston, Kluwer.

Appendix A – continued

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Appendix B
Summary of U.S. cigarette advertising elasticity estimates

Study (pub. date, page no.)	Sample period	Ad elast. (s.e.)	Study comments & quote
Abernathy & Teel (1986, p. 54)	1949-70	0.018 (.016)	OLS semi-log; wt. ave of print & broadcast ads; "advertising had a relatively minimal influence" (p. 54).
Abernathy & Teel (1986, p. 54)	1949-81	-0.007 (.007)	OLS semi-log; wt. ave of print & broadcast ads; "cigarette advertising primarily affects the market share of brands" (p. 55).
Baltagi & Levin (1986, p. 151)	1963-80S	0.038 (.032)	OLS pooled state panel data; national ads stock; "advertising is insignificant" (p. 151).
Baltagi & Levin (1992, p. 331)	1963-88S	-0.029 (.027)	Wallis two-stage; wt. ave of 46 state estimates; national ads; "advertising ... has a negative significant sign [15 states]" (p. 330).
Bishop & Yoo (1985, p. 406)	1954-80	0.091 (.050)	2SLS; total cigarette sales; no lag of dep. var.; "advertising appears to increase demand, but only slightly" (p. 408).
Cameron (1997, p. 10)	1930-78	0.002 (.022)	OLS linear; stationarity tests; war years removed; "advertising does not ... have a significant positive effect" (p. 11).
Doron (1979, p. 66)	1954-75	0.041 (.023)	OLS linear; reports data, elasticity at means; "advertising serves ... to increase share of the existing market" (p. 79).
Doroodian & Seldon (1991, p. 362)	1952-63	0.060 (.026)*	NLLS; short-run elasticity; zero lags; "government policies ... effectively reduced the ... advertising elasticity to zero" (p. 363).
Doroodian &Seldon (1991, p. 362)	1964-70	0.023 (.026)	NLLS; no lags; "policies have eliminated the ... demand shifting potential of advertising" (p. 363).
Doroodian &Seldon (1991, p. 362)	1971-84	-0.035 (.036)	NLLS; wt. ave. for 1971-78 and 1979-84; zero lags; "at present advertising is simply redistributing market share" (p. 363).
Farr et al. (2001, p. 154)	1955-70	0.030 (.030)	2SLS linear; wt. ave. for 1955-67 and 1968-70; "none of the advertising coefficients are significant" (p. 154).
Farr et al. (2001, p. 154)	1971-94	0.036 (.053)	2SLS linear; "the results support the hypothesis that advertising enhances market power" (p. 154).
Franke (1994, p. 37)	1961-90Q	-0.011 (.035)	OLS; quarterly data; "no indication of Granger causality from advertising to consumption is found" (p. 37).
Gallet (1999; p. 301)	1958-71	-0.209 (.128)	2SLS; no lag; large negative elasticity; "advertising elasticity in the pre-ban period [is] insignificant" (p. 301).
Gallet (1999; p. 301)	1972-91	0.084 (.051)	2SLS; no lag; marginal effect of TV ban is positive; "we find that advertising has an insignificant effect on demand" (p. 302, n. 7).
Goel & Morey (1995, p. 455)	1959-82S	-0.025 (.030)	IV for price; state panel & national ads; current period est.; "advertising may just be ... inducing brand switching" (p. 455).
Hamilton (1972, p. 405)	1953-70	0.006 (.030)	OLS; aggregate stock ads; "short-run elasticities fell far short of statistical significance" (p. 405).
Kao & Tremblay (1988, p. 774)	1953-80	0.121 (.043)*	IV for price; reports numerous estimates; autocorrelation adjusted; "advertising ... [has] the correct sign and [is] significant" (p. 774).
McAuliffe (1988, p. 60)	1957-85	-0.028 (.026)	2SLS; log-difference model to eliminate trend effects; "advertising variables were not significant" (p. 61).
Peles (1971, p. 1056)	1954-66	0.073 (.056)	Koyck linear model; total sales; "lag effect of advertising ... is the outcome of serially correlated residuals" (p. 1052).

Appendix B – continued

Porter (1986, p. 467)	1947-82	0.094 (.020)*	2SLS; ads stock; no lag; numerous estimates; “estimated effect of advertising on demand, while small, is double [others]” (p. 455).
Schmalensee (1972, p. 188)	1956-67	0.078 (.066)	IV model; reports numerous estimates; net effect; “current advertising is not significant” (p. 187).
Schnable (1972, p. 332)	1948-63	0.100 (.052)	OLS linear; relative ads; “short-run advertising elasticity of demand was about 0.10" (p. 332).
Schneider (1980, p. 88)	1935-75	-0.084 (.047)	OLS-ARIMA process; study reports numerous estimates; “none of the measures of current advertising is significant” (p. 87).
Schneider et al. (1981, p. 593)	1930-78	0.046 (.066)	IV; no lag; ads stock; “advertising coefficients ... indicate very small, statistically insignificant consumption responses” (p. 594).
Seldon & Boyd (1991, p. 323)	1953-84	0.027 (.049)	Cooley-Prescott; without ban dummies; “advertising elasticity turns negative after 1971" (p. 323).
Simonich (1991, p. 147)	1959-83Q	0.014 (.047)	2SLS; quarterly data; ads stock; “increases in real advertising are not associated with increased demand” (p. 155).
Tegene (1991, p. 1180)	1953-67	0.019 (.042)	Kalman filter; ads stock; wt. ave. under structural change; “advertising elasticity ... [is] insignificant in most years” (p. 1181).
Tegene (1991, p. 1180)	1968-85	0.034 (.023)	Kalman filter; ads stock; wt. ave. under structural change; “advertising elasticity tended to increase over time” (p. 1181).
Tremblay & Tremblay (1995, p. 119)	1955-70	0.106 (.065)	2SLS linear model; no lag; “advertising expenditures have a positive influence” (p. 120).
Tremblay & Tremblay (1995, p. 119)	1971-90	0.057 (.054)	2SLS linear model; no lag; “advertising enhances market power in the cigarette industry” (p. 121).
Yuclet & Kaynak (1984, p. 216)	1955-79	0.021 (.033)	OLS log; total advertising; “effect of advertising on cigarette consumption ... [is] statistically insignificant” (p. 217).

Notes: See Appendix A for study references. Asterisk indicates significant estimate at the 95% level. For the sample period, Q indicates quarterly data and S indicates state data.

Appendix C
Summary of non-U.S. cigarette advertising elasticity estimates

Study (country, pub. date)	Sample period	Ad elast. (se)	Study comments & quote
Annett (SA, 1998, p. 73)	1970-94	0.100 (.102)	2SLS; log-difference model; cointegration; "advertising was not found to be statistically significant" (p. 73).
Chetwynd et al. (NZ, 1988, p. 412)	1973-85	-0.010 (.030)	OLS; no lag; print advertising only; ads stock; "coefficient for advertising was ... not significant" (p. 411).
Duffy (UK, 1995, p. 573)	1963-88Q	0.004 (.006)	Rotterdam system model; exp. data; "significant, positive advertising elasticities are never estimated" (p. 575).
Duffy (UK, 2003, p. 67)	1963-96Q	0.057 (.031)	AIDS system model; exp. data; "little evidence here to support the view that advertising is a potent force" (p. 69).
Harrison et al. (NZ, 1989, p. 1252)	1973-85Q	0.080 (.020)*	IV; short-run elasticity; print advertising only; "model and conclusions appear to be very robust" (p. 1254).
Hofmann (WG, 1987, p. 264)	1960-79Q	-0.037 (.051)	2SLS; Granger causality; "no significant influence of advertisement on overall cigarette consumption" (p. 270).
McGuinness & Cowling (UK, 1975, p. 325)	1957-62Q	0.013 (.005)*	OLS; ads stock; exp data; "advertising has had a statistically significant effect on the expansion of sales" (p. 327).
McGuinness & Cowling (UK, 1975, p. 325)	1962-68Q	0.009 (.004)*	OLS; ads stock; exp data; "effects of health publicity appear to have reduced the sales impact of advertising" (p. 327).
Radfar (UK, 1985, p. 227)	1965-71Q	0.094 (.031)*	OLS; ads stock; "advertising variable has a positive, small but significant effect on consumption" (p. 230).
Radfar (UK, 1985, p. 227)	1971-80Q	0.051 (.026)*	OLS; ads stock; weighted average; "advertising variable ... is partly offset by the anti-smoking publicity" (p. 230).
Reuijl (WG, 1982, p. 90)	1961-65Q	0.087 (.026)*	OLS, excludes price and income; "advertising was found to have a significant influence on sales" (p. 121).
Reuijl (WG, 1982, p. 90)	1971-75Q	0.040 (.038)	OLS, excludes price and income; "advertising elasticity did not even differ significantly from zero" (p. 122).
Sinnott et al. (UK, 1979, p. 48)	1962-70Q	0.022 (.022)	OLS; ads stock; "no significant advertising effect over the period 1962-70" (p. 50).
Sinnott et al. (UK, 1979, p. 48)	1971-78Q	-0.050 (.050)	OLS; ads stock; "effect of advertising on sales showed as statistically insignificant regardless of the time period" (p. 51).
Smee et al. (UK, 1992, p. 46)	1960-87	0.050 (.020)*	OLS log-difference model; unit root & cointegration tests; "advertising does have an effect on consumption" (p. 28).
Valdes (SP, 1993, p. 154)	1964-88	0.080 (.040)*	OLS; Hausman test; advertising levels estimated; "advertising elasticity of demand for cigarettes is very low" (p. 155).
Witt & Pass (UK, 1983, p. 29)	1955-75	0.068 (.025)*	OLS; no lag; "advertising has a small but significant effect on cigarette consumption" (p. 30).

Notes: See Appendix A for study references. Asterisk indicates significant estimate at the 95% level. For the sample period, Q indicates quarterly data and S indicates state data.

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Figure 1. Cigarette Consumption and Advertising, 1947-2002

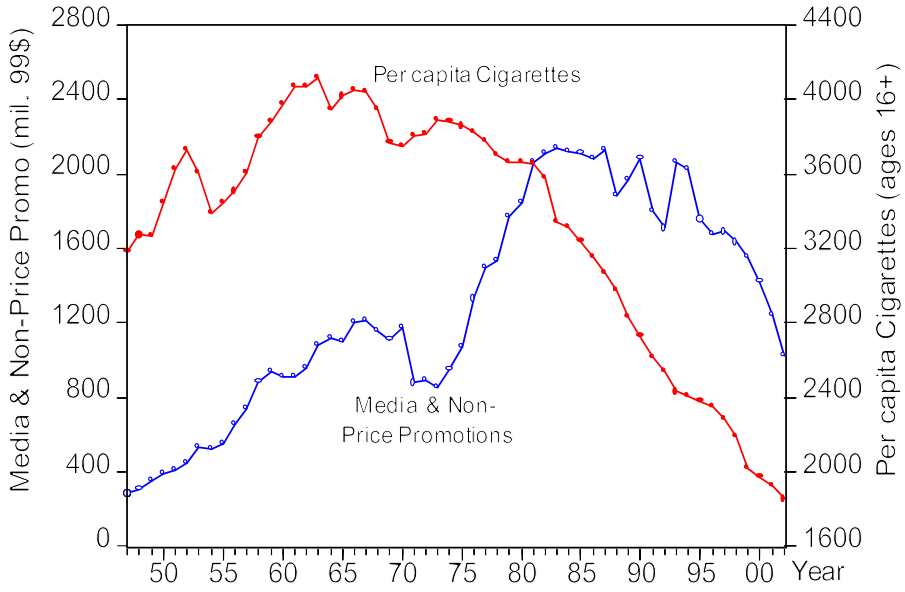

Table 1
Cigarette consumption, advertising, and promotion, 1947-2002

Year	USDA total sales (bil.)	USDA per capita sales (ages 16+)	Nominal ads, 5-media (mil $)	Nominal non-price promos (mil $)	Real ads & non-price promos (mil $)	Nominal price-promos (mil $)	Real price-promos (mil $)
1947	335.4	3,187	44.1	na	282.3	na	na
1950	375.8	3,443	65.5	na	392.8	na	na
1955	395.3	3,447	104.6	na	553.4	na	na
1960	484.4	3,976	193.1	na	910.7	na	na
1963	523.9	4,116	237.2	na	1,079.3	na	na
1964	511.2	3,950	249.1	na	1.116.9	na	na
1965	528.7	4,019	249.9	na	1.099.7	na	na
1970	536.4	3,749	296.6	29.6	1,174.7	34.8	125.3
1975	607.2	3,859	330.8	78.1	1,069.0	82.4	215.4
1980	631.5	3,662	790.1	216.4	1,846.6	235.8	432.6
1985	594.0	3,243	932.0	552.5	2,108.2	991.9	1,408.6
1986	583.8	3,151	796.3	703.4	2,084.0	882.7	1,226.6
1987	575.0	3,068	719.2	859.6	2,129.7	1,001.7	1,351.2
1988	562.5	2,973	824.5	618.2	1,882.3	1,832.2	2,390.5
1989	540.0	2.829	868.3	699.6	1,970.5	2,049.1	2,575.2
1990	525.0	2,725	835.2	888.8	2,085.5	2,268.0	2,743.6
1991	510.0	2,616	772.6	769.5	1,799.9	3,108.0	3,672.6
1992	500.0	2,535	621.5	879.4	1,710.2	3,731.0	4,251.4
1993	485.0	2,430	542.1	1,312.7	2,063.8	4,180.6	4,651.8
1994	486.0	2,406	545.1	1,312.9	2,025.2	2,975.5	3,243.3
1995	487.0	2,382	564.2	1,083.3	1,757.5	3,247.7	3,464.5
1996	487.0	2,352	578.2	1,023.2	1,675.9	3,506.3	3,669.3
1997	480.0	2,287	575.7	1,072.8	1,692.2	4,011.5	4,117.7
1998	465.0	2,187	645.6	967.4	1,635.7	5,120.2	5,192.1
1999	435.0	2,019	487.7	1,061.5	1,549.2	6,688.4	6,688.4
2000	430.0	1,971	355.8	1,100.7	1,425.4	8,136.1	7,962.6
2001	425.0	1,923	212.8	1,082.0	1,237.8	9,921.4	9,484.5
2002	415.0	1,854	156.6	933.6	1,026.4	11,376.2	10,710.7

Notes: *Media ads* includes newspapers, magazines, outdoor, transit (prior to 2000), and radio and TV (prior to 1971). *Non-price promotions* include point-of-sale, direct mail, internet, specialty items, endorsements & testimonials, public entertainment, and sampling distribution. *Price promotions* include retailer & wholesaler promotional allowances, retail value added & discount coupons (after 1987), and all other. Real expenditures deflated by the implicit price deflator (IPD) for GDP. The IPD and population series (16 years and older) are from the *Economic Report of the President*. Total cigarette sales are from USDA (1996) and FTC Report (2004). Nominal advertising and promotion expenditures are from FTC Report (2004) and Schmalensee (1972).

Table 2
Weighted-mean advertising elasticities

Model – country	Ave. year 1954-63	Ave. year 1964-70	Ave. year > 1970
Fixed-effects mean – U.S.	0.024 (.009)*	0.011 (.006)	0.001 (.010)
Q statistic (χ^2 critical value)	14.0 (19.7)	38.0 (15.5)	11.3 (18.3)
Random-effects mean – U.S.	0.026 (.011)*	0.041 (.020)	0.002 (.011)
Model – other counties	---	Ave. Year 1964-70	Ave. Year > 1970
Fixed-effects mean – non-U.S.	---	0.013 (.004)*	0.018 (.005)*
Q statistic (χ^2 critical value)	---	21.9 (14.1)	26.2 (15.5)
Random-effects mean – non-U.S.	---	0.043 (.019)	0.037 (.013)*

Notes: Asterisk indicates significantly different from zero at the 95% confidence level, sample size adjusted. Random-effects variance weights for the U.S. are 0.00030, 0.00221, and 0.00015, respectively. Random-effects variance weights for the non-U.S. countries are 0.0014 and 0.0008, respectively.

Table 3
Meta-regression results (dependent variables are advertising elasticity estimates)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ave. sample yr <1964 (yes = 1)	0.024 (.014)	0.024 (.013)	0.033 (.015)*	0.029 (.016)	---	---	---	---
Ave. sample yr 1964-1970 (yes = 1)	0.011 (.009)	0.012 (.009)	0.022 (.015)	0.030 (.015)	0.013 (.007)	0.001 (.024)	0.068 (.033)*	0.058 (.035)
Ave. sample yr > 1970 (yes = 1)	0.003 (.015)	0.003 (.015)	-0.002 (.013)	-0.002 (.013)	0.018 (.010)	0.011 (.010)	0.050 (.017)*	0.047 (.024)
OLS estimator used (yes = 1)	---	---	-0.025 (.017)	-0.028 (.017)	---	0.054 (.026)*	0.007 (.028)	0.014 (.034)
Linear model estimated (yes = 1)	---	---	-0.004 (.018)	0.014 (.018)	---	---	---	---
Lag dep. variable incl. (no = 1)	---	---	0.048 (.024)*	0.046 (.023)*	---	0.014 (.052)	-0.007 (.043)	-0.004 (.029)
Stock measure of advertising (yes = 1)	---	---	0.032 (.020)	0.032 (.020)	---	-0.043 (.029)	-0.024 (.025)	-0.037 (.029)
Expenditure dep. var. used (yes = 1)	---	---	---	---	---	---	-0.043 (.017)*	-0.027 (.026)
R-squared (wt.)	-0.094	-0.155	0.452	0.416	-0.530	0.001	0.397	0.269
F-stat (p value)	0.564	0.564	0.002	0.012	0.703	0.266	0.059	0.574
J-B stat (p value)	0.781	0.697	0.862	0.891	0.585	0.519	0.646	0.740
White stat (p value)	0.050	0.051	0.470	0.588	0.613	0.676	0.153	0.197
RESET stat (p value)	---	---	0.540	0.355	---	0.231	0.656	0.534
SEE (OLS)	0.1205	0.0603	0.0366	---	0.0323	0.0266	0.0261	---
Sample of countries	U.S.	U.S.	U.S.	U.S.	Other	Other	Other	Other
Mixed-effects model?	No	No	No	Yes	No	No	No	Yes

Notes: All estimates obtained by weighted least squares; asterisk indicates statistically significant at the 95% confidence level. Constant terms are omitted from all regressions reflecting the three time dummies. The R^2 values are descriptive and are not well-defined measures of the degree of fit. F-statistic tests the null hypothesis that the regression coefficients are jointly equal to zero. J-B statistic tests the null hypothesis that the residuals are normally distributed. White's statistic tests the null hypothesis of no heteroscedasticity. Ramsey's RESET statistic tests the null hypothesis that there are no specification errors (one fitted term). SEE is the OLS residual sum of squares. The random-effects standard error is 0.0176 in regression (4) and 0.0427 in regression (8). Regression (1) includes an outlier that is omitted in other regressions. No linear model estimates were obtained for the non-U.S. countries and no U.S. study used expenditures on cigarettes as the dependent variable. Only one estimate for the pre-1963 period was found for non-U.S. countries and this estimate is omitted from all results in the paper.

Table 4
U.S. cigarette regulation estimates and weighted means

Study (pub. date)	Sample period	1953 health reports	1964 Surgeon General's report	1967-70 Fairness Doctrine	1971 broadcast ban
Abernathy & Teel (1986)	1949-70	---	---	-0.068 (.026)*	---
Abernathy & Teel (1986)	1949-81	---	---	-0.064 (.025)*	0.011 (.011)
Baltagi & Levin (1986)	1963-80S	---	---	-0.005 (.050) ---	---
Baltagi & Levin (1992)	1963-88S	---	---	--- 0.002 (.019)	---
Bishop & Yoo (1985)	1954-80	---	-0.059 (.040) -0.064 (.040)	---	---
Franke (1994)	1961-90Q	---	-0.055 (.026)* -0.137 (.042)*	-0.025 (.020) -0.022 (.013)	-0.004 (.025) ---
Fujii (1980)	1929-73	0.072 (.036) 0.079 (.040)	-0.008 (.020) -0.003 (.030)	-0.042 (.028) -0.039 (.026)	---
Gallet (1999)	1958-71	---	-0.034 (.021)	---	---
Goel & Morey (1995)	1959-82S	---	---	---	-0.042 (.014)*
Hamilton (1972)	1926-70	-0.096 (.036)* -0.084 (.041)*	-0.076 (.033)* -0.073 (.035)*	-0.044 (.040) -0.047 (.042)	---
Hamilton (1972)	1953-70	---	-0.070 (.023)* -0.076 (.020)*	--- -0.070 (.031)*	---
Ippolito & Ippolito (1984)	1934-80	-0.171 (.023)*	---	---	---
Ippolito et al. (1979)	1926-75	-0.176 (.031)*	-0.034 (.035)	-0.011 (.039)	-0.006 (.065)
Kao & Tremblay (1988)	1953-80	---	-0.135 (.057)* -0.099 (.050)	-0.033 (.047) ---	0.165 (.922) ---
McAuliffe (1987)	1956-83	---	-0.012 (.030)	---	---
Porter (1986)	1947-82	-0.101 (.024)* -0.072 (.017)*	---	-0.061 (.016)* -0.043 (.014)*	---
Schmalensee (1972)	1956-67	---	-0.046 (.019)*	---	---
Schneider (1980)	1935-75	---	-0.048 (.035) -0.049 (.036)	---	---
Schneider et al. (1981)	1930-78	0.038 (.076) 0.165 (.071)*	-0.115 (.067) -0.074 (.070)	-0.114 (.062) -0.129 (.066)	---
Simonich (1991)	1959-83Q	---	-0.128 (.034)* -0.182 (.039)*	-0.014 (.031) -0.063 (.032)	-0.025 (.049) -0.028 (.047)
Yuclet & Kaynak (1984)	1955-79	---	---	---	-0.026 (.016) -0.023 (.018)
Weighted mean – fixed-effects		-0.081 (.009)*	-0.057 (.006)*	-0.039 (.006)*	-0.014 (.007)
Q statistics (χ^2 critical value)		74.4 (16.9)	37.1 (32.7)	17.7 (28.9)	10.3 (16.9)
Weighted mean – random-effects		-0.047 (.029)	-0.062 (.009)*	na (Q < N–1)	-0.016 (.008)

Notes: See Appendix A for study references. Asterisk indicates significant estimates at the 95% level.