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ABSTRACT

We assess substitutable and complementary relationships among eight national advertising media classes, as well as the magnitude of their own-price elasticities. We use a translog demand model, whose parameters we estimate by three-stage least squares, based on 1960-94 annual U.S. data.We find aggregate demand by national advertisers for each of the eight media is own-price inelastic, and that cross-price elasticities suggest slightly more substitute than complementary relationships, although both are rather weak. These patterns are consistent with long prevailing institutional arrangements and media selection practices.

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I. INTRODUCTION

The U.S. advertising market can be decomposed into two segments, based on the geographical scope of advertisers' operations. National advertisers consisting of firms that market their products and services on a national or broad regional basis constitute the largest segment, accounting for about 58% of total U.S. advertising expenditures in the 1990's.[1] National advertisers employ a variety of media, including direct mail, magazines, newspapers, outdoor, radio (network and spot), and television (network and spot). Local advertisers, accounting for the other 48% of total U.S. advertising outlays, are primarily retailers that serve geographically limited markets. Local advertisers also utilize many classes of media but certain media used by national advertisers, such as network radio and network television, are not suitable for local advertisers because the market areas the latter serve constitute only a fraction of the total nationwide audience reached by those mass media.

In this paper we examine national advertisers' aggregate demand for different types of media. We address two questions: (1) To what extent do the major categories of mass media substitute for or complement one another as modes of advertising communication; and (2) How price-sensitive is national advertisers' aggregate demand for each of the major categories of mass media? The two questions are, of course, related since we know from economic theory that for any input, the sum of its own-price elasticity plus all its cross-price elasticities with respect to other inputs is zero (cf., Henderson and Quandt 1980).

[1] On the distinction between national and local advertisers, see Owen and Wildman (1992, pp. 12-14)

A priori, it is unclear whether any particular pair of media employed by national advertisers are substitutes or complements. While substitutability is certainly plausible, complementary relations may be expected as well since advertisers often use more than one class of media in a given campaign. Indeed, integrated use of different media, in order to exploit interactions among them (Rossiter and Danaher 1998), is often considered as the hallmark of effective planning of marketing communications campaigns (Schultz, Tannenbaum, and Lauterborn 1993).

Intermedia substitutability is also an implicit consideration in the formulation of regulatory policies involving advertising. To prohibit tobacco and liquor advertising on radio and television, but not in print (cf., Duffy 1996), would appear, for example, to presume weak intermedia substitutability or complementarity. Restrictions on cross ownership of broadcasting and newspaper establishments in the same geographic market were historically rationalized on grounds of extensive intermedia substitutability (Picard 1989), although recently the Federal Communications Commission announced that a review of these policies would be undertaken (Dreazen 2001). Finally, the evolution of the World Wide Web as an advertising medium raises questions about its potential as a substitute or complement for existing media (Bank 1996; Silk, Klein, and Berndt 2001).

While measurement of the price elasticity of market demand for advertising in different media and intermedia substitutability/complementarity are clearly important, to date empirical both of these matters in general is relatively sparse. Moreover, as will be shown below, the handful of existing studies have produced some seemingly inconsistent conclusions. Upon closer scrutiny, it becomes apparent that a variety of approaches have been taken with respect to aggregating data across different types of advertisers (national vs. local) and various classes of media in different ways, thereby undermining the comparability of the results.

Here we build on this literature in several ways. First, we focus only on national advertisers, since there is evidence that local and national advertising markets exhibit quite different sensitivities to cyclical and secular forces (Blank 1962; Schmalensee 1972;

and Yang 1964).[2] Second, we disaggregate national advertisers' expenditures into eight distinct media categories, and then test whether the aggregation of these categories into fewer, more global, media classes is supported by our data. Third, instead of a log-log demand model used in some earlier studies that imposes constant cross-price elasticities (Eklund, Ford, and Jackson 1999, 2000), following Seldon and Jung (1993) we utilize an extension of the translog functional form that allows cross-price elasticities to vary along with prices and expenditure shares. Our formulation also includes a number of non-price factors that affect national advertisers' media shares. Finally, we employ annual data on national advertisers' expenditures for the period 1960 through 1994. Terminating the time series at the latter date avoids the potential confounding effect of any disequilibria associated with the introduction of the Internet as an advertising medium in the mid-1990's, as well as changes in the concentration of media suppliers following in the wake of the Telecommunications Act of 1996.

The paper is organized as follows. In Section II we advance two propositions bearing on the magnitudes of own-price and cross-price elasticities of market demands for media time and space by national advertisers. Section III presents our model specification and estimation methods. Section IV discusses the data employed and estimation results, while Section V reports our estimates of own and cross-price elasticities for eight media categories. In Section VI we relate our findings to industry media selection practices and institutional arrangements, discuss implications of market-level elasticity estimates for the demand elasticity faced by individual vehicles within a given media category, and then review factors that differentiate media substitutes and complements. Section VII summarizes our principal findings and conclusions.

[2] Several factors suggest differences between national and local advertisers with respect to price elasticity and intermedia substitutability of the market demands for media time and space. Whereas national advertisers generally undertake campaigns for brand-building purposes and assign media planning and buying to advertising agencies, local advertisers are more likely to focus on availability, price, and temporary promotions and often deal directly with media suppliers. Media offering flexible contractual terms, such as newspapers, represent a larger share of local than national advertising expenditures.

II. MARKET DEMAND BY NATIONAL ADVERTISERS FOR MEDIA SPACE AND TIME

We begin by considering theoretical arguments and empirical evidence that leads us to advance two propositions concerning the likely size of own and cross-price elasticities of national advertisers' demand for media space and time.

> P1. Intermedia price substitutability and complementarity among the major classes of media employed by national advertisers will tend to be relatively weak.
>
> P2. Market demand by national advertisers for the major classes of media will tend to be relatively price inelastic.

From the perspective of the economics of information, national advertisers' demand for media space and time is derived from consumers' demand for information about the goods and services sold by national advertisers (Ehrlich and Fisher 1982; Nelson 1974). In Section II.1 we examine what the theory of derived demand implies about the price elasticity of market demand for media advertising and the empirical evidence bearing on the factors influencing it, including intermedia substitutability (P1). Against this background, in Section II.2 we review the available empirical evidence relating to the price sensitivity of demand for advertising in various media (P2).

II.1 Derived Demand for Media Advertising

The theoretical framework we employ is a very simple but elegant one governing the derived demand for factors of production, originally enunciated by Marshall (1922) as four "laws" of demand.[3] Adapted to the present context, these laws imply that the derived demand by sellers of goods and services for advertising in a medium will be more price inelastic: (i) the weaker is the substitutability with other media; (ii) the more inelastic is consumer demand for information about products and services; (iii) the more inelastic is the supply of other advertising media; and (iv) the smaller is the share

[3] See Friedman (1976) and Stigler (1986) for further discussion of Marshall's laws of demand.

of total costs accounted for expenditures on the advertising medium. Below we review the available evidence bearing on these four factors.

II.1.A *Intermedia Substitutability and Complementarity*

There are relatively few empirical studies examining national advertisers' demand for media time and space and fewer still that have attempted estimate to own or cross-price elasticities. Most of the available evidence has been motivated by regulatory concerns. Although early analyses of intermedia competition has frequently depicted network and spot television as being fairly close substitutes, typically the underlying evidence was been drawn from examinations of bivariate price correlations rather than from multivariate econometric estimates of demand cross elasticities.[4] Among such bivariate studies are one by the U.S. Federal Communications Commission (1980) which compared transactions prices for network and spot television (adjusted for differences in audience size and composition) and another due to Peterman (1979) which showed that the costs of reaching equivalent audiences via network and spot television were roughly the same.

INSERT TABLE 1

Table 1 summarizes four recent econometric studies of market demand for media advertising and intermedia substitutability/complementarity. Some degree of substitutability was reported in all four investigations, with only Seldon and Jung (1993) finding indications of complementarity between their global "Print" and "Broadcast" categories in four years of their time series of thirty-seven annual observations. In interpreting these findings, one should note that the data underlying three of the four studies are either unknown mixes of national and local advertisers (Ekelund, Ford, and Jackson 1999,2000) or the sum of expenditures by national and local advertisers (Seldon and Jung 1993). As noted in Section I, there are grounds for expecting differences between national and local advertisers with respect to the cross-elasticities for various media and hence aggregating their market demands may camouflage different patterns and levels of intermedia substitutability/complementarity among more

[4] See Owen and Wildman (1992, Chapter 5), for further discussion.

finely disaggregated components. This is an empirical issue on which we provide evidence below. [5]

Of the four studies summarized in Table 1, only McCullough and Waldon (1998) focussed exclusively on national advertisers and disaggregated media classes (network and spot tv). The medians of the pairs of annual cross-elasticities reported for these two media were 0.106 (effect of change in network tv price on spot tv demand) and 0.079 (effect of changes in spot tv prices on network tv demand), where the own-elasticity estimates indicated inelastic market demands for both media the median estimates being –0.777 and –0.342 for network and spot tv, respectively. Thus in accord with P1, we conclude that the evidence reviewed above suggests that while media substitutes exist, they tend not to be "close" substitutes.

II.1.B *Consumer Demand for Information*

Marshall's second law, adapted to the demand for advertising, is that the derived demand for advertising will be more inelastic, other things equal, when consumers' demand for information about products and services is more inelastic. The economic theory of advertising as information emphasizes the role of advertising in reducing the time consumers expend on search and hence their total (purchase price plus search costs) acquisition cost (Ehrlich and Fisher 1982; Nelson 1974,1975). Despite the potential of media advertising to reduce search costs, to the extent that consumer demand for information is insensitive to the time cost of search, sellers' derived demand for advertising will tend to be inelastic with respect to media prices.

The only research estimating the elasticity of consumer demand for information of which we are aware is that by Moorthy, Ratchford, and Talukdar, hereafter MRT (1997) who report "A puzzling but consistent empirical finding is that consumers exhibit very limited pre-purchase information-search activity" (p. 263).[6] MRT argue that advertising

[5] The only study of firm-level demand for advertising in different media we have encountered is that due to Seldon, Jewell, and O'Brien (2000). Based on data for six beer firms, they report positive cross-price elasticities between two global media categories ("print" and "radio") but negative cross-price elastiicies between "television" and "print." However, intermedia substitutabilty/complementarity at the firm-level may be expected to differ from that at the market-level for reasons discussed later in Section VI.3

[6] Previous reviews of research on consumer search have drawn essentially the same conclusion. See: Alba, Hutchinson, and Lynch (1991) and Andreason (1991).

plays a critical role not only in reducing the time cost of search but also in influencing consumers' prior beliefs about choice alternatives, thereby affecting the order in which alternatives are searched. This helps explain why consumers engage in seemingly low levels of external search, even when their product class involvement is high and their search costs are low.

Based on their field study, MRT found that the total amount of external search consumers reported undertaking for new automobiles was inelastic with respect to consumers' perceived search costs. MRT's work represents the only estimate of the elasticity of consumer demand for information uncovered in the literature known to the present authors. In the case of low involvement packaged goods where consumers appear to rely relatively more on internal (memory-based) as opposed to external search (Alba, Hutchinson, and Lynch 1991), we conjecture that consumer demand for information for such products and services will also tend to be inelastic. Although the empirical evidence presently available is very limited, it is plausible to postulate that consumers' demand for information is inelastic, thereby rendering more inelastic the derived demand for advertising. Obviously, more empirical research on this topic is needed.

II.1.C *Elasticity of Supply of Media Advertising*

Marshall argued that the demand for an input was more price inelastic, *ceteris paribus,* the more price inelastic is the supply of other inputs. While the long-run supply of advertising time and/or space can be presumed to be highly elastic for all the major media, there are good reasons for expecting that the short-run elasticity of supply varies considerably by medium.[7] Bowman (1976) estimated the elasticity of supply for network television commercials to be 0.15 using monthly observations for the 1964-69 period. This relatively inelastic estimate of the short-run supply of television advertising may reflect the fixed number of commercial slots available in the short-run

[7] Jung and Seldon (1995) estimated the long-run elasticity of supply of total advertising (national and local) to be infinite.

for any program and/or viewing period. In contrast, such binding constraints are less likely to be operative for other media and thus for a medium like direct mail, we would expect the short-run elasticity of supply to be substantial.

More generally, we conjecture that for broadcast media and outdoor advertising, short-run supply elasticities will tend to be relatively small but for print media, they will be considerably larger. We discuss intermedia differences in the elasticity of short-run supply further in Section VI.2 below.

II.1.D *Advertising's Share of Total Costs*

Marshall's fourth law of demand, often dubbed "the importance of being unimportant," posits that the demand for an input is more price inelastic, *ceteris paribus*, the smaller is its share of total costs. In the current context, we use advertising-to-sales (A/S) dollars ratios as a proxy for advertising's share of total costs. In 1994, national advertising represented 1.3% of Gross Domestic Product while local advertising represented 0.9%. A/S ratios are known to vary markedly across firms and industries, e.g., being greater for experience goods than for search goods (Nelson 1974) and higher for new products than for established ones (Farris and Albion 1981). Data on A/S ratios for the 200 four-digit SIC industries with the largest advertising expenditures in 1994 show that the median ratio was 2.4%, with a range from 0.2% to 16.4% (Advertising Age 1994). The distribution of A/S ratios across industries is markedly skewed but only 13.5% of the industries had A/S ratios between 5% and 10% and just 5% of the industries had A/S ratios in excess of 10%. This suggests that instances where outlays for media advertising account for a substantial share of total costs are more likely to be the exception rather than the rule. As a consequence, we expect generally low A/S ratios to contribute to the inelasticity of market demand for an advertising medium.

II.2 Empirical Evidence on the Own-Price Elasticity of Demand for Media Advertising

With the insights from Marshall's four laws of demands adapted to national advertisers' demand for media time and space as background, we now briefly summarize the available empirical literature reporting own-price elasticity estimates for various advertising media.

The earliest study of which we are aware is that by Bowman (1976), who estimated a simultaneous equations model using monthly data for the period 1964-69. He reported an estimated price elasticity of market demand by national advertisers in all three networks of -0.73 (the 95% confidence interval ranged from -0.35 to -1.12). A later study by Busterna (1987) employed a series of single equation demand models and 1971-1985 annual data and reported an own-price elasticity estimate of -0.8 for newspaper advertising. Jung and Seldon (1995) investigated demand for total advertising using annual data for 1972-87 which aggregated expenditures in all media by both national and local advertisers. Their estimate of own-price elasticity of –0.17 indicated that demand for total advertising was quite price inelastic.

Own-elasticity estimates were also reported in the four more recent studies of market demand for media advertising summarized in Table 1. The estimates reported by Seldon and Jung (1993) and McCullough and Waldon (1998) indicated inelastic market demand for all the media categories investigated in those studies. Specifically, for a representative year (1969) from their time series, Seldon and Jung reported own-elasticity estimates of -0.4 for the aggregate "broadcast" category, -0.4 for another aggregate category, "print," -0.7 for direct mail, and about -0.8 for the residual "other" category. McCullough and Waldon estimated the own-elasticities for network and spot television to be –0.776 and –0.384, respectively for the mid-point (1977) of their time series.

The other two studies included in Table 1 due to Ekelund, Ford, and Jackson (1999, 2000) both found evidence of elastic demand. Their estimates of –2 .1 for the own-price elasticity of demand for spot radio and –4.3 for spot television are by far the largest we have uncovered in the literature. Note however, that whereas both of these estimates are based on data for a cross section of the largest regional media markets, the observations used by Seldon and Jung and McCullough and Waldon were for the total U.S.

The only study of demand for different media at the level of the firm (rather than the market) known to us is that due to Seldon, Jewell, and O'Brien (2000). Their analysis

utilized a time series (1983-1994) of quarterly expenditures for six major brewers in three global media classes. The own-price elasticity estimates at the mean of the observations indicated that demand for "print" (magazines, newspapers, and outdoor) and "radio" (network and spot) were both elastic (–1.70 and –7.7, respectively) while that for "television" (network and spot) was inelastic (-0.248). For reasons discussed later in Section VI.3, the elasticities of demand for media time and space by individual firms would be expected to differ from those for the market as a whole.

Finally, using data on "advertising expenses" reported in corporate tax returns over the period 1947-1969, Ehrlich and Fisher (1982) found own-price elasticities greater than unity (in absolute terms) for several industry sectors roughly corresponding to one- and two-digit SIC classifications. It is difficult to interpret these estimates since what is reported in Statistics of Income as "advertising expense" represents the combined total of deductible expenses for promotions (consumer and trade), sampling and publicity in addition to that for media advertising (cf. Rogers and Tockle 1995).

Overall then, we conclude that the bulk of the available empirical evidence is consistent with P2, i.e., market demand by national advertisers for the major classes of media tends to be price inelastic.

III. ECONOMETRIC MODEL AND METHODS

III.1 Model Specification

As noted above, existing studies of demand for media advertising have typically investigated an unspecified mix of local and national advertisers or the sum of the two. Since there are good reasons to expect differences in price elasticities of demand for national and local advertisers, here we focus our attention only on national advertisers, and leave the analysis of local advertisers for future research. Moreover, we disaggregate expenditures by national advertisers into eight media categories, the largest number for which we can obtain consistent annual data from 1960 onward.

Numerous mathematical functional forms can be employed for empirical implementation. A rather common formulation in empirical econometrics is the

translog (transcendental logarithmic) model, which can be interpreted as a second order Taylor's series approximation in logarithms to an arbitrary homogeneous cost function.[8] The translog advertising cost function can be written as follows:

$$\begin{aligned}\ln C_A = {} & \ln \alpha_0 + \sum_{i=1}^{N} \alpha_i \ln P_i + \alpha_A \ln A + \frac{1}{2}\alpha_{AA}(\ln A)^2 \\ & + \sum_{k=1}^{K} \alpha_{zk} \ln Z_k + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln Z_k \ln Z_l \\ & + \sum_{i=1}^{N}\sum_{k=1}^{K} \beta_{ik} \ln P_i \ln Z_k + \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} \beta_{ij} \ln Pi \ln P_j\end{aligned} \qquad (1)$$

where the α's and β's ($\beta_{ij} = \beta_{ji}$) are unknown parameters to be estimated; the P_i are media prices per unit of exposure; A is the total output quantity (in exposure units) of advertising effort employed; the Z_k are non-price exogenous variables affecting choices among advertising media discussed below; C_a is total advertising expenditures and equal to $\sum P_i A_i$, where the A_i denotes the quantity of exposures for the various media.

Following Shepard (1970), cost-minimizing demand equations for the various advertising media cost share equations can be obtained by logarithmically differentiating Eq. (1) with respect to the various media prices, thereby yielding media-specific share equations, each of the form:

$$\frac{\partial \ln C_a}{\partial \ln P_i} = \frac{P_i \partial C_a}{C_a \partial P_i} = \frac{P_i A_i}{C_a} \equiv S_i = \alpha_i + \sum_{j=1}^{N} \beta_{ij} \ln P_j + \beta_{iz} \ln Z \,. \qquad (2)$$

There exists a variety of measures of substitution possibilities among the inputs. With the translog function, the common own-price elasticity E_{ii} of demand can be shown to be:

$$E_{ii} \equiv \left.\frac{\partial \ln A_i}{\partial \ln P_i}\right|_{\substack{A,\ Z,\ P_j \text{ fixed} \\ j \neq i}} = \frac{\beta_{ii} + S_i^2 - S_i}{S_i}, \qquad i = 1, \ldots, N \qquad (3)$$

[8] See Christensen, Jorgenson, and Lau (1973).

while the cross-price elasticity of demand equals:

$$E_{ij} \equiv \left.\frac{\partial \ln A_i}{\partial \ln P_j}\right|_{\substack{A,Z,P_i \text{ fixed} \\ j \neq i}} = \frac{\beta_{ij} + S_i S_j}{S_i}, \; i, j = 1, \ldots, N \qquad (4)$$

where the S_i and S_j are the shares of total advertising expenditures realized by media i and media j, respectively. Curvature restrictions imply that the $E_{ii} \leq 0$; hence when $E_{ij} > 0$ then A_i and A_j are price substitutes, and if $E_{ij} < 0$, then A_i and A_j are price complements.

III.2 Exogenous Influences on the Demand for Media Advertising

A review of the advertising literature suggests two categories of factors besides relative prices that are hypothesized to have influenced media shares during the period 1960-1994. The first comprises the following consumer economic and demographic characteristics that the economic theory of advertising as information suggests affect the attractiveness of audiences delivered by the mass media as target groups for national advertisers' products and services: (a) components of personal consumption expenditures; (b) female labor force participation rates; and (c) the purchasing power of family households. Factor (a) captures the distinction between search and experience goods which differ in advertising intensity (Nelson 1974) while factors (b) and (c) are proxies for influences on consumer search costs (Pashigian and Bowen 1994).

For the second category, namely, technological and regulatory influences, we utilized measures of three variables: (a) expenditures on computer technology; (b) growth of cable and syndicated television as an advertising medium; and (c) the 1971 ban on tobacco advertising in broadcast media. Details pertaining to variable definitions and data sources are presented in Table 2.

III.3 Estimation Procedure

Our theoretical model consists of the eight share equations (see Eq. (2)) derived from the translog cost function. Since the share equations sum to unity at each annual observation, only seven of the eight equations are linearly independent. We add a normal disturbance term to each of the seven equations and specify that the resulting random disturbance vector is identically distributed. Following Berndt and Savin (1975), we allow for first order autocorrelation of this disturbance vector; provided that the autocovariance matrix is diagonal with equal diagonal elements, the resulting estimates are numerically invariant to the choice of which equation is deleted. We arbitrarily choose to delete the direct mail media share and estimate directly the remaining seven equations. Since "adding up" of the share equations implies that $\sum_i \alpha_i = 1, \sum_j \beta_{ij} = 0, \sum_i \beta_{ik} = 0$; i, j = 1,...,8, estimates of α_1, β_{1j} and β_{1k} can be obtained indirectly by manipulating the parameters directly established.[9]

Although media prices may well be exogenous at the level of the individual vehicles, for the market as a whole, prices and quantities of the various media are likely to be jointly determined. To allow for possible simultaneous equations bias, we treat media prices as endogenous and utilize data series for a number of other exogenous variables as instruments in the iterative, three-stage least squares estimation process.[10] We test for exogeneity of price using a Hausman (1978) specification test. We also investigated a more restrictive grouping of the media into a set of composite categories similar to those employed by Seldon and Jung (1993), namely print (magazines plus newspapers), broadcast (network plus spot for both radio and television), direct mail,

[9] With 34 generalized first difference observations in each of the 7 linearly independent share equations, there is a total of 238 observations. In the 7 share equations, there are 7 different constant terms, 28 distinct parameters on the price variables, and 56 distinct parameters on the non-price variables, for a total of 91 distinct parameters; this leaves 147 residual degrees of freedom (238-147=91). Note that the number of parameters appearing in each equation is 16 (though many cross-equation restictions occur), much less than the 34 annual time series observations.

[10] We employed as instruments data on: broadcast industry earnings; cost of materials for the publishing industry; a price index for newsprint; postal rates; the number of magazines and newspapers per capita; and the number of television and radio stations. Definitions and sources of these data series along with parameter estimates and fit measures are given in Appendix B.

and a residual "other" category. We then test for the empirical validity of the parameter restrictions implied by Seldon and Jung's grouping procedure.[11]

IV. DATA BASE AND ECONOMETRIC RESULTS

We investigated intermedia substitutability by national advertisers among a cross-section of eight basic classes of media: direct mail, magazines, newspapers, network radio, spot radio, network television, spot television, and outdoor. Each medium's annual share of total national advertising expenditures was computed using national advertisers' annual expenditures (in current dollars) for each medium. The time series analyzed comprised 35 annual observations covering the period 1960-1994 which encompasses six business cycles as defined by the National Bureau of Economic Research's dating of turning points (Boldin 1994).

Table 1 contains operational definitions and data sources for the share and price variables employed, together with measures of exogenous variables considered in the analysis. Here, we begin by reviewing the pattern of changes in media shares and prices observed over the 1960-1994 period. Then we discuss estimation results for our media share model, including specification checks. Finally, we summarize the estimates obtained for the price parameters that are used to calculate the elasticity estimates, per Eq. (3) and (4) above and briefly discuss the effects of the exogenous variables.

INSERT TABLE 2 HERE

IV.1 Trends in Media Shares and Prices: 1960-1994

Figure 1 present a time series plot for the shares of national advertising expenditures realized annually by each of the five largest media for the 35 year period 1960-94. As can be seen, direct mail predominated throughout the period, maintaining its share relatively stable at about 34% from 1960 until the late 1970s. From 1980 onward, its share grew steadily, reaching the 46% level by the early 1990s.

INSERT FIGURES 1 and 2 HERE

[11] These restrictions are also known as separability restrictions. See Berndt (1991, Chapter 9) for further discussion.

Magazines and newspapers, in contrast, experienced more or less steady declines in their shares. Magazines' share dropped from 17% to 12-13%, while newspapers' share decreased by nearly half, from 14% in the early 1960s to 6-7% in the early 1990s.

Network and spot television exhibited similar patterns of substantial growth throughout the 1960s. The 1971 ban on tobacco advertising in broadcast media precipitated an immediate drop in their shares. Both TV and radio recovered their pre-tobacco ban share levels — 20% in the case of network television and 14-15% for spot television — by the mid-1970s. Whereas spot television's share subsequently remained relatively flat until the early 1990s, network television's share continued its upward trend throughout the 1970s, peaking at 22-23% in early 1980s. The latter's share subsequently entered a period of continued decline from 1985 onward, falling to around 17% in 1994.

The shares of the three smallest media are plotted in Figure 2. Network radio's share remained flat throughout the 1960-1994 period, never representing as much as 1% of total national advertising expenditures. Both spot radio and outdoor experienced slow, long-term declines in share, spot radio's dropping from approximately 4% in 1960 to around 3% in the early 1990s, and outdoors' share declining from roughly 2% to 1% over the same period.

The behavior of media prices is plotted in Figure 3, which presents mean annual percentage changes in the cost per thousand exposures (CPM) price indices for the eight media over the period 1960-1994. As a summary measure, we constructed a Divisia price index (Diewart 1981) for all eight media combined. Figure 3 also plots mean changes in the eight media index, together with comparable figures for the Producer Price Index, Finished Consumer Goods (PPIFCG) and Consumer Price Index (CPI). The CPI is believed by many to overstate the rate of inflation, particularly for the 1970s and 1980s (Gordon 1987, pp. 53-54).

INSERT FIGURE 3 HERE

From 1961 to 1994, advertising prices for six of the eight media rose, on average, at a more rapid rate than did PPIFCG (the exceptions being the two small share radio media). Moreover, for five of the eight media (network and spot television, direct mail, newspapers, and outdoor), mean CPM increases exceeded growth in the CPI.

The relative volatility of changes in advertising rates is evident from the values of the coefficients of variation for annual changes in the media CPM indices reported in Figure 3. The standard deviation of the percent changes in CPMs exceeded the mean value for all four broadcast media (network and spot television and radio). The marked variability in advertising prices for all of the media over the period of analysis is reflected in the difference between the minimum and maximum values of the eight coefficients of variation, 0.58 (for direct mail) and 2.01 (for network television), respectively. This heterogeneity among media with respect to the rates at which prices have changed over time suggests that an econometric analysis of cross-price effects might well be informative in generating relatively precise elasticity estimate.

IV.2 Specification Checks and Estimation Results

A Hausman (1978) test for exogeneity suggests that media prices are jointly rather than exogenously determined; the χ^2 test statistic is 236.92, with the .01 critical value being 83.49. As a check on model specification, we also grouped the media into a set of composite categories similar to those employed by Seldon and Jung (1993), namely, print, broadcast, and direct mail. This grouping implies restrictions, decisively rejected when subjected to a nested model specification test, on parameters in the share equations of our eight-equation model (Deaton and Muellbauer 1980, Ch. 5). Finally, to ensure that the own-price elasticities of demand for the two media with the smallest shares were non-positive, we constrained the values of β_{ii} for network radio and outdoor. Three-stage least square estimates of the model's parameters are given in Appenidx A (Tables A1 and A2). Summary statistics pertaining to the model's fit are presented in Table A3.

The model fits the data quite well; the R^2 value for the share equations ranges from 0.753 to .986, exceeding .9 for six of the eight media. The estimate of ρ, the

autocorrelation coefficient, is -0.371 and statistically significant (t = 5.63). We interpret this somewhat unusual finding as a reflection of the oscillating cycle of political elections in the United States, which as Coen (1994) has pointed out, has a significant biannual fluctuating impact on the level and composition of media advertising expenditures.

IV.3 Price Parameters

Iterative, three-stage least squares estimates of the translog parameters that relate to price sensitivity are shown in Table A1 of Appendix A. Recall from (2) that the direct interpretation of these symmetric ($\beta_{ij} = \beta_{ji}$) translog parameters is the change in the expenditure share of media i given a 1% change in the price of media j, *ceteris paribus*.[12] Of the six estimated "own-price" effects, four estimated β_{ii}'s are positive (three statistically significant) and two negative (but not statistically significant). Thus, in most cases, media price increases translate into expenditure share increases for that medium, indicating limited substitution. Estimates of the β_{ij} parameters were subsequently used in (3) and (4) to generate estimates of own- and cross-price elasticities.

Examining estimates of cross price effect parameters for individual media, we find that 20 of the 28 estimated β_{ij} ($i \neq j$) parameters in Table A1 are statistically significant at the 5% level or beyond. For magazines, network television, and outdoor, six of the seven, and for direct mail, newspaper, and network radio, five of the seven, β_{ij} ($i \neq j$) parameters are statistically significant. The relative frequency of statistically significant parameters is smaller for spot radio and spot television.

IV.4 Effects of Exogenous Variables

Our media share demand equations depend on various exogenous influences as well as media prices and we include a number of demand shifting variables in the share

[12] Note that from (5), the dependent variable is expenditure share (not quantity share) and hence the parameters, β_{ii} and β_{ij}, reflect the net effects on revenues of changes in both quantities and prices.

model.[13] The effects of these variables on advertising media shares can be directly inferred by examining the parameter estimates in Table A2 of Appendix A, subject to the constraints imposed by the system of share equations, to wit: all parameter estimates for a given exogenous variable must sum to one. General patterns can nonetheless be recognized.

With the ban on broadcast advertising for tobacco products, media shares increased for direct mail and newspapers and, as expected, decreased for network television and spot television (each of the four corresponding estimated coefficients is statistically significant at the 5% level). Similarly, consumers' spending for non-durables correlates negatively and substantially with the media share for direct mail, but positively with the media shares of magazines, newspapers, spot radio, network, and spot television and outdoor (seven of the eight estimated coefficients for consumer non-durable spending are statistically significant). These findings are not unexpected, manufacturers of non-durables (e.g., packaged goods) have traditionally emphasized the use of mass media over direct consumer communication. Consumer outlays for services, on the other hand, are (significantly) negatively correlated with the media shares of newspapers, spot radio, and outdoor (four of the eight estimated coefficients are statistically significant at the 5% level).

The observed pattern of consumer expenditure effects on media shares is interesting for two reasons. First, the media that have benefited most by the recent growth of the service sector as a proportion of the U.S. economy are network radio and television and direct mail. In contrast, the more "regional" media traditionally dominated by local advertisers (i.e., the retail sector) have benefited least. (Our measures of advertising expenditures cover only *national* advertisers and all advertising activity by local service businesses usually associated with local/regional media is excluded.) Second, deregulation of the airline and telecommunications industries

[13] A dummy variable for Olympics/U.S. presidential election years and a measure of the installed base of VCRs were initially included as exogenous variables, both turned out to be statistically insignificant and were subsequently deleted.

which includes some of the largest national advertisers in the service sector, has exerted a significant impact on advertising spending as competition in these industries increasingly revolves around escalating advertising. Consumer spending on durables, on the other hand, exhibits no clear pattern of effects on media shares (only two of the eight estimated coefficients being statistically significant).

Increased female participation in the labor force correlated *ceteris paribus* with increases in the media shares of newspapers, spot radio, and outdoor and with decreases in the shares of direct mail, network radio, and spot television (the impact on the latter media being only marginally significant statistically). Our magazines' share variable may be too aggregated to reflect the influences of such major trends. Very likely, for example, increased female participation in the labor force participation had a substantially negative impact on traditional women's magazines (e.g., those related to home and cooking), but a largely positive impact on news weeklies and business-related magazines. Extrapolating, we might intuitively conjecture a positive effect on newspapers, reflecting working women's heightened interest in news events, and, with respect to outdoor and spot radio, that working and commuting are more likely than carpooling to occasion women's viewing of billboards and listening to car or portable radios.

Expenditures on information technology exerted a large positive impact on direct mail and a large negative impact on network television. Direct marketers tended to benefit most from technological advances that afforded increasingly sophisticated and cost-effective ways to target consumers and track advertising response. For television, benefits from advances in computer technology were outweighed by relative increases in the attractiveness of alternative media, as suggested by the positive signs of the parameter estimates for all other media save network and spot television.

Parameter estimates for cable and syndicated televisions (CTV) suggest that growth of this alternative medium has most adversely affected network television. That the signs of the parameters for five of the other six media are also negative suggests that national advertisers have employed cable and syndicated television as a

substitute for virtually all other media (negative coefficients for direct mail and magazines, as well as for network television, were statistically significant). The positive (and statistically significant) parameter estimate for newspapers, the single exception to this pattern of negative coefficients, implies a complementary relationship between that medium and cable and syndicated television.

Increases in the purchasing power of households headed by 25-44 year-olds affected positively (and statistically significantly), only direct mail, which might be construed to reflect increasing time sensitivity, an effect likely to be especially prevalent among dual career and single parent households.[14] Such households' use of direct mail to reduce search costs would seem to account for the negative relationship between their increased purchasing power and the media shares of magazines, network television and (less statistically significantly) network radio.

IV. ELASTICITY ESTIMATES

Estimates of own- and cross-price demand elasticities reflect, ceteris paribus, the percent change in quantity of advertising demanded from a medium, given a small (say, 1%) change in the price of a medium. Because they depend on the estimated β_{ij} parameters and time-varying values of the shares (Eqs. (3) and (4), Section 3), these demand elasticities are not constant over time. Four important conclusions emerge from our analysis of the mean values of the 34 annual own- and cross-price elasticities estimated for the period 1961-1994 and presented in Table 3.

INSERT TABLE 3 HERE

(i) Mean own-price elasticity estimates in Table 3 suggest that national advertisers' demand for seven of the eight media is price inelastic. Newspaper advertising has an approximately unit mean demand elasticity (-1.06). Mean demand elasticities for four of the other media are significantly less than zero ($p < .01$) at -0.75 for direct mail, -0.69 for network television,

[14] See Pashigian and Bowen (1994) for an analysis of the effects of two-earner households and women's earnings on search and shopping time.

-0.41 for outdoor, and -0.25 for network radio. Inelastic demand is indicated for the remaining media, but the estimates were insufficiently precise to differ significantly from zero at the 1% level, although two of the three were significant at the 5% level (magazines at -0.32 and spot radio at -0.25). The mean estimated elasticity for spot television (-0.26) exceeded its estimated mean standard error but failed to achieve significance at even the 10% level.

(ii) Mean cross-price elasticity estimates suggest that intermedia substitutability is slightly more prevalent than intermedia complementarity.[15] Of the 28 pairs of mean cross-price elasticities, (off-diagonal entries in Table 3), 57% (16/28) indicate substitute relations, by virtue of the positive signs of the estimated values.[16] Moreover, the precision of the estimates tended to be greater for substitute than for complementary relationships; about two-thirds (22/32) of the positive mean cross-price elasticities were statistically significant (as judged by a two tail test, $p < .05$), compared to half (12/24) of the negative cross-price elasticities.

(iii) The magnitude of cross-price effects, whether substitutes or complements, tends to be limited, as can be seen from the size of the mean cross-price elasticities in Table 3.[17] The median value of the 32 positive mean cross-price elasticities (substitutes) is 0.27 (range: 0.01 to 1.23) and only four exceed unity. The median value of the 24 negative cross-price elasticities (complements) is -0.20 (range: -0.01 to -1.63), with only two less than minus one.

(iv) Whereas direct mail and newspapers tend to be related to the alternative media primarily as substitutes, cross-price elasticities indicate a balance between substitutability and complementarity for the other six media. Substitution holds for six of the seven cross-price elasticities involving direct mail and for five of the seven involving newspapers. For the other six media, three or four of the seven price interdependencies are

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[15] Note that the translog model yields pairs of cross-elasticities that are symmetric with respect to sign (since $\beta_{ij} = \beta_{ji}$), but asymmetric in magnitude (since in general, $S_i \neq S_j$).

[16] For all 28 pairwise relationships, the cross-price elasticities estimated for each annual observation remained sign-invariant over the entire 1961-1994 period.

[17] This conclusion is also supported by an analysis of the Morishima elasticies of substitution reported in Appendix C.

complements.[18]

VI. DISCUSSION

VI.1 Media Selection Practices and Institutional Factors

The results reported in Section V indicate that national advertisers' demands for time and space in the major media tend to be price inelastic, while interdependencies among market demands for the separate media involve substitute and complementary relationships, both characteristically weak. These demand conditions are consistent not only with our two propositions about the derived demand by national advertisers' for media time and space (discussed in Section II), but also with media selection practices and institutional arrangements that have long prevailed in the U.S. advertising industry.

Observers of media planning practices typically describe the process as a sequential one and emphasize the differences between intermedia and intramedia decisions. Intermedia choices are often effectively preempted by judgments about the fit between message strategy and alternative media exercised in the early stages of a campaign's development and prices are frequently a secondary consideration (Jones 1992). To the extent that intermedia comparisons are undertaken at all, they are likely to be made informally on the basis of criteria of uncertain validity. Data to support intermedia comparisons are lacking (Raymond 1976, Stewart and Ward 1994). As a result, the application of optimization methods to media planning is primarily concerned with intramedia decisions (vehicle selection and scheduling) rather than supporting intermedia choices (Ha 1995, Rust 1986).

An additional factor contributing to the relative price insensitivity of national advertisers' choice of media mix is the existence of a classic principal-agent incentive

[18] The signs of the cross elasticities for network and spot television shown in Table 3 are negative implying complementarity. This would appear to be an anomolous result in light of the evidence discussed in Section II.1.A that these two media are substitutes. It also bears noting that the cross-elasticity estimates for network and spot television just achieve significance at the .05 level and the estimate of the own-elasticity for spot television, while having the expected sign, lacks precision, with its t-ratio being only 1.42.

problem which arises from the role "full service" advertising agencies traditionally played in media selection. Media planning and placement are but one component of the bundle of services full service agencies typically perform for national advertisers. An advertising agency, when compensated by a fixed percentage of a client's media expenditures, has relatively little incentive, at least in the short run, to seek out the least cost combination of media. Fixed media commission rates were the dominant mode of agency compensation until the mid-1980's when studies conducted among large national advertisers began to detect a shift away from reliance on the traditional 15% media commission rate (Lundin and Jones 1998). Thus, both the nature of media selection practices and the vertical structure of the advertising industry might be expected to render market demand for media advertising price inelastic and intermedia price substitutability weak.

VI.2 Implications of Aggregate Media Cross-Price Elasticities

Our estimates of relatively weak substitute/complement relationships between the eight media classes imply correspondingly small cross-price elasticities between vehicles within the various media classes. Specifically, for illustrative purposes, assume there are two media classes, medium A and medium B, the former comprised of vehicles i and j and the latter vehicles k and l. Defining the cross-price elasticities as in Eq. (3) above, Berndt and Christensen (1973) have shown that aggregating vehicle i and j into a composite medium A and similarly aggregating vehicles k and l into a composite medium B, is equivalent to assuming the following equality restrictions on the cross-price elasticities:

$$\begin{aligned} E_{ik} &= E_{jk} = E_{Ak} \\ E_{il} &= E_{jl} = E_{Al} \\ E_{ki} &= E_{li} = E_{Bi} \\ E_{kj} &= E_{lj} = E_{Bj} \end{aligned} \qquad (5)$$

These equality relationships imply that the relatively small estimated values of the cross-price elasticities among the major media classes reported here will be

accompanied by cross-price elasticities between two vehicles in two different media classes that are also correspondingly small. Because the required data are not available, we have by necessity assumed the existence of eight aggregate media classes and have not been able to test this assumption empirically. However, because we decisively rejected parameter restrictions implied by Seldon and Jung's (1993) aggregation procedure in which our eight classes were combined into four, implicitly we rejected the cross-price elasticity equality restrictions, analogous to those in Eq. (5) above, that are implied by Seldon and Jung's approach.

In particular, whereas Seldon and Jung's aggregation procedure assumes that network radio and network television have equal cross-elasticities with magazines, our estimate of these elasticities is signficantly negative and significantly positive, respectively (see Table 3).

VI.3 Intermedia vs. Intramedia Price Sensitivity

Our findings of inelastic market demands and weak cross-media price effects are also congruent with descriptions of media planning as a multistage decision process in which *intermedia* choices are made on strategic and creative grounds, with price playing a more important role in subsequent *intramedia* comparisons. Consider how the elasticity of demand faced by particular advertising vehicles within some media category relates to the market demand for the medium as a whole, when the latter is comprised of F identical vehicle suppliers.[19] This relationship takes the form

$$e_v = E_{ii} F - \eta_s \left(\frac{F}{F-1} \right) \qquad (6)$$

where e_v denotes the price elasticity of demand for advertising vehicle v ($e_v \leq 0$); E_{ii} is the market (own) price elasticity for medium i ($E_{ii} \leq 0$); F is the number of identical firms comprising the medium/industry (F>1); and η_s is the elasticity of supply for the F-1 other firms ($\eta_s \geq 0$).

[19] See Carlton and Perloff (1990, pp. 79-81) for the derivation.

Thus, it may be seen from (6) that the demand elasticity associated with a particular vehicle depends not only on the elasticity of market demand for the medium, but also on the market structure of the medium/industry (i.e., the number and size distribution of vehicles within the same media category) and the elasticity of the supply of the medium (i.e., responsiveness of capacity to changes in price).[20] In general, (6) implies that the elasticity of demand at the vehicle level is greater (in absolute value) than that at the market level. This distinction is in line with Coen's (1983) observation that the process whereby media plans are adjusted to shifts in intermedia price differentials is phased or hierarchical, wherein *intramedia* changes are expected to precede a realignment of *intermedia* allocations.

When applied to media advertising, a further implication of (6) is that, although own-price elasticities may vary little across media at the market demand level, there is likely to be considerable variation in the elasticity of demand for individual vehicles across media categories, particularly in the short run because of intermedia differences in market structure and the elasticity of supply.

Table 4 cross-classifies the eight major classes of advertising media by market structure and short-run elasticity of supply. There being practically no published empirical estimates of supply elasticities for advertising media, we adopt a simple dichotomous classification of the eight media for this construct. The vertical ordering of the media reflects the level of concentration within each of the eight categories as indicated by prior studies and empirical evidence. A detailed explanation of the bases used for the classification in Table 3 is provided in Appendix D.

INSERT TABLE 4 HERE

[20] The relationship between the elasticity of demand for a specific supplier (vehicle) and that for the industry (medium) as whole depicted in (6) assumes the special case of identical suppliers. Of course, the nature of that relationship will vary with changes in the assumption made about the market structure (number and size distribution) of suppliers (vehicles) comprising the industry (medium). For an analysis of the case where the market structure consists of a dominant firm and a competitive fringe, see Carlton an Perloff (1990, pp. 205-207).

Relating the classification in Table 4 to (6), we see that network television and direct mail are polar opposites with respect to both market structure and short-run elasticity of supply. Whereas there were only three television networks from 1960-1990, the number of firms supplying direct mail advertising services grew from fewer than a thousand to nearly four thousand over the same period, the four firm concentration ratio being only 19%. Similarly, in the short-run, say one quarter, a network's supply of slots for some program or viewing period is essentially fixed, the elasticity of supply approaching its lower bound of zero.[21] Direct mail campaigns, in contrast, are readily expanded or contracted over short periods of time, and we would expect this short-run elasticity of supply to be substantial. Hence, even though market demands for both media appears similarly inelastic (-0.69 and -0.75 in Table 2), differences in market structure and supply conditions tend to make the demand faced by a supplier of direct mail services much more price elastic than that faced by a television network.

VI.4 Distinguishing Between Intermedia Substitutes and Complements

The estimates of cross-price elasticities (summarized in Table 2) reveal a persistent pattern of interdependencies among the eight media classes over the 1961-94 period consisting of an almost equally balanced mix of substitutive and complementary relations. This pattern of pairwise interrelationships among the media raises a more fundamental question: What determines whether a pair of media is substitutes or complements? Are our estimates consistent with what one might expect *a priori*?

Elsewhere, we (Silk, Klein, and Berndt 2001) proposed the following hypotheses pertaining to underlying media characteristics which serves to differentiate between substitutes and complements:

> A pair of media are more likely to be substitutes than complements when they offer national advertisers: (H1) similar levels of *audience addressability* (Porter 1976); (H2) dissimilar levels of *audience control over attention to advertising* (Owen 1999)); and (H3) dissimilar levels of *flexibility with respect to contractual requirements* (Yang 1962a,b).

[21] Bowman (1976) estimated the elasticity of market supply for network television commercials to be 0.15 using quarterly data.

These hypotheses were supported in a preliminary test conducted using the cross-elasticities reported in Table 1.[22] Thus, our estimates of the patterns of substitutability and complementary relationships among the eight advertising media are consistent with *a priori* expectations.

VII. SUMMARY AND CONCLUSIONS

Our econometric analysis of national advertisers' demand for media advertising has yielded two main conclusions: market demand for seven of the eight major mass advertising media is price inelastic[23]; and interdependencies among these demands involve a balanced mix of substitute and complementary relationships, both characteristically weak.

Inelastic market demand for the major categories of media advertising is congruent with the treatment of national advertisers' demand for media time and space as being derived from consumers' demand for information about the goods and services sold by national advertisers. In the case of media advertising, the factors which theory identifies to be basic determinants of the elasticity of derived demand would appear to operate in the case of media advertising so as to generate inelastic market demand — although our knowledge of the relevant underlying parameters affecting advertising is quite primitive.

The demand conditions revealed here also appear to be consistent with the nature of institutional arrangements and media selection practices that have long prevailed in the United States. Inelastic market demand and weak cross-media effects are congruent

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[22] An ordered probit was estimated where the 28 cross-elasticities reported in Table 2 were as a trichotomized dependent variable (substitute vs. independent vs. compliment) and related to the similarity/dissimilarity of the media pairs with respect to each of the three hypothesized media factors. The signs of the coefficients for all three factors were in the hypothesized direction with the ratios of the estimated coefficients to their standard errors being 2.3 and 1.7 for audience addressability and contractual flexibility, respectively, but only 1.1 for audience control. See Silk, Klein, and Berndt (2001) for details.

[23] As may be seen from Table 2, the exception is newspapers for which the own-elasticity estimate was -1.06, indicating a slightly elastic demand, the estimate being within one standard error of the inelastic region.

with industry practices in which media planning is conducted as a multistage decision process, with intermedia choices made primarily on strategic and creative grounds, followed by price-sensitive intramedia comparisons of alternative vehicles. Full-service advertising agencies have historically played a critical role in media selection, and their reliance on media commissions as the basis for agency compensation may have served to mitigate price sensitivity in media buying decisions.

Finally, there is evidence that the pattern of substitution and complementary relationships among media classes reported here is associated with three basic attributes which differentiate the media from one another, namely the addressability or divisibility of audience reached by a medium; the amount of control a medium's audience can exercise over exposure to advertising messages carried in that medium; and the degree of flexibility with respect to the contractual arrangements required by the medium.

Driven by the rapid diffusion of digital technology, changing macroeconomic conditions, and shifts in regulatory policy, interest in research on the economics underlying the evolution of the demand and supply of media advertising is likely to increase. Elsewhere we have argued that the traditional pattern of inelastic demand and weak substitutability/complementarity reported here can be expected to change substantially in the future under the growing new technology threat of direct and indirect substitutes and rising demands by national advertisers for efficiency and accountability in media selection (Silk, Klein, and Berndt 1999).

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Figure 1

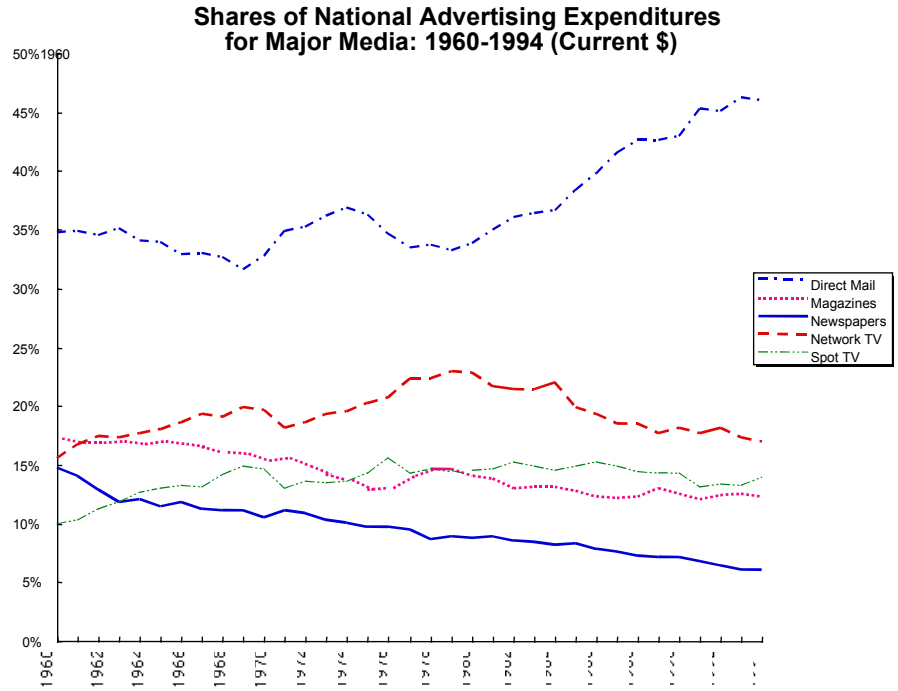

Figure 2

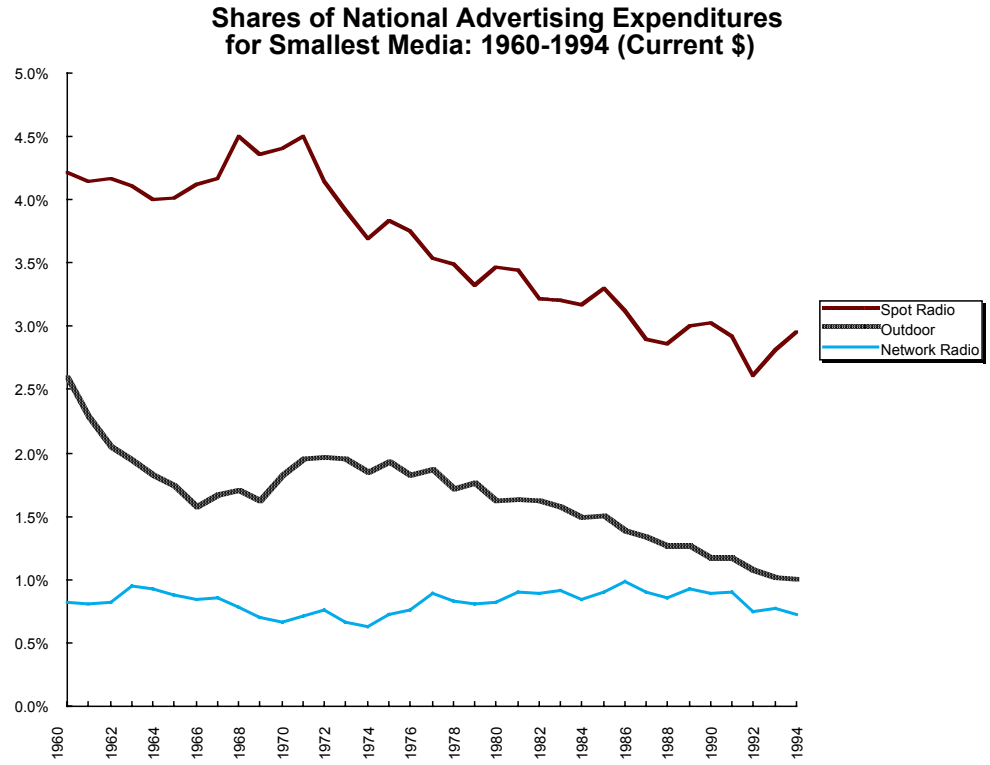

Figure 3

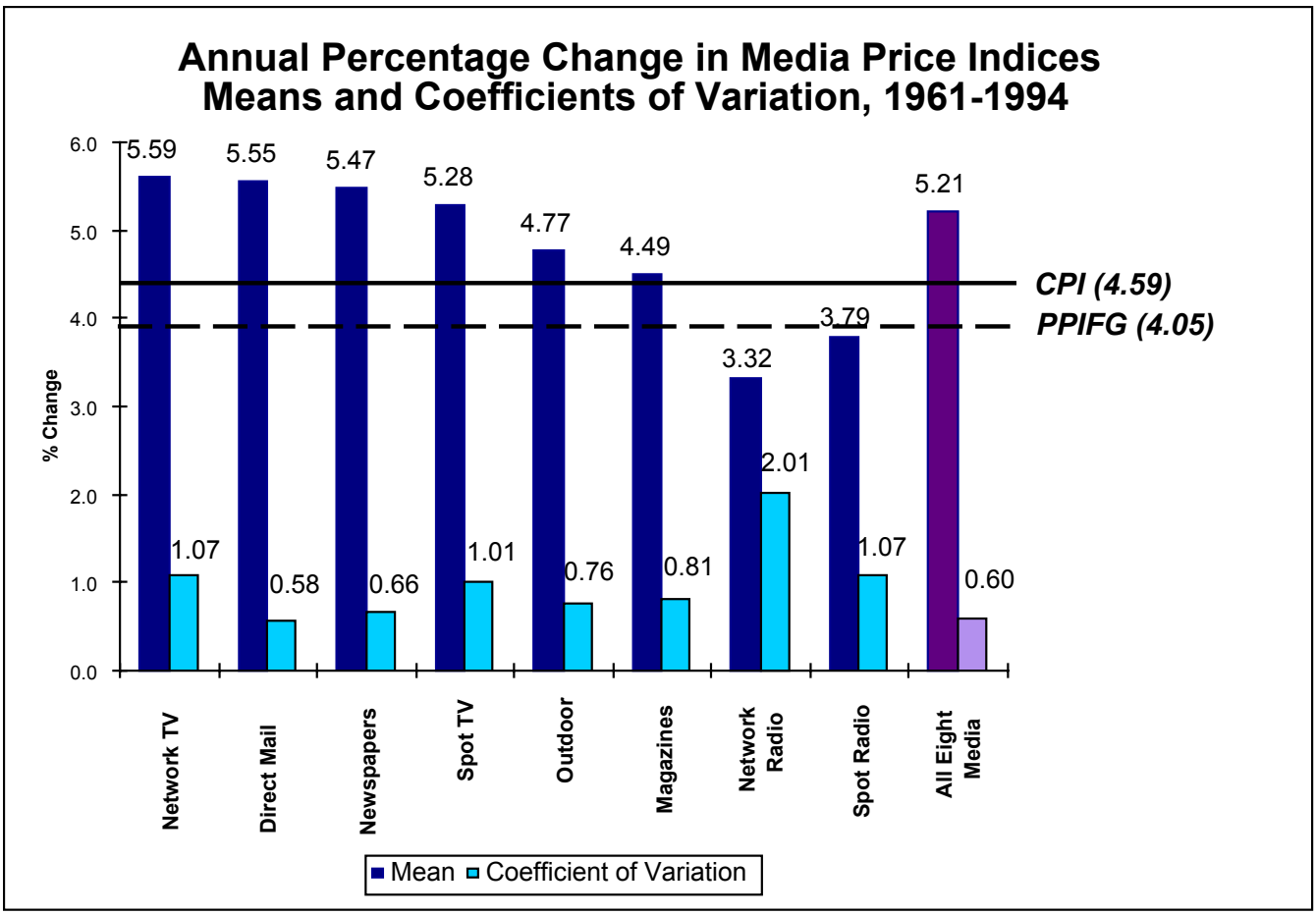
Annual Percentage Change in Media Price Indices
Means and Coefficients of Variation, 1961-1994
% Change
6.0
5.0
4.0
3.0
2.0
1.0
0.0
5.59
5.55
5.47
5.28
4.77
4.49
3.32
3.79
5.21
1.07
0.58
0.66
1.01
0.76
0.81
2.01
1.07
0.60
CPI (4.59)
PPIFG (4.05)
Network TV
Direct Mail
Newspapers
Spot TV
Outdoor
Magazines
Network Radio
Spot Radio
All Eight Media
Mean
Coefficient of Variation

Table 1
SUMMARY OF RECENT ECONOMETRIC STUDIES OF MARKET DEMAND FOR MEDIA ADVERTISING AND INTERMEDIA SUBSTITUTABILITY

Reference	STUDY DETAILS					Findings	
	Type of Advertiser	Classes of Media	Unit of Observation	Data Base	Demand Model	Own-Elast.	Cross-Elast.
Seldon & Jung (1993)	Total of National plus Local	Four aggregate categories: Broadcast, Print, Direct Mail, All Other	Total U.S.	Annual time series of expend., 1950-87	Translog	All four aggregate categories inelastic	Varying degrees of substitution among all 4 media, except for complementarity between Broadcast & Print, 1951-54
McCullough & Waldon (1998)	National	Network (Net) TV, Spot TV	Total U.S.	Annual time series of expend., 1960-94	Translog	Both Net TV & Spot TV inelastic	Net TV & Spot TV substitute for one another
Ekelund, Ford, & Jackson (1999)	Unspecified mix of National & Local	Newspaper, Spot Radio, Spot TV	Regional market area	1995 adv. rev. for cross-section of 110 of the largest 200 radio mkts.	Log-log	Spot Radio elastic	Newspaper & Spot TV substitute for Spot Radio
Ekelund, Ford, & Jackson (2000)	Unspecified mix of National & Local	Newspaper, Spot Radio, Spot TV	Regional market area	1995 adv. rev. for cross-section of 101 of the largest 200 TV mkts.	Log-log	Spot TV elastic	Newspaper & Spot Radio substitute for Spot TV

Table 2

VARIABLE DEFINITIONS

Abbreviation	Definition
SHR_{it}	Medium i's share of total expenditures (current dollars) made by U.S. national advertisers in year t, i = 1,...,8; t = 1960,...,1994, where: $\sum_{i=1}^{8} SHR_i = 1, for all t$
CPM_{it}	A price index reflecting the cost per thousand exposures in medium i during year t (C_{it}, current dollars), relative to the cost in the base period (C_{i0} for 1982-84), i.e., $CPM_{it} = (C_{it}/C_{i0})*100$
PCE_{kt}	Personal consumption expenditures in category k in year t (billions of constant 1982 dollars), where k =1,2,3, denotes durable goods, nondurable goods, and services, respectively
FLP_t	Civilian female labor force as a percentage of female civilian noninstitutionalized population age 16 and over
HPP_t	Purchasing power of family households (millions of constant 1992 dollars) with heads of household aged 25-44 in year t—calculated by multiplying the median income (constant 1982 dollars) by the number of households for this age cohort
CSE_t	Expenditures on computer software and services (millions of constant 1987 dollars) in year t—calculated by deflating these expenditures in current dollars with the Producer Price Index Finished Goods (1987=100). This series begins in 1965 and hence for t prior to that, CSE = 0.
CTV_t	Index of share of total national advertising expenditures in cable network and syndication television in year t, relative to that share for 1980 — where CTV = 0 for t = 1960,...,1979; CTV = 1 for 1980 and CTV > 0, thereafter.
BAN_t	Index to represent the effect of the ban on tobacco advertising in broadcast media initiated on January 2, 1971. We hypothesized the effect to be greatest in 1971 but gradually diminishing thereafter as media mixes were adjusted (Teinowitz 1995). Thus, the index is defined as $BAN_t = 0$ for t = 1960,...,1970, and $BAN_t = 1/y+1$, thereafter, where y = 1 for t = 1971 and y is increased by 1 in each subsequent year.

Data Sources: Annual expenditures by medium for national and local advertising are regularly reported in Advertising Age (e.g., Vol. 64, May 3, 1993, p. 4) and the extended time series are published in the Statistical Abstract of the United States (e.g., 114 ed., 1994, p.580). The indices of cost per thousand exposures are found in "McCann-Erickson Cost Indices," (unpublished paper, November,1995), available from Robert Coen, Senior Vice-President and Director of Forecasting, Universal McCann, New York.

Recent data on PCE and FLP are taken from Statisical Abstract, 1995. Earlier data for these two series are reported in U.S. Bureau of Economic Analysis, National Income and Product Accounts, Vol. 2, 1959-88 and U.S. Bureau of Labor Statistics, Bulletin 2307 and annual editions of Employment and Earnings. HPP was constructed from data reported in U.S. Bureau of the Census, Current Population Reports, Series P-20. Expenditures on computer software and services are published annually by the Computer and Business Equipment Manufacturers Association (CBEMA) in CBEMA Industry Marketing Data Book.

Table 3

MEAN VALUE OF ESTIMATES OF ANNUAL OWN- (E_{ii}) AND CROSS-PRICE ELASTICITIES (E_{ij}) OVER THE PERIOD 1961-94

(Mean Ratio of Annual Elasticity to Annual Asymptotic Standard Error in Parentheses)

	Mag-azine	Net-work TV	Out-door	Spot Radio	Net-work Radio	Spot TV	News-paper	Direct Mail
Magazine	-0.32 (1.75)	+0.75 (5.40)	-0.06 (1.64)	+0.02 (0.44)	-0.10 (3.38)	-0.15 (1.09)	-0.27 (2.14)	+0.11 (0.88)
Network TV	+0.55 (5.40)	-0.69 (4.77)	-0.10 (4.26)	-0.12 (3.38)	+0.02[a] (0. 97)	-0.19 (1.65)	-0.05 (0.61)	+0.58 (4.86)
Outdoor	-0.51 (1.64)	-1.19 (4.25)	-0.41 (40.74)	-0.45 (2.60)	+0.57 (7.28)	-0.24 (0.90)	+1.00 (3.32)	+1.23 (5.69)
Spot Radio	+0.09 (0.44)	-0.66 (3.37)	-0.20 (2.60)	-0.25 (1.88)	-0.14 (2.29)	+0.27 (1.56)	+0.49 (2.63)	+0.40 (2.27)
Network Radio	-1.63 (3.37)	+0.39 (0.97)	+1.10 (7.17)	-0.61 (2.28)	-0.25 (12.28)	+1.19 (3.24)	+0.15 (0.35)	-0.33 (1.07)
Spot TV	-0.15 (1.09)	-0.26 (1.64)	-0.03 (0.90)	+0.07 (1.56)	+0.07 (3.24)	-0.26 (1.42)	+0.26 (2.52)	+0.30 (2.44)
Newspapers	-0.42 (2.14)	-0.11 (0.61)	+0.17 (3.32)	+0.19 (2.63)	+0.01 (0.35)	+0.39 (2.52)	-1.06 (5.12)	+0.83 (5.23)
Direct Mail	+0.04 (0.88)	+0.31 (4.86)	+0.05 (5.70)	+0.04 (2.27)	-0.01 (1.08)	+0.11 (2.44)	+0.21 (5.23)	-0.75 (7.78)

[a]Read: Cross-elasticity of demand for Network Radio (Column variable) with respect to the price of Network TV (Row variable). Own-price elasticities are unshaded. Substitutive relations are lightly shaded and complimentary relations are darkly shaded.

Table 4

CLASSIFYING NATIONAL ADVERTISING MEDIA BT MARKET STRUCTURE AND THE SHORT-RUN ELASTICITY OF SUPPLY

Market Structure	Short-Run Elasticity of Supply	
	Low	High
High Concentration[a]	Network TV (99%)	Newspaper (22%)[b]
	Network Radio (95%)	
	Outdoor (31%)	Magazine (26%)
	Spot TV (25%)	
		Direct Mail (19%)
Low Concentration	Spot Radio (12%)	

[a] Estimate of four firm concentration ratios for 1995 in parentheses—see Appendix C for details.

[b] This number represents the four firm percentage of total (circulation plus local and national advertising) revenues.

APPENDIX A
Table A1

THREE STAGE LEAST SQUARES ESTIMATES OF PRICE PARAMETERS FOR MEDIA SHARE MODEL
(Ratio of Parameter Estimate to Asymptotic Standard Error in Parentheses)

Parameter	Estimate	Parameter	Estimate	Parameter	Estimate
α_1	-1.39	β_{22}	0.08	β_{44}	0.03
	(1.56)		(2.92)		(4.92)
α_2	0.49	β_{23}	-0.05	β_{45}	-0.03
	(1.13)		(2.94)		(4.42)
α_3	1.47	β_{24}	$-1.69e^{3}$	β_{46}	-0.01
	(5.27)		(0.21)		(2.42)
α_4	0.11	β_{25}	0.08	β_{47}	$4.61e^{3}$
	(0.82)		(3.99)		(0.75)
α_5	1.24	β_{26}	-0.01	β_{48}	-0.01
	(2.12)		(3.69)		(2.83)
α_6	0.04	β_{27}	-0.04	β_{55}	0.02
	(0.71)		(2.10)		(0.78)
α_7	-1.38	β_{28}	-0.01	β_{56}	$1.60e^{3}$
	(3.29)		(2.13)		(0.49)
α_8	0.41	β_{33}	-0.01	β_{57}	-0.06
	(5.54)		(0.72)		(2.89)
β_{11}	-0.04	β_{34}	0.01	β_{58}	-0.02
	(1.26)		(2.10)		(5.00)
β_{12}	-0.04	β_{35}	-0.03	β_{66}	**0.006**
	(1.99)		(1.78)		**(NA)**
β_{13}	0.04	β_{36}	$0.48e^{3}$	β_{67}	0.01
	(2.85)		(0.13)		(2.87)
β_{14}	$9.97e^{3}$	β_{37}	0.02	β_{68}	0.01
	(0.16)		(1.61)		(7.23)
β_{15}	0.04	β_{38}	0.01	β_{77}	0.08
	(1.76)		(2.99)		(3.24)
β_{16}	$-5.73e^{3}$			β_{78}	-0.01
	(2.31)				(1.45)
β_{17}	-0.01			β_{88}	**.009**
	(0.56)				**(NA)**
β_{18}	0.01			ρ	-0.37
	(3.97)				(5.63)

Key: 1 = Direct Mail; 2 = Magazines; 3 = Newspapers; 4 = Spot Radio; 5 = Network TV; 6 = Network Radio; 7 = Spot TV; 8 = Outdoor

Note: NA signifies fixed parameters.

Table A2

THREE STAGE LEAST SQUARES ESTIMATES OF PARAMETERS FOR EXOGENOUS VARIABLES (B_{iz}) IN MEDIA SHARE MODEL

(Ratio of Parameter Estimate to Asymptotic Standard Error in Parentheses)

	Medium (i)							
Exogenous Variable	Direct Mail	Mag-azine	News-papers	Spot Radio	Net-work TV	Net-work Radio	Spot TV	Out-door
PCE-Durables	0.02 (0.67)	-4.33e^{3} (0.26)	0.01 (0.52)	-0.01 (1.36)	+0.01 (0.56)	-3.55e^{4} (0.171)	-0.04 (2.33)	0.01 (3.06)
PCE-Nondurable	-0.96 (5.15)	0.19 (2.16)	0.12 (2.12)	0.10 (3.58)	0.32 (2.85)	-3.97e^{3} (0.369)	0.21 (2.44)	0.03 (1.97)
PCE-Services	0.28 (1.98)	-4.08e^{3} (0.06)	-0.28 (6.46)	-0.08 (3.94)	0.11 (1.19)	0.01 (1.68)	0.03 (0.45)	-0.07 (6.16)
Tobacco Ban	0.04 (4.02)	-3.48e^{3} (0.567)	0.02 (4.12)	2.15e^{3} (1.10)	-.043 (6.49)	-1.17e^{3} (1.34)	-0.01 (2.30)	1.35e^{3} (1.25)
CTV	-.01 (3.96)	-3.07e^{3} (3.75)	1.20e^{3} (2.12)	-9.34e^{5} (0.367)	-.004 (3.42)	-.0000 (0.462)	-.0009 (1.105)	-.000 (0.854)
CSE	0.74 (2.85)	7.16e^{7} (0.42)	1.06e^{7} (0.94)	2.34e^{8} (0.42)	-8.50e^{7} (4.81)	3.98e^{8} (1.67)	-1.65e^{7} (1.14)	3.29e^{8} (1.14)
FLP	-0.29 (1.80)	-0.05 (0.55)	0.29 (4.44)	0.08 (2.63)	0.56 (0.44)	-0.03 (1.78)	-0.15 (1.63)	0.09 (4.79)
HPP	0.43 (4.85	-0.12 (2.80)	-0.60e^{3} (0.02)	-0.01 (0.51)	-0.29 (5.40)	-0.01 (1.77)	-0.27e^{2} (0.07)	-0.01 (0.79)

Table A3

SHARE EQUATION SUMMARY FIT STATISTICS

	Direct Mail	Mag-azines	News-papers	Spot Radio	Net-work TV	Net-work Radio	Spot TV	Out-door
Mean Share	0.37	0.14	0.09	0.04	0.19	0.01	0.14	0.02
R^2 (adjusted)	0.96	0.95	0.99	0.95	0.92	0.75	0.89	0.97
Standard Error of Estimate	0.01	$0.40e^2$	$0.24e^2$	$0.12e^2$	0.01	$0.44e^3$	$0.38e^2$	$0.58e^3$
Durbin-Watson	1.31	1.36	2.08	1.15	1.75	1.67	1.25	1.85

APPENDIX B

FIRST STAGE MEDIA PRICE EQUATIONS

B1.0 Instruments

B1.1 *Definitions*

Table B1 presents definitions of the variables used as instruments in the first stage media price equations.

B1.1 *Sources*

Time series for radio and television employee average hourly earnings (BRE) are found in the Statistical Abstract of the United States: 1960-1995 and regularly published in Employment and Earnings, U.S. Bureau of Labor Statistics, Bulletins 2370 and 2429 Washington, D.C. Data on the number of TV and Radio Stations are published in the Annual Report of the Federal Communications Commission, Washington, D.C., U.S. Government Printing Office. Data on the number of newspapers and magazines in circulation (MCAP and NCAP) are published in the Editor and Publisher International Year Book Annual, Editor and Publisher Co., New York, NY. The Producer Price Index for Newsprint (PPIN) is obtained from the U.S. Dept. of Labor, Bureau of Labor Statistics, and also regularly published in Statistical Abstracts. Third Class Postal Rates (3rd class) were obtained from United States Post Office, as published in U.S. Domestic Postal Rates 1872-1993, Tables 27-1, 2, 3, 4 and 28-1-6. Cost of materials for the publishing industry is reported in the Census of Manufactures, series MC87-1-27A, and the Annual Survey of Manufactures.

B2.0 First Stage Equation Results

Results from regressions of the prices on the instruments are included in Tables B2 and B3. All variables measured in dollar terms were converted to constant (1987) dollars and transformed to natural logarithms. All exogenous variables included in the price regressions appear in the same form as that used in the media share equations.

Table B1

INSTRUMENT DEFINITIONS

Abbreviation	Definition
POST	The postage price of a typical direct mail piece weighing 4 oz. sent third-class bulk rate.
PPIN	A price index reflecting producer prices for newsprint.
BRE	Average hourly earnings for radio and television employees.
PCOG	Average cost of goods for publishers, including magazines and newspapers
TV	The number of commercial television stations registered in the United States.
AMRST	The number of AM radio stations registered in the United States.
MCAP	The number of magazines published in the United States, divided by the total U.S. population.
NCAP	The number of newspapers published in the United States, divided by the total U.S. population.

Table B2

ESTIMATES OF REGRESSION COEFFICIENTS FOR EXOGENOUS VARIABLES IN FIRST STAGE PRICE EQUATIONS

(Ratio of Parameter Estimate to Asymptotic Standard Error in Parentheses)

Exogenous Variables and Instruments[a]	Medium (i) Direct Mail	Mag-azines	News-papers	Spot Radio	Network TV	Network Radio	Spot TV	Out-door
PCE- Durables	0.11 (1.28)	0.28 (1.23)	0.15 (0.91)	0.15 (0.64)	0.51 (1.87)	0.78 (2.21)	0.55 (2.74)	-0.02 (0.11)
PCE- Nondurables	-1.50 (4.07)	2.43 (2.52)	1.47 (2.09)	3.34 (3.28)	3.16 (2.75)	2.75 (1.85)	3.48 (4.07)	1.91 (2.01)
PCE- Services	0.60 (2.86)	-2.49 (4.55)	-0.94 (2.37)	-2.36 (4.08)	-2.64 (4.04)	-3.76 (4.45)	-2.63 (5.40)	-0.97 (1.80)
BAN	0.01 (0.70)	0.01 (0.26)	-0.02 (1.45)	-0.06 (3.01)	-0.06 (2.96)	-0.04 (1.250)	-0.06 (3.95)	-0.003 (0.19)
CTV	$-9.12e^{4}$ (0.31)	$-2.73e^{3}$ (0.36)	$3.30e^{3}$ (0.60)	-0.01 (1.01)	$-2.76e^{3}$ (0.30)	$3.70e^{3}$ (0.31)	$-5.03e^{4}$ (.074)	0.01 (0.82)
CSE	$6.50e^{8}$ (0.13)	$3.10e^{6}$ (2.42)	$1.17e^{6}$ (1.25)	$1.08e^{6}$ (0.80)	$2.62e^{6}$ (1.72)	$1.68e^{6}$ (0.85)	$1.90e^{6}$ (1.67)	$-1.09e^{6}$ (0.86)
FLP	0.12 (0.43)	0.05 (0.07)	-0.11 (0.20)	0.18 (0.24)	0.94 (1.11)	1.86 (1.69)	-0.62 (.94)	-0.25 (0.35)
HPP	0.373 (2.440)	-0.865 (2.170)	-0.669 (2.300)	-1.111 (2.640)	-1.483 (3.110)	-1.754 (2.850)	-1.433 (4.040)	-0.104 (0.264)

[a] See Table B1 for definitions of the variables.

Table B3

ESTIMATES OF REGRESSION COEFFICIENTS FOR INSTRUMENTS
IN FIRST STAGE PRICE EQUATIONS

(Ratio of Parameter Estimate to Asymptotic Standard Error in Parentheses)

Exogenous Variables and Instruments[a]	Medium (i)							
	Direct Mail	Mag-azines	News-papers	Spot Radio	Network TV	Network Radio	Spot TV	Out-door
POST	0.02	-0.05	-0.08	-0.03	-0.08	-0.03	-0.01	-0.08
	(1.13)	(0.99)	(2.21)	(0.66)	(1.43)	(0.38)	(0.29)	(1.74)
PPIN	0.01	-0.05	0.15	-0.10	0.13	0.03	0.20	-0.04
	(0.24)	(0.37)	(1.47)	(0.68)	(0.75)	(0.15)	(1.59)	(0.31)
BRE	0.08	-0.06	-0.13	0.25	-0.08	-0.01	-0.20	0.11
	(1.03)	(0.28)	(0.85)	(1.15)	(0.30)	(0.04)	(1.09)	(0.53)
PCOG	0.10	-0.07	-0.03	-0.08	0.39	0.43	0.22	-0.16
	(1.43)	(0.34)	(0.21)	(0.40)	(1.85)	(1.57)	(1.42)	(0.89)
TVST	0.12	-0.02	0.08	0.29	-0.10	-0.28	-0.11	0.01
	(1.70)	(0.09)	(0.58)	(1.49)	(0.45)	(0.98)	(0.68)	(0.07)
AMRST	0.21	1.05	-0.03	0.41	0.75	1.48	1.49	-0.32
	(0.93)	(1.78)	(0.08)	(0.65)	(1.06)	(1.62)	(2.84)	(0.55)
MCAP	-0.10	0.63	0.36	0.37	0.39	0.85	0.63	0.31
	(1.58)	(3.81)	(2.99)	(2.12)	(1.96)	(3.34)	(4.32)	(1.93)
NCAP	0.13	-0.53	-0.23	-0.40	-0.53	-1.06	-0.73	-0.18
	(2.06)	(3.24)	(1.92)	(2.310	(2.74)	(4.21)	(5.06)	(1.10)

[a] See Table B1 for definitions of the variables.

Table B4

PRICE EQUATION SUMMARY FIT STATISTICS

	Direct Mail	Mag-azines	News-papers	Spot Radio	Net-work TV	Net-work Radio	Spot TV	Out-door
R^2 (adjusted)	.99	0.98	0.93	0.98	0.93	0.97	0.95	.89
Standard Error of Estimates	.01	.01	.01	.01	.02	.02	.01	.01
Durbin-Watson	2.10	1.98	1.89	1.82	1.94	2.01	2.49	1.94

APPENDIX C

ANALYSIS OF MORISHIMA RELATIVE EXPENDITURE SHARE ELASTICITIES

The magnitudes of own- and cross-price elasticities have implications for the patterns of influence occurring among a set of media as a result of changes in their relative prices. These interdependencies were investigated by calculating the Morishima elasticity of substitution for relative expenditure shares and relative prices, (M_{ij}), defined as (Blackorby and Russell 1981, 1989):

$$M_{ij} \equiv \left. \frac{\partial \ln (S_j / S_i)}{\partial \ln (P_j / P_i)} \right|_{\substack{A, Z \text{ and} \\ P_j \text{ fixed } (j \neq i)}} = 1 + E_{ii} - E_{ij} \qquad \text{(C1)}$$

The Morishima relative share elasticity (M_{ij}) answers the following question: How sensitive is the *share* of total advertising expenditures realized by media j *relative* to the share obtained by medium i, given a small change in the *relative prices* due to an action taken by i, *ceteris paribus*? It is apparent from (C1) that the sign and magnitude of M_{ij} depend upon the sign and magnitude of the relevant own- (E_{ii}) and cross-price elasticities (E_{ij}).

In particular, the value taken by M_{ij} reflects (a) whether demand for medium i is elastic or inelastic, and (b) whether medium i and j are substitutes or complements. When M_{ij} is zero, medium j's share relative to that of i is *independent* of a change in their relative prices initiated by i. When i and j are *substitutes*, non-zero values of M_{ij} indicate that j's share position relative to that of i is *vulnerable* to a change in their relative prices initiated by i. When i and j are *complements*, non-zero values of M_{ij} indicate that j's share position relative to that of i is *co-dependent* on changes in their relative prices initiated by i.

Table C1 presents the possible combinations of inelastic/elastic demand conditions and substitute/complement relationships as a 2 x 2 matrix. Each of the four cells of Table C1 may be further split according to whether M_{ij} is greater than or less than zero. When a pair of media are price substitutes (upper half of Table C1), negative values of M_{ij} denote *strong substitutability* in the sense that the magnitude of the cross-price elasticity exceeds the extent of inelasticity (elasticity), i.e., $E_{ij} > (1 + E_{ii})$. *Positive* values of M_{ij} indicate *weak substitutability* in the sense that the magnitude of the cross-price elasticity is less than the extent of inelasticity (elasticity), i.e., $E_{ij} < (1 + E_{ii})$. Similarly, for media pairs that are complements (lower half of Table C1), the sign of M_{ij} distinguishes instances of *weak complementarity* ($M_{ij} > 0$) from those of *strong complementarity* ($M_{ij} < 0$).

****

INSERT TABLE C1 HERE

****

Morishima elasticities were estimated for each year of the 1961-1994 study period. Mean values and the corresponding mean ratios to their asymptotic standard errors are presented below in Table C2. Table C1 summarizes how the incidence and magnitude of the mean values of the Morishima elasticities for the various media pairs vary across the combinations of own- and cross-price elasticity conditions defined by the six relevant cells of the table.

Consider first the case of the substitutes in the upper half of Table C1. That weak substitutability was more prevalent than strong substitutability is indicated by the positive mean Morishima elasticities for 18 of the 32 pairs. Nine of the fourteen cases of strong substitutability ($M_{ij} < 0$) accompanied inelastic demand, which was to be expected, newspapers being the only medium for which demand was elastic.[11] [22] For each instance of strong substitutability, we tested the null hypothesis that $M_{ij} = 0$ and found that for only seven of the fourteen M_{ij}'s, could the latter hypothesis be rejected at the .05 level (one-tail test). These seven cases of "significant strong substitutability" are listed below in Table C3.

Given that direct mail and newspapers are the two media that were predominantly substitutes, it is not surprising that direct mail was the source of influence or "clout" in three of the seven cases of significant strong substitution, newspapers played a similar role in the other two cases.

Table C3 also displays the value of the Morishima elasticity for the reciprocal relationship (M_{ji}) for each of the seven cases of strong substitutability. A reciprocal substitute relationship was designated as "independent" when the null hypothesis that $M_{ji} = 0$ could not be rejected at the .05 level (one-tail test). The resulting classification of the reciprocal M_{ji}'s is presented in the last column of Table C3.

Contrasting the pairwise values of M_{ij} and M_{ji} underscores the asymmetry of intermedia competition. For each of the seven cases, the reciprocal substitute relationship (M_{ji}) appears substantially weaker (i.e., either "weak" or "independent") than that of its strong counterpart (M_{ij}). Thus, the intermedia relationships identified in Table C3 are situations where one medium operates at a competitive advantage (disadvantage) relative to the other

It is apparent from the summary of the Morishima elasticities for cases in which media pairs are complements (lower half of Table C3) that the weak complementarity condition predominates (23 of 24 pairs of complements). All but one of the complementary relationships involved inelastic demand. That the market demand for only one of the eight media (newspapers) was elastic clearly restricted the possibilities for strong complementarities to be observed here.

Although it predominates over intermedia complementarity, intermedia substitutability tends to be weak as reflected in our analysis of the Morishima elasticities. The few cases of strong substitutability that were observed, seem to be characterized by asymmetric competition, the media most often involved being direct mail and newspapers. Weak complementarity was universally observed; no instances of significant strong complementarity appeared.

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[22] Quasi-concavity conditions on the advertising cost function (see equation (2) above) imply that $M_{ij} \leq 1$. For the complement/inelastic demand condition shown in Table C1, six of the 22 estimated M_{ij}'s exceeded unity. However, a one-tail test of the null hypothesis that $M_{ij} = 1$ could be rejected in only two of the six cases (at p=.05).

Table C1

MORISHIMA ELASTICITY OF SUBSTITUTION AS A FUNCTION OF OWN- AND CROSS-PRICE ELASTICITIES (1994 Estimates)

$$M_{ij} = \frac{\partial \ln (S_j / S_i)}{\partial \ln (p_j / p_i)} = 1 + E_{ii} - E_{ij} \qquad (9)$$

Cross-price Elasticity		**Own-price Elasticity**				Totals
		Inelastic $0 > E_{ii} > -1$		**Elastic** $E_{ii} \le -1$		
		$M_{ij} < 0$	$M_{ij} > 0$	$M_{ij} < 0$	$M_{ij} > 0$	
		$(1 + E_{ii}) < E_{ij}$	$(1 + E_{ii}) > E_{ij}$	$(1 + E_{ii}) < E_{ij}$		
		Strong Substitution	Weak Substitution	Strong Substitution		
Substitutes	Median	-0.44	+0.58	-0.32	Not Applicable	
$E_{ij} > 0$	(Range)	(-.05/-0.99)	(+0.004/+0.73)	(-0.21/-1.06)		
	Test: ($M_{ij} = 0$)					
	Do Not Reject	Independent 4	Independent 4	Independent 3	— -	11
	Reject[a]	Vulnerable 5	Vulnerable 14	Vulnerable 2		21
	Total No. ij Pairs	9	18	5		32
		$M_{ij} < 0$	$M_{ij} > 0$	$M_{ij} < 0$	$M_{ij} > 0$	
			$(1 + E_{ii}) > E_{ij}$	$(1 + E_{ii}) < E_{ij}$	$(1 + E_{ii}) > E_{ij}$	
			Weak	Strong	Weak	
		Not Applicable	Complementarity	Complementarity	Complementarity	
Complements	Median		+0.88	(-0.01)	(+0.21)	
$E_{ij} < 0$	(Range)		(+0.43/+2.32)			
	Test: ($M_{ij} = 0$)					
	Do Not Reject	— -	Independent 0	Independent 1	Independent 1	2
	Reject[a]		Co-Dependent 22	Co-Dependent 0	Co-Dependent 0	22
	Total No. ij Pairs		22	1	1	24
	TOTALS	9	40	6	1	56

[a]One tail test, $p \le .05$.

Table C2

MEAN VALUE OF ESTIMATES OF ANNUAL MORISHIMA SHARE ELASTICITY OF A SUBSTITUTION, 1961-1994
(Mean Ratio of Annual Elasticity to Annual Asymptotic Standard Error in Parentheses)

$$M_{ij} = \frac{\partial \ln (S_j / S_i)}{\partial \ln (P_j / P_i)}\Bigg| P_j \text{ fixed but } P_i \text{ var ies } (i \neq j)$$

	M_{ij} where j equals:							
M_{ij} where i equals:	Network TV	Networ k Radio	Spot TV	Spot Radio	News-Paper	Outdoor	Mag-azine	Direct Mail
Network TV		-0.08 (0.17)	0.57 (2.08)	0.97 (3.75)	0.43 (1.75)	1.50 (5.84)	-0.44 (2.22)	0.04 (0.02)
Network Radio	0.73 (24.26)		0.68 (20.62)	0.89 (13.24)	0. 73 (15.50)	+0.17 (2.04)	0.84 (22.22)	0.75 (29.60)
Spot TV	0.93 (3.36)	-0.45 (1.08)		0.47 (2.17)	0.35 (1.43)	0.98 (2.63)	0.89 (13.24)	0.63 (3.29)
Spot Radio	0.87 (5.74)	1.36 (4.83)	0.68 (4.44)		0.56 (3.61)	1.20 (6.21)	0.73 (3.90)	0.71 (4.68)
Newspaper	-0.01 (0.04)	-0.21 (0.40)	-0.32 (1.33)	-0.55 (2.16)		-1.06 (6.21)	0.21 (0.69)	-0.27 (1.09)
Outdoor	0.69 (25.38)	-0.51 (3.24)	0.62 (18.72)	0.79 (10.10)	0.42 (7.78)		.65 (17.57)	0.54 (31.67)
Magazine	0.14 (0.63)	2.32 (4.93)	0.83 (2.89)	0.59 (1.65)	1.11 (3.30)	1.19 (2.86)		0.64 (3.38)
Direct Mail	-0.33 (1.64)	0.58 (1.86)	-0.05 (0.30)	-0.15 (1.55)	-0.58 (2.91	-0.99 (3.72)	0.14 (0.71	

Table C3

SIGNIFICANT STRONG SUBSTITUTE RELATIONS

Substitute Relation		M_{ij} (i-->j) Influence i Exerts on j: Strong	Reciprocal Relation M_{ji} (j--> i) Influence j Exerts on i	
Inelastic Demand for Medium (i)				
Network TV (i)	-- Magazine (j)	-0.44	+0.14	Independent
Outdoor (i)	-- Network Radio (j)	-0.51	+0.17	Weak
Direct Mail (i)	--Network TV (j)	-0.33	+0.004	Independent
Direct Mail (i)	-- Newspaper (j)	-0.58	-0.27	Independent
Direct Mail (i)	-- Outdoor (j)	-0.99	+0.54	Weak
Elastic Demand for Medium (i)				
Newspaper (i)	-- Spot Radio (j)	-0.55	+0.56	Weak
Newspaper (i)	-- Outdoor (j)	-1.06	+0.42	Weak

APPENDIX D

CLASSIFYING NATIONAL ADVERTISING MEDIA BY MARKET STRUCTURE AND THE SHORT-RUN ELASTICITY OF SUPPLY

This appendix explains how the classification of media by market structure and short-run elasticity of supply presented in Table 4 was developed.

D.1 Short-Run Elasticity of Supply

Given the absence of empirical studies of this quantity, we resorted to a simple dichotomous categorization of the media based upon judgmental estimates of how expandable the amount of space or time available to advertisers was in the short-term, say a quarter. The short-run elasticity of broadcast media tends to be relatively low given that the numbers of stations and time slots are essentially fixed. Similarly, the supply of outdoor advertising space cannot be quickly expanded in the near term because of the restricted availability of suitable locations. In contrast, for print media, the elasticity of supply is comparatively greater since the amount of advertising space available within an issue or edition can be increased within a relatively short time frame.

D.2 Market Structure

We arrayed the eight media in Table 4 according to the levels of concentration prevailing in each category as indicated by published studies and evidence.* The newspaper industry is generally characterized as monopolistic, with 90% of the United State's 1,600 daily newspapers being the only papers published in their served markets and 85% of these papers owned by larger publishing or media firms (Picard 1993). However, the percentage of the industry's total revenue (circulation plus national and local advertising) accounted for by the four largest publishing firms was in 1995. Since the division of newspaper company revenues into circulation and advertising sources is not usually divulged, the four firm concentration level was calculated using total company and industry revenues as reported by the American Newspaper Association and Advertising Age. Network television remained a three-firm oligopoly for four decades until Fox formed a fourth network in 1990 (Owen and Wildman 1992), followed by two additional entries in 1994.

In contrast, radio networks are more numerous (72 were operating in 1995) and differentiated. However, concentration in the network radio market is high and increasing. As of 1996, the top three firms - ABC, CBS, and Westwood One - accounted for over 95% of network advertising revenues (ABC Network Radio Research). Following the early 1997 merger of Westwood and the CBS Radio Network, the industry will be a virtual duopoly. Overall, radio derives only about 20% of its advertising revenues from national (as opposed to local) advertisers. Further, 80% of spending on radio by national advertisers is spot rather than national (McDonough 1995). Spot radio markets are typically served by dozens of competing stations and, although the relaxation of regulations on multiple station ownership has been accompanied by an increase in concentration in recent years, the four largest ownership groups controlled only 12% of the industry's total revenue in 1995 (Noam 1996). Similarly, major spot television markets are generally served by several local television stations and the gradual

* See Gomery (1993) , Neuman (1991), and Picard (1989) for reviews of research on market structures in the media industries. Discussions of concentration levels in media industries typically rely on audience size and/or sales revenue as the relevant measure of size or output. Measures of the concentration of advertising volume and revenue have not been developed.

reduction of limits on nationwide ownership of stations has led to an increase in concentration over time. By 1995, the four largest ownership groups accounted for about 25% of television station revenues in the United States (Noam 1996).

A competitive market structure prevails in the national magazine advertising market, with 12 thousand titles being published. The largest publishers are diversified media firms; the four leading magazine publishers accounted for 25.9% of all magazine revenues in 1995 (Endicott 1996). Data from the Census of Service Industries showed that in 1992 outdoor advertising services were supplied by approximately 1,300 firms and the four firm concentration ratio was 31.2%. Direct mail services were available from almost 4,000 firms in 1992, with a four firm concentration ratio of 19.1%.