

The Substitutability of Network and National Spot Television Advertising

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The translog method is used to obtain estimates of the Morishima substitution elasticity between television network advertising and national spot television advertising. Dickey-Fuller and cointegration tests lead to a partially differenced system estimated via SUR. Confidence intervals for the estimates are derived by treating the time series of elasticity estimates as a realization from a stochastic process and applying an ergodic theorem after discussing a failed attempt to bootstrap the confidence intervals. We find that television network advertising and national spot television advertising are substitutes.

INTRODUCTION

In 1946 the Federal Communications Commission issued regulations prohibiting television licensees from entering into agreements that allow a television network to influence or control the rates the licensees can charge for nonnetwork advertising time. This regulation is based on the belief that some advertising time offered by affiliates (national spot advertising) competes with advertising time offered for sale by television networks (network advertising). In 1959 the Commission adopted a regulation that strengthened the rule further by prohibiting independently owned television affiliates from being represented by their networks in the sale of nonnetwork advertising time. The FCC expressed concern that even though networks were rarely involved in the national spot advertising representation business, that national spot advertising provided a mechanism through which networks could influence the spot advertising rates of their affiliates.

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At the time the latter rule was implemented the evidence that network advertising time and national spot advertising time were substitutes for each other consisted of statements of advertisers, advertising sales representatives, television licensees, and television networks. Since then many briefs submitted to the FCC have contained *ad hoc* regressions or correlation analyses purporting to demonstrate substitutability. On the basis of such anecdotal evidence some studies (FCC's Network Inquiry Special Staff Study, 1980; Owen, Beebe, and Manning, 1974; and Owen and Wildman, 1992) have asserted the substitutability of network and national spot television advertising. To date, however, no formal econometric study of this question has been conducted. Seldon and Jung (1993) thoroughly investigate the substitutability of advertising among various media (e.g., television and print) but they do not disaggregate television into network and national spot components.

This issue recently has increased in importance. The FCC currently is considering the continued necessity of rules restricting network involvement in the national spot advertising rates and sales of their affiliates. In addition, the Telecommunications Act of 1996 has raised national television ownership limits, thereby allowing a television broadcast network to own an unlimited number of stations in the national market as long as the stations reach no more than 35 percent of television households in the aggregate.¹ If networks choose to increase their station portfolios, the potential competitive impact on the advertising market will be of interest. Crucial to this analysis will be an accurate measurement of the degree to which the acquiring and acquired firms compete.

Because we expect the question to recur in future FCC proceedings, it is important that a formal basis for the assertion of substitutability be established. In the usual fashion, we employ the translog methodology to estimate the elasticity of substitution between network and national spot advertising. In this particular application of the translog, the cost function contains no parameters of interest and is not included in the estimated system. We consider the asymmetric Morishima elasticity of substitution rather than the more commonly-used symmetric Allen elasticity because symmetry is not a natural property of an elasticity of substitution when the curvature of the isoquant depends on the direction in which prices change (Blackorby and Russell, 1989). The Morishima elasticity has been used by Seldon and Jung (1993), Thompson and Taylor (1995), and Davis and Gauger (1996), among others.

In contrast to most translog studies, we check to ensure that the levels of the variables are not cointegrated and that we perform estimation on stationary variables, thus avoiding attendant problems of failure of the estimators to converge to their true values. Also in contrast to typical translog studies that evaluate elasticities only at one point, we estimate elasticities over the entire sample. Given the fluid nature of some markets, it is possible that in some years network and national spot advertising act as substitutes and in other years as complements. If network and national spot advertising are substitutes some years and complements others, the policy implications are different than if they are substitutes for all years or complements for all years.

¹ The *duopoly rule* effectively precludes owning more than one television station in a local market; 47 CFR §73.3555(b).

Because the Morishima elasticities are nonlinear functions of estimated parameters, derivation of confidence intervals is problematic. An approach that previously has been used in this context, Efron's bootstrap (1979, 1982), fails. We briefly examine this failure. As point estimates without confidence intervals are meaningless, we propose a novel method of obtaining confidence intervals for elasticity estimates from a translog system. We appeal to ergodicity and an ergodic theorem to derive confidence intervals by treating the sequence of estimated substitution elasticities as a realization of a stochastic process. We find that network advertising and national spot advertising are substitutes.

THE MODEL AND THE DATA

Assume the existence of a twice differentiable aggregate sales function that expresses the quantity sold, Y , as a function of the number of advertising messages, X , in the various media. Dual to this sales function is a cost function, so the producer's problem is to minimize the cost of advertising subject to the constraint that at least some number of units of output, Y , are sold:

$$(1) \min_x X \cdot P \text{ such that } Y = \Psi(X)$$

where:

P = The price of messages in the media.

Such a cost function leads to a nonhomothetic translog production function, and application of Shephard's Lemma yields the traditional share equations:

$$(2) S_i = \alpha_i + \sum_j \beta_{ij} \cdot \ln P_j + \gamma_{qi} \cdot \ln Q_t + \varepsilon_{it}$$

for sectors $j = 1, \dots, J$ and time periods $t = 1, \dots, T$.

We have three sectors of interest: network television advertising, N , national spot television advertising, S , and a composite of all other advertising forms, C . Imposing homogeneity of input prices and the symmetry conditions ($\gamma_{NS} = \gamma_{SN}$, $\gamma_{NC} = \gamma_{CN}$, $\gamma_{SC} = \gamma_{CS}$), dropping the share equation for C , and appending error terms yields the estimable system:

$$(3) S_N = \alpha_N + \gamma_{NN} \cdot \ln \frac{P_N}{P_C} + \gamma_{NS} \cdot \ln \frac{P_S}{P_C} + \gamma_{NY} \cdot \ln Y + \varepsilon_N$$

$$(4) S_S = \alpha_S + \gamma_{SS} \cdot \ln \frac{P_S}{P_C} + \gamma_{SN} \cdot \ln \frac{P_N}{P_C} + \gamma_{SY} \cdot \ln Y + \varepsilon_S$$

where $\varepsilon = [\varepsilon_N \ \varepsilon_S]$ and $\varepsilon \varepsilon' = \Sigma$. The cost-per-thousand indices for N , S , and C represent P_N , P_S , and P_C , while Y is GNP. As our primary concern is substitution elasticities, not returns to scale, and estimation of the former is not contingent upon estimation of the latter, the cost function is not included in the system. This has the added advantage of conserving considerable degrees of freedom.

The Allen partial elasticities of substitution estimates are given by:

$$(5) \hat{\sigma}_{ii}^A = \frac{(\hat{\gamma}_{ii} + S_i^2 - S_i)}{S_i^2}$$

and

$$(6) \hat{\sigma}_{ij}^A = \frac{(\hat{\gamma}_{ij} + S_i - S_j)}{S_i - S_j} \quad \forall i \neq j$$

While the Allen elasticities do not provide information on the questions at hand, they are useful in calculating the measures of interest, the Morishima elasticity of substitution, and the price elasticity of demand. The price elasticities of demand can be calculated as:

$$(7) \hat{\eta}_{ij} = S_j - \hat{\sigma}_{ij}^A$$

and the Morishima elasticities of substitution can be calculated as:

$$(8) \hat{\sigma}_{ij}^M = S_j - (\hat{\sigma}_{ij}^A - S_j - \hat{\sigma}_i^A)$$

The asymmetry of the Morishima elasticity becomes apparent when it is recognized that σ_{ij}^M measures curvature of the isoquant in the direction of the i -th price holding the j -th price constant, while σ_{ji}^M allows the j -th price to vary while holding the i -th price constant.

Unlike the Allen cross elasticities, Morishima cross elasticities are not constrained to be equal. The parameter σ_{ns}^M measures the curvature of the isoquant when changes in the price ratio between network and national spot advertisements are solely a result of a change in the price of network advertisements, while σ_{sn}^M measures the curvature when a change in the price ratio is due to changes in the price of national spot advertisements. Again the asymmetry becomes apparent when it is recognized that while the change in the price ratio between network and national spot prices is not sensitive to which price changes, the change in the price ratios between the composite advertising good and network and national spot advertising prices will differ depending on whether network or national spot price changes. Because of this asymmetry, one wonders which is the correct substitution elasticity: σ_{sn} or σ_{ns} ? As with any non-CES elasticity, the answer depends upon the prevailing prices and institutional knowledge of the relevant industry: Which prices are more likely to change and which prices are more likely to remain constant?

An estimate of γ_{ns} from equations (3) and (4) together with the dependent variables enables calculation of the Morishima elasticities for a given year. Equations (5) and (6) highlight the difficulty of determining confidence intervals for the estimated elasticities. The estimated coefficients are random variables, and the shares, as dependent variables, are random by definition and cannot be treated as fixed. Thus the elasticities, are (nonlinear combinations of) sums and differences of ratios of random variables. Obtaining confidence intervals is not straightforward.

The data for this exercise were provided by Mr. Robert Coen who tracks media advertising expenditure for McCann-Erickson in New York City. For the years 1960 to 1994 the categories for advertising expenditure are: Newspapers, national and local; Magazines, weeklies, women's, and monthlies; Farm Publications; Television, network, local spot, national spot, cable network, and cable non-network; Radio, network, local spot, and national spot; Direct Mail; Business Papers; Outdoor, local and national; and Miscellaneous, local and national. Cost-per-thousand indices are on a slightly more aggregated level: Newspapers, Magazines, Network TV, Cable TV, Spot TV, Network Radio, Spot Radio, Outdoor, and Direct Mail. Expenditure and cost data for network TV and national spot TV are used for S_N and S_S , respectively. The others are combined using a Divisia index to form composite expenditure and composite cost indices representing all other forms of advertising.

ESTIMATION

The theoretical translog model is specified in levels, not first differences. Accurate estimation of the parameters requires that the estimation procedure satisfy conditions such as stationarity of variables and a finite covariance matrix. If the levels of the variables are not stationary, then the traditional asymptotic results for convergence of estimators are not applicable. Regressions involving nonstationary, non-cointegrated variables are subject to the spurious regression phenomenon (Granger and Newbold, 1974; see Bannerjee, *et al.* 1993, ch. 3 for an extended discussion of this point). On the other hand, if the variables are not cointegrated, then regressing first differences to induce stationarity will not lead to estimates of the parameters of interest because the model is specified in terms of levels. Partial differencing, however, can lead to accurate estimation of the parameters of a model specified in levels. If the levels of the variables are nonstationary and cointegrated, then even partial differencing is inappropriate. Therefore, these matters must be considered with caution to ensure accurate estimation of the parameters of interest.

Graphical representations of the data suggest, and Dickey-Fuller unit root tests confirm, that the variables S_N and S_S are stationary while the variables $\ln(P_N/P_C)$, $\ln(P_S/P_C)$, and $\ln(Y)$ are not.² A cointegrating regression of the three nonstationary variables indicates that the variables are not cointegrated; therefore a partial differencing approach is in order.³ Choice of the partial-differencing parameter naturally suggests itself, as SUR (seemingly unrelated regressions) estimation on the levels of equations (3) and (4) produce Durbin-Watson statistics that indicate autocorrelated errors in both equations; we choose the partial differencing parameter to ensure white noise errors, i.e., we employ the Cochrane-Orcutt procedure. The model to be estimated is:

$$(9) \tilde{S}_N = \alpha_N + \gamma_{NN} \tilde{V}_N + \gamma_{NS} \tilde{W}_N + \gamma_{NY} \tilde{X}_N + \tilde{\epsilon}_N$$

$$(10) \tilde{S}_S = \alpha_S + \gamma_{SS} \tilde{W}_S + \gamma_{NS} \tilde{V}_S + \gamma_{SY} \tilde{X}_N + \tilde{\epsilon}_S$$

² Augmented Dickey-Fuller F test statistics for the null of a unit root with rejection signified by an asterisk are $\ln(P_N/P_C) \rightarrow 2.95$; $\ln(P_S/P_C) \rightarrow 4.07$; $\ln(Y) \rightarrow 2.80$; $S_N \rightarrow 24.4^*$; $S_S \rightarrow 13.8^*$.

³ Dickey-Fuller t-test statistics applied to the residuals of the following pairwise cointegrating regressions are $\ln(P_N/P_C)$ and $\ln(P_S/P_C) \rightarrow 1.3$; $\ln(P_N/P_C)$ and $\ln(Y) \rightarrow 1.5$; $\ln(P_S/P_C)$ and $\ln(Y) \rightarrow 1.2$.

where:

$$\tilde{S}_N = (1 - \rho_N)S_N \text{ and } \tilde{S}_s = (1 - \rho_s)S_s$$

$$\tilde{V}_N = (1 - \rho_N)\ln\frac{P_N}{P_c} \text{ and } \tilde{V}_s = (1 - \rho_s)\ln\frac{P_s}{P_c}$$

$$\tilde{W}_N = (1 - \rho_N)\ln\frac{P_s}{P_c} \text{ and } \tilde{W}_s = (1 - \rho_s)\ln\frac{P_s}{P_c}$$

$$\tilde{X}_N = (1 - \rho_N)\ln Y \text{ and } \tilde{X}_s = (1 - \rho_s)\ln Y$$

In this system, ρ_N and ρ_s are estimated from the residuals of SUR estimation on equations (3) and (4), respectively. Kmenta (1986, §8.3) shows that the coefficients of the partially differenced model correspond to the parameters of interest.

The Prais-Winsten transformation of the first observation is not effected, because the resultant first observation becomes a decided outlier for each variable. Hence, regression will be on years 1961 through 1994. Dickey-Fuller tests show that the partial differencing due to the AR(1) correction renders the transformed variables stationary.⁴ Hence, consistent parameter estimates are available. Because the Oberhoffer-Kmenta (1974) conditions are not fulfilled for the Cochrane-Orcutt/SUR combination, there are no gains to iteration. Results of SUR estimation of (9)-(10) are as follows:

$$(11) \quad \tilde{S}_N = 0.0684 + 0.0124\tilde{V}_N - 0.0004\tilde{W}_N - 0.0273\tilde{X}_N$$

(2.89) (1.20) (-0.06) (-1.91)

$$R^2 = 0.11$$

$$(12) \quad \tilde{S}_s = 0.0098 - 0.0474\tilde{W}_s - 0.0004\tilde{V}_s - 0.0066\tilde{X}_s$$

(0.61) (-3.58) (-0.06) (-1.13)

$$R^2 = 0.32$$

with t-statistics in parentheses. As is not uncommon in translog models, the individual coefficients are not all significant and the coefficients of determination for the individual equations are not high, but McElroy's (1987) system R^2 measure is 0.977. Further, the substitution elasticities, presented in Table 1, all are significant. In addition, we note that the estimated own-price elasticities, presented in Table 2, all are negative. A positive own-price elasticity would constitute *prima facie* evidence of model misspecification.

The point estimates for σ_{Ns}^M and σ_{sN}^M indicate that network and national spot advertising messages appear to be substitutes. Point estimates for σ_{Ns}^M range from a high of 0.48 in 1982 to a low of 0.24 in 1961. Point estimates for σ_{sN}^M range from a low of 0.87 in 1961 to a high of 0.90 in 1980. The estimated cross-price elasticities range from 0.056 to 0.129, further reinforcing the impression that the two forms of advertising are substitutes.

⁴ Dickey-Fuller t-test statistics applied to the transformed variables are as follows (asterisk denotes rejection of the null hypothesis): S_N -- 26.46*; V_N -- -40.3*; W_N -- -34.6*; X_N -- -43.7*; S_s -- -36.6*; V_s -- -35.7*; W_s -- -30.0*; X_s -- -19.7*

Table 1—Estimated Values of the Morishima Elasticity of Substitution

Year	σ_{NS}^M	σ_{SN}^M	Year	σ_{NS}^M	σ_{SN}^M
1961	0.872	0.249	1978	0.898	0.435
1962	0.878	0.314	1979	0.901	0.424
1963	0.878	0.348	1980	0.902	0.442
1964	0.881	0.389	1981	0.899	0.448
1965	0.883	0.405	1982	0.899	0.477
1966	0.886	0.413	1983	0.897	0.460
1967	0.889	0.405	1984	0.900	0.450
1968	0.887	0.444	1985	0.890	0.460
1969	0.890	0.462	1986	0.886	0.469
1970	0.889	0.451	1987	0.880	0.452
1971	0.877	0.373	1988	0.880	0.434
1972	0.878	0.391	1989	0.874	0.426
1973	0.880	0.377	1990	0.879	0.438
1974	0.883	0.389	1991	0.878	0.400
1975	0.887	0.411	1992	0.882	0.414
1976	0.891	0.470	1993	0.876	0.402
1977	0.899	0.421	1994	0.874	0.434

σ_{NS}^M = The Morishima elasticity of substitution that measures the curvature of the isoquant when changes in the price ratio between network and national spot advertisements result solely from a change in the price of network advertisements

σ_{SN}^M = A measure of the curvature of the isoquant when changes in the price ratio between network and national spot advertisements are due solely to a change the price of national spot advertisements

Point estimates without confidence intervals are meaningless, as there is no indication of the variability likely to be associated with the estimate. Interpreting point estimates without confidence intervals, though frequently done, is an unfounded conjecture. Even a point estimate that is large from an economic point of view may not be statistically different from zero. For example, Koshal, Shukla, and Koirala (1992) estimate a long-run supply elasticity to be 25.50 and conclude, without benefit of statistical testing, that the long-run supply is elastic. Vinod and McCullough (1994) calculate a 95 percent bootstrap confidence interval of [-145.4, 169.7] for that elasticity: the elasticity is not significantly different from zero. Derivation of confidence intervals in this application, however, is problematic.

DERIVATION OF CONFIDENCE INTERVALS

The usual method for estimating confidence intervals for ratios, the delta method, cannot be applied to the translog model. As an alternative, some researchers make assertions about the parameter value based on the point estimate, the danger of which we already have noted. Other researchers calculate standard errors as if random variables were fixed constants instead of random variables; however, such confidence intervals are inconsistent, tending to produce standard errors that are too small. Efron's (1979, 1982) bootstrap has been employed with success in the translog context by Krinsky and Robb (1991) and Kelly and Buono (1993). Unfortunately, in this particular case the bootstrap fails, and this failure merits brief mention as a caution against rote application of the bootstrap without carefully examining the results to see if they make sense. An algorithm for bootstrapping a regression equation and associated details are in McCullough and Vinod (1993).

Table 2—Estimated Values of the Allen Elasticity of Substitution and the Price Elasticity of Demand

Year	σ_{NS}^A	σ_N^A	σ_S^A	η_{NS}	η_{SN}	η_N	η_S
1961	0.927	-8.176	-2.638	0.088	0.056	-0.774	-0.160
1962	0.936	-7.563	-2.987	0.096	0.059	-0.776	-0.189
1963	0.944	-7.199	-3.584	0.102	0.066	-0.777	-0.243
1964	0.947	-7.232	-3.817	0.102	0.069	-0.777	-0.279
1965	0.951	-7.094	-4.033	0.104	0.074	-0.777	-0.314
1966	0.953	-6.995	-4.101	0.106	0.076	-0.777	-0.328
1967	0.955	-6.775	-4.134	0.110	0.078	-0.777	-0.336
1968	0.956	-6.578	-4.103	0.113	0.077	-0.777	-0.329
1969	0.958	-6.722	-4.220	0.111	0.082	-0.777	-0.362
1970	0.960	-6.569	-4.253	0.113	0.085	-0.777	-0.377
1971	0.959	-6.650	-4.235	0.112	0.083	-0.777	-0.368
1972	0.948	-7.336	-3.960	0.100	0.072	-0.777	-0.301
1973	0.950	-7.244	-4.046	0.102	0.074	-0.777	-0.317
1974	0.950	-7.107	-3.977	0.104	0.073	-0.777	-0.304
1975	0.952	-6.950	-4.035	0.106	0.074	-0.777	-0.315
1976	0.955	-6.760	-4.122	0.110	0.077	-0.777	-0.333
1977	0.961	-6.499	-4.263	0.115	0.087	-0.776	-0.384
1978	0.961	-5.997	-4.156	0.124	0.079	-0.775	-0.342
1979	0.961	-6.021	-4.198	0.124	0.081	-0.775	-0.354
1980	0.962	-5.849	-4.164	0.127	0.079	-0.774	-0.344
1981	0.963	-5.768	-4.214	0.129	0.082	-0.773	-0.360
1982	0.962	-6.054	-4.230	0.123	0.083	-0.775	-0.366
1983	0.964	-6.031	-4.270	0.124	0.088	-0.775	-0.390
1984	0.963	-6.098	-4.248	0.122	0.085	-0.775	-0.375
1985	0.963	-5.888	-4.232	0.127	0.084	-0.774	-0.367
1986	0.960	-6.556	-4.249	0.114	0.085	-0.776	-0.375
1987	0.959	-6.812	-4.261	0.109	0.086	-0.777	-0.383
1988	0.955	-7.189	-4.236	0.103	0.083	-0.777	-0.369
1989	0.954	-7.179	-4.197	0.103	0.080	-0.777	-0.354
1990	0.951	-7.536	-4.175	0.098	0.079	-0.776	-0.347
1991	0.954	-7.222	-4.207	0.103	0.081	-0.777	-0.357
1992	0.950	-7.294	-4.081	0.101	0.075	-0.777	-0.324
1993	0.953	-7.032	-4.135	0.105	0.078	-0.777	-0.337
1994	0.950	-7.435	-4.092	0.099	0.076	-0.776	-0.326

σ_{NS}^A = Allen cross-elasticity of substitution between network and national spot advertising

σ_N^A = Allen elasticity of substitution of network advertising

σ_S^A = Allen elasticity of substitution of national spot advertising

η_{NS} = Cross-price elasticity of demand when the price of network advertising is allowed to change

η_{SN} = Cross-price elasticity of demand when the price of national spot advertising is allowed to change

η_N = Price elasticity of demand for network advertising

η_S = Price elasticity of demand for national spot advertising

Our 95 percent bootstrap confidence intervals for σ_{NS}^M were wide; they include the origin for each year. *Prima facie*, this may lead one to conclude that σ_{NS}^M is not significantly different from zero. If this were true, however, we would expect to see estimates of σ_{NS}^M above and below zero, while in fact all the estimated values of σ_{NS}^M are above zero. If σ_{NS}^M were equal to zero, what is the probability that all 34 estimates would be above zero? Heuristically, on the assumption that the sequence of substitution elasticities is uncorrelated, this is easily seen to be $(1/2)^{34} \approx 0$. Of course, the sequences are not independent; the first order autocorrelations for the estimates of σ_{NS}^M and σ_{SN}^M are 0.6 and 0.8, respec-

tively. An *equivalent degrees of freedom* argument (Newton, 1988, p. 162) shows that the probability of observing all positive estimates is zero even for these correlated sequences. Thus, we do not believe the bootstrap result that the parameters equal zero.

Further evidence that the bootstrap has failed is that the bootstrap confidence intervals (which are conditional) are 14 times as wide as the intervals estimated via the ergodic theorem (which are unconditional). The explanation for this phenomenon is simple. When estimating a ratio, the bootstrap can fail if the denominator fluctuates too much relative to the numerator (Hall, 1992, §3.10). The Morishima elasticity [equation (7)] can be rewritten as a ratio, and we find that the denominator has a much higher variance than the numerator. This corresponds to a situation where scale cannot be stably estimated; thus, the bootstrap cannot be applied (Hall, 1992, p. 14). This study serves as a cautionary warning against rote application of the bootstrap methodology. A new approach to deriving confidence intervals for substitution elasticities is needed.

Most translog studies evaluate elasticities at a single point, such as the mean values of the independent variables for a cross-sectional study, or a single point in time, for example the midpoint of the series, for a time series. To obtain statistically valid results in this case, we treat the sequence of substitution elasticities as a realization from a stochastic process rather than concentrating on a single point. Dickey-Fuller tests indicate that the sequences of substitution elasticities are stationary.⁵ If a strictly stationary stochastic process is ergodic, then the time average for a realization converges to the mean at a point in time as the sample size increases. Thus, we can apply an ergodic theorem to obtain confidence intervals. Mathematically:

Definition: (Spanos, 1986, p. 143) A second order stationary stochastic process $\{X(t): t \in \mathbb{T}\}$, $t = 0, 1, 2, \dots$ is *ergodic* if

$$\lim_{t \rightarrow \infty} \frac{1}{t} \sum_{\tau=0}^{t-1} \text{COV}(X(t)X(t+\tau)) \rightarrow 0$$

Ergodic theorems state what type of information about the mean at a point in time can be inferred from the mean over time. In particular, we appeal to the following:

Theorem: (White, 1984, p. 42) Let $X(t)$ be a stationary ergodic sequence with $E[X(t)] < \infty$. Then

$$\frac{1}{N} \sum X \rightarrow E[X(t)]$$

Thus, we can use the mean over time to represent the mean of the process at a point in time. Assuming finite fourth moments we also can calculate confidence intervals for the mean.

Figure 1 graphs σ_{SN}^M with its mean (= 0.866) and 95 percent interval. The series appears ergodic. Figure 2 graphs σ_{NS}^M with its mean (= 0.417) and 95 percent confidence interval. From 1964 onward the series is ergodic. By any interpretation, the

⁵ Dickey-Fuller t-test statistics are $s_{SN}^M = -6.7^*$; $s_{NS}^M = -10.2$

Figure 1— σ_{SN}^M Spot for Network Morishima Substitution Elasticity With Mean and 95 Percent Confidence Interval

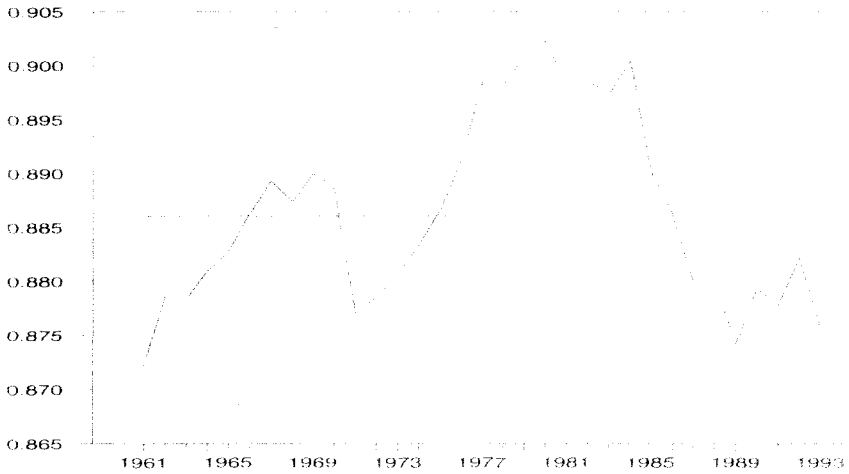
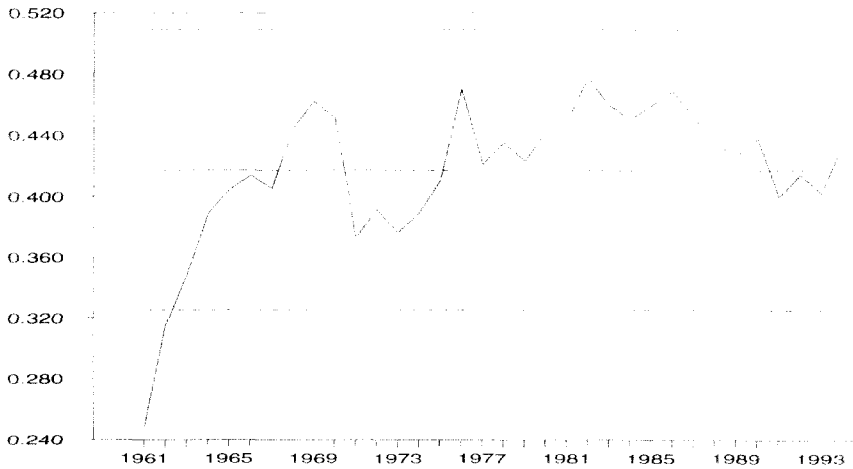


Figure 2— σ_{Ns}^M Network for Spot Morishima Substitution Elasticity With Mean and 95 Percent Confidence Interval



confidence intervals produced by the ergodic theorem suggest that both elasticities of substitution are positive over the period in question and, hence, are substitutes. The confidence intervals do not overlap, suggesting that $\sigma_{SN}^M > \sigma_{NS}^M$.

IMPLICATIONS OF THE RESULTS

The substitution elasticities suggest that network and national spot advertisements have been, and continue to be, good substitutes in the aggregate. Table 2 presents the point estimates of the price elasticities of demand for the inputs to the estimated cost functions. The point estimates of the cross-price elasticities allow us to further refine our examination of the degree to which network and national spot advertisements compete in the advertising marketplace. In 1994 the cross-price elasticity between network and national spot advertising was 0.1, while that between national spot and network advertising was 0.08. The influence of national spot rates on network advertising sales is relatively minor when compared to the own-price elasticity of demand of 0.78. Comparing this impact with the influence of network ad rates on national spot advertising sales, we see that the own-price elasticity of demand for national spot advertising was 0.33.

One of the traditional arguments used to support many of the FCC regulations governing the relationship between a network and its affiliates has been that networks possess undue bargaining power. While our results cannot address the issue of bargaining power between an individual network and an affiliate, we can address one facet of the bargaining relationship between these two segments of the broadcast industry. One of the ways in which parties in a bargaining relationship will interact is through threats and forays into their opponents' territories or markets. The estimated elasticities allow us to examine the ability of networks, as a group, to affect the revenues of the sellers of national spot advertising through strategic price changes. Our results suggest that a strategic 1 percent decrease in 1994 to the price of network advertisements would have led to a 0.1 percent hit on affiliate's spot revenues, but a 0.2 percent loss in network advertising revenues. Networks would have had to forego \$25 million in order to impose \$9 million in costs on their affiliates.⁶ These estimates indicate that networks are unable to credibly impose any costs on their affiliates through strategic pricing actions in the national advertising market.

An equivalent calculation can be used to examine the thesis that led to the promulgation of the ban on networks representing their affiliates in the sale of national spot advertising time. Under the scenario hypothesized at the time, networks collectively would force their affiliates to raise national spot rates to shift purchasers toward network advertisements. cursory examination of the estimated price elasticity of demand for national spot advertising indicates that it is inelastic. Consequently, an increase in national spot prices will increase revenues to sellers of national spot advertisements, thus benefiting, not harming, both affiliates and independents. This result calls into question the basis of concerns that a cartel of networks would be able unilaterally to impose disadvantageous national spot advertising rates on their affiliates.

⁶ These estimates are based on network television advertising revenues of \$10,942 million and national spot revenues of \$8,993 million in 1994.

While our results alleviate concern over the undue bargaining power of networks, they do suggest an additional area of concern. Because the two forms of television advertising appear to be substitutes, there are incentives for sellers to reach cooperative outcomes that benefit both parties at the expense of advertisers. Given that there are 1,176 commercial television stations in the U.S. with 452 distinct owners (BIA, 1997) the possibility of such cooperation may seem to be of minor concern. Network affiliates are in constant contact with their networks as they discuss programming, scheduling, and promotional issues, however. This contact may facilitate the exchange of information that could lead to cooperative outcomes. Because limiting the communication between networks and affiliates destroys the inherent benefits of network television, the importance of fostering the development of additional television networks and unaffiliated broadcast stations is evident.

Finally, we observe that the price elasticities of demand (given in the final two columns of Table 2) are relatively constant. We note that there is little indication of major shifts in the elasticity of demand for national spot advertisements or in the cross-price elasticities that could be interpreted as evidence of the encroachment of network sectionals into the national spot advertising market. Whether this is due to the youthfulness of the product or to the preferences of advertisers, we cannot tell.

CONCLUSIONS

Whether network television advertising and national spot television advertising are relevant substitutes is an important policy question. If networks can exert sufficient influence on national spot prices by changing their own prices, then repeal of some regulations may be contraindicated. We estimate the Morishima substitution elasticities using a translog specification. Recognizing the importance of obtaining accurate confidence intervals to determine whether these elasticities are nonzero, we first attempt a bootstrap. While the bootstrap has been used successfully with a translog model, the bootstrap fails for this particular data set; we advise against rote application of the bootstrap. We appeal to an ergodic theorem for derivation of confidence intervals and conclude that network and national spot advertising are substitutes. We investigate the policy implications of this substitutability and find that the networks have little incentive to engage in predatory behavior vis-à-vis their affiliates, although there may be cause for concern about cooperative arrangements between networks and their affiliates.

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