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I. Introduction 1/

The effect of oligopolistic collusion on profits and the effectiveness of antitrust conduct remedies against such collusion are important industrial organization and policy issues. Yet our understanding of these relationships remains incomplete. To the question, "Does price-fixing enhance profits?", Elzinga (1983, p. 16) suggests two answers: an "introductory economics course" answer, "Yes", and a "more advanced undergraduate" answer, "No, supracompetitive profits will be dissipated through cheating, non-price competition, or rent seeking." In his contracting approach to oligopoly, Williamson concludes (1975, pp. 246-247):

> "Except...in highly concentrated industries producing homogeneous products, with nontrivial barriers to entry, and at a mature stage of development, oligopolistic interdependence is unlikely to pose antitrust issues for which dissolution is an appropriate remedy. In the usual oligopoly situation, efforts to achieve collusion are unlikely to be successful or, if they are, will require sufficient communication that normal remedies [original emphasis] against price fixing, including injunctions not to collude, will suffice.
>
> Where, however, the industry is of the special sort just described, recognized interdependency may be sufficiently extensive to permit tacit collusion to succeed. Injunctive remedies, as Turner noted, are in such circumstances unsatisfactory (1962, p. 669). Accordingly, dissolution ought to be considered."

Relatively few empirical studies have examined either the impact of conspiracy on profitability, or the effectiveness of antitrust intervention (see Scherer 1980, pp. 276-77). In one of these studies, Asch and Seneca (1976) looked at a sample of 51 firms that were found guilty of, or that pleaded nolo contendere to, Sherman Act conspiracy charges during 1958-67. When these companies were compared to a random sample of 50 other firms, the

authors found (to their surprise) that the conspiring firms were less profitable than those in the control group, other things equal. In another study, Sultan observed a positive but insignificant relationship between price fixing meetings and turbine generator prices. In a subsequent simulation analysis, however, he found a significant impact of conspiracy: predicted turbine generator prices for a model including conspiracy effects were about nine percent higher than those for a model without conspiracy (1975, p. 348). In sum, the questions of conspiracy's impact and antitrust's effectiveness remain uncertain.

The present study examines the impacts of collusion and antitrust conduct remedies on profitability in electrical equipment markets. We inquire whether conspiracy raised equipment manufacturers' returns and whether antitrust conduct remedies were an effective policy response. We also examine whether market signaling increased turbine generator makers' profitability after antitrust ended the conspiratorial meetings. 2/ In the next section, we provide a short history of collusion in electrical equipment markets between 1950 and 1970. Then, we describe the structure-conduct-performance model that we use to estimate the impacts of collusion and antitrust on profitability. Following that, we discuss the data used for estimation of the model. And finally, we present the results of that estimation.

II. Collusion in Electrical Equipment Markets

During the 1950's, more than 30 electrical equipment manufacturers engaged in elaborate conspiracies to fix the prices they charged utilities (Herling, 1962; and Walton and Cleveland,

1964). The conspirators' illegal meetings covered 20 product lines with annual sales approaching $2 billion in the late 1950's. In July 1959 the meetings ended (Sultan, 1974, p. 71). In that same month, the Department of Justice announced that a grand jury was investigating identical bidding on electrical equipment, and in February 1960 the first indictments were handed down (Walton and Cleveland, 1964, pp. 32-33). Following successful prosecution under section I of the Sherman Act, conspiring companies and individual officers were fined more than $1 million, and some executives received jail sentences. Subsequent damage suits by privately-owned utilities and by state and local governments obtained refunds from the manufacturers, lowering their after-tax incomes in the early 1960's by more than $150 million. Consent agreements with the manufacturers forbade further price fixing activities, and the available evidence indicates that the meetings were not resumed (Ohio Valley Electric et al. v. General Electric et al., 1965, p. 925; and U.S. v. General Electric et al., 1976, p. 3).

In 1963, however, The General Electric Company announced major changes in its turbine generator pricing policies (Electrical World, May 27, 1963, p. 27), which were interpreted by the Department of Justice as an attempt to engage in price signaling. These changes included a revised price book that greatly simplified price calculation for the complex, custom-built product and a published multiplier that facilitated price change computation. Another important change was the initiation of a "price protection" (or most favored buyer) policy in which any discount given to one buyer would be granted retroactively to

all buyers who had ordered in the previous six months. Through this policy, GE raised the cost to itself of discounting. In early 1964 GE's major rival, Westinghouse Electric Corporation, responded with similar price policy changes. These policies continued in effect at least until the end of the decade.

A Department of Justice investigation of the revised turbine generator pricing policies found no evidence of conspiracy between GE and Westinghouse. However, interpreting the two companies' new policies as devices to achieve adherence, via public communication and facilitating practices, to the same quoted price, Justice obtained modifications in the consent agreements with the companies to forbid the objectionable activities.

Despite the passage of more than 20 years since the equipment manufacturers' conspiracies were exposed, their impact remains in question. In numerous damage suits, utilities argued, and the courts generally agreed, that the meetings raised equipment prices (Bane, 1973). Manufacturers and others asserted, however, that uncontrollable cheating on agreements prevented price elevation (U.S. Senate, 1961; and Sultan, 1974 and 1975). Similarly, the impact of price signaling is uncertain.

In addition to being unsettled questions, the impacts of conspiracy, signaling, and conduct remedies on electrical equipment markets are important ones. Proper implementation of antitrust policy in the future requires information on the successes and failures of past applications. The electrical equipment conspiracies were one of the most widespread, dramatic

violations of the Sherman Act's Section I. The conduct remedies imposed were among the strongest ever. The investigation of market signaling involved a novel extension of the antitrust laws to a form of conduct alleged to fix prices without conspiracy. In addition to banning certain facilitating practices, the remedies required sellers to reduce the amount of information on prices and pricing policy that they make public about their product. This implies that, in a highly concentrated industry such as turbine generators, too much such information can be disseminated, from a public welfare point of view.

III. The Model

To estimate the effects of collusion and antitrust on profitability, we use a structure-conduct-performance model. The performance variable to be explained is the ratio of product line operating income to net sales (OPSALE). 3/ The explanators include conduct variables to capture the effects of conspiracy and signaling, as well as industry structure variables, product line characteristics, and company characteristics that might influence product line profitability. 4/

In general, our model can be written as follows:

profitability = f(seller conduct, industry structure, company size, market share, capital/sales ratio),

where all variables are defined on an annual basis for product lines. While profitability is assumed to be endogenous, industry structure, seller conduct, and all other explanatory variables are assumed to be determined exogenously. 5/

Our model differs from most previous structure-conduct-

performance models in its treatment of conduct. First, conduct variables appear explicitly in our model--in fact they are the main focus of our study. Due perhaps to a paucity of data, most previous studies have examined only structure-performance links. 6/ Second, we assume that, between 1950 and 1970, the electrical equipment manufacturers' decision whether or not to conspire on prices was determined largely by public policy. In other words, the choice between clearly illegal price fixing meetings and other (possibly legal) forms of pricing, such as market signaling, is assumed to have depended primarily on the probabilities of detection and punishment and on the cost of any resulting penalties (Becker 1968). These probabilities and penalties are assumed to have depended, in turn, on antitrust policy.

The historical relationship between antitrust and conspiracy in the electrical equipment industries is consistent with Becker's (1968) theory of crime. The electrical equipment cases significantly reduced the expected net returns to conspiracy relative to the returns to other forms of pricing. Prior to those cases, criminal penalties were generally too small, relative to the expected gains, to deter price fixing (Posner, 1970, pp. 388-395). Fines were insignificant, and jail sentences were almost never imposed. By contrast as a result of criminal prosecutions, some electrical equipment executive were jailed, and several were fired or demoted. In addition, a large number of damage suits obtained refunds for equipment buyers that cost the conspiring manufacturers more than $150 million after taxes (see Lean, Ogur, and Rogers, 1982, p. 28). As described above in section II, the evidence indicates that the meetings ended when

antitrust investigations began, and were not resumed.

The importance of the link between antitrust policy and conspiracy is also suggested by the industrial organization paradigm. Although that paradigm emphasizes links from structure to conduct to performance, Scherer (pp. 5-6) refers to "...public policy measures [an element of 'basic conditions'] designed to improve performance by manipulating structure or conduct" (emphasis added). Antitrust's "conduct remedies", the focus of our study, are a familiar example of measures designed to affect performance by changing conduct, but not structure. 7/

The conduct variables in our model represent periods of price fixing conspiracy during the 1950's and a period of price signaling during the 1960's. Three of these variables, CON5054, CON5659, and CON5759, capture the impacts of conspiratorial meetings during the periods 1950-54, 1956-59, and 1957-59, respectively. A fourth conduct variable, CON55, represents the "white sale", a period of sharp price reductions starting in January 1955, accompanied by a cessation of meetings in at least some markets (Sultan, 1974, pp. 40, 46, and 63). And CON5059 permits an appraisal of conspiracy's impact over the entire decade of the 1950's. Finally, SIG6470 captures the effect of price signaling between 1964, when GE and Westinghouse made major revisions in their pricing policies, and 1970, the end of our study period. With the exception of CON55, we expect these conduct variables to have positive regression coefficients. We expect CON55's coefficient to be insignificant, or at least smaller than the other conspiracy coefficients.

The conduct variables discussed thus far capture the average effect of conspiracy across the eight product markets in our sample. In some regressions, we instead use eight product-specific conspiracy variables to permit variation in the impact of conspiracy across markets. We expect these conspiracy variables to have positive coefficients. 8/

Data on the organization of conspiracies in the eight electrical equipment industries in our sample consist primarily of the number of participants in each conspiracy. As indicated in the indictments (see Lean, Ogur, and Rogers, 1982, pp. 57-59), this number varied from three in the meter industry to nine in the insulator industry. Findings by Comanor and Schankerman (1976) suggest that such variation is associated with differences in the organization of price fixing activities. Those authors observed that in a sample of sealed bid markets, 9/ the collusive pricing scheme varied with the number of conspirators. In industries with a relatively large number of firms, conspirators tended to set identical prices without attempting to allocate market shares. By contrast, in industries with few sellers, conspirators were more likely to allocate market shares by rotating low bid status and charging different prices. Given the existence of at least this difference in conspiracy organization, it is of interest to test whether the effectiveness of conspiracy varies across the industries in our sample.

Following Kwoka (1978), we use two variables to capture the effect of industry concentration on sellers' profitability: CONC2, the two-firm concentration ratio, and SELLER3, the third largest seller's market share. Based on the numerous industry-

level structure-performance studies in the literature, we would expect CONC2 to have a positive coefficient. However, studies by Ravenscraft (1983) and by others at the line of business or company level (see Ravenscraft, 1983, p. 26) have observed negative concentration-profitability relationships when the positive impact of market share is taken into account. SELLER3's coefficient allows us to test for electrical equipment markets the hypothesis that the third leading firm tends to undermine industry pricing agreements (Kwoka, 1978). Under the assumption that the impact of these firms' pricing policy varies positively with their market share, SELLER3 will have a negative coefficient if third leading firms are price cutters.

Also included in our model are other industry structure variables that affect the ability of sellers to raise prices and profitability. GROWDEV is a measure of excess demand, which we expect to have a positive coefficient. Unlike the demand growth variables in most structure-performance studies, GROWDEV is designed to reflect the part of total demand growth that sellers do not anticipate in their capacity expansion decisions, i.e. the deviations from the growth trend (Lean, Ogur, and Rogers, 1982, p. 34). It is these deviations, positive and negative, that should increase or decrease seller profitability.10/ The industry asset/sales ratio, ASALIND, is designed to capture the allegedly disruptive effect of a high fixed/variable cost ratio on the ability of sellers to maintain price agreements in the face of cyclical demand fluctuations (Scherer, 1980, pp. 205-212). According to this hypothesis, ASALIND's coefficient is

negative. On the other hand, Telser (1972, p. 199) argues that, in these circumstances, sellers will be particularly careful to avoid such breakdowns, and to the extent they succeed, profit/sales ratios will be higher. The custom building of some electrical equipment may facilitate quality competition and make price agreements more difficult to police. The variable CUSTOM is included in our model to capture this effect. We expect it to have a negative coefficient. Finally, competition from foreign producers of electrical equipment is represented by IMPORTS. We expect this variable to have a negative coefficient. 11/

Given industry structure, profitability has been observed to vary with the magnitude of seller operations (Lean, Ogur, and Rogers, 1982, pp. 37-39). Our model includes two variables to express the effects of size: COMSIZE, absolute company size, and SHARE, market share or product line size in relation to industry size. We expect both of these variables to have positive coefficients. COMSIZE is intended to reflect any advantages of large companies over smaller ones. For example, previous studies have found that large firms borrow at lower interest rates than small firms (Scherer, 1974). SHARE is included to express the sum of any large suppliers' advantages over their smaller rivals, such as cost advantages or advantages in producing high-quality products.

Finally, Weiss (1974) has observed that the use of accounting data in a structure-conduct-performance model requires the inclusion of a capital/sales variable to correct for the presence of normal returns in observed profits. In our model, the capital/sales variable is ASALPRLN, product line

assets/sales, and is expected to have a positive coefficient.

IV. The Data

Of the 20 industries in which conspiracy was uncovered, this study examines eight. 12/ The chosen markets account for just over 60 percent of total sales affected by the electrical equipment conspiracies. The industries included in our sample are: insulators, steam turbine generators, steam surface condensers, demand and watt-hour meters, power transformers, distribution transformers, power circuit breakers, and power capacitors.

Data on these eight industries were collected by a Federal Trade Commission survey of 35 firms, many of which had access to the records of other companies in addition to their own, due to mergers and acquisitions. As a result, the survey obtained data for about 70 firms that made one or more of the eight products during the 1950-70 period. The resulting sample is unique in that it contains annual data on sales, assets, and profits at the product line level. 13/ Thus, our observations more closely approximate true economic markets than those usually available for economic analysis.

Using the survey data, we were able to develop 553 observations for the 1950-70 period. Due to company organizational changes and differing data retention policies across companies, many more observations are available per year from 1957 on than for earlier years. The changing composition of companies and industries could bias our results, for example if the profitability of the firms whose data are available for 1950-

70 differs systematically from that of the firms whose data become available in 1957.

To control for this possible bias, we carried out our analysis using two data samples, one for 1957-70, and one for the entire 1950-70 period. We assumed that the 1957-70 sample would be free of bias because change in the composition of firms and industries was minimal during that period. When we used the 1950-70 sample, we included in our model dummy variables that reflect the year of initial data availability for each firm. These variables (DATA50, DATA53, DATA55, and DATA56) are designed to capture systematic differences in profitability that could bias our results.

Another possible source of bias is the accounting treatment of antitrust damage payments by some electrical equipment manufacturers. 14/ Some firms subtracted damages from net sales and/or added them to cost of operations. If these adjustments were allocated to the product line level, bias could result because post-conspiracy profits would be reduced even if the conspiracy had not been successful. Because we did not know whether such allocation was done, we deleted from our sample, for the years in which damage payments were made, all 23 product line observations of the firms that followed this accounting convention. 15/ After adjustments, the resulting data samples consisted of 527 observations for 1950-70 and 446 observations for 1957-70. 16/

V. The Results

Tables 1 and 2 present, respectively, ordinary least squares (OLS) and generalized least squares (GLS) regression results for

our structure-conduct-performance model. 17/ Most of the independent variables have coefficients of the expected sign, and the overall explanatory power of the equations is similar to that in other recent structure-conduct-performance studies. 18/

Equations (1) and (5) pertain to the 1957-70 period and embody the maintained hypothesis that conspiracy had the same impact in each of the eight product markets. The results are consistent with the existence of a successful conspiracy during the latter part of the 1950's. Profit/sales ratios are about two percentage points higher during 1957-59 than otherwise.

Equations (2) and (6) also pertain to the 1957-70 period, but relax the hypothesis of an equal conspiracy impact across electrical equipment markets. According to the results, some conspiracies appear to have been successful in raising product line returns, while others appear to have failed. During 1957-59, profit/sales ratios were over three percentage points higher in insulators and over 10 percentage points higher in circuit breakers (according to the GLS results in Table 2). With the exception of turbine generators, all other product lines have higher returns during 1957-59, but none is significantly higher. Contrary to expectations, turbine generator returns are lower during 1957-59. 19/

Equations (3) and (7) examine the longer 1950-70 period and divide the conspiracy into two parts: 1950-54, when meetings may have been relatively infrequent and unorganized, and 1956-59, when organized meetings may have been held relatively frequently. 20/ This division allows us to test whether the conspiracy was

more effective in the latter part of the 1950's than earlier in that decade. The intervening year, 1955, was the time of the "white sale" when meetings were discontinued and prices fell sharply (Sultan, 1974, pp. 40, 46, and 63). The results again suggest that meetings raised profitability. Profit/sales ratios were over six percentage points higher in 1950-54 and over three percentage points higher in 1956-59. By contrast, profit/sales ratios were not significantly higher in 1955. No support is given, however, to the notion that the meetings were more effective after the white sale than before. To the contrary, the coefficient of CON5054 is larger than that of CON5659.

In equations (4) and (8), we replace the three conspiracy variables with a variable equal to one for the entire 1950's (CON5059). With this regression, we estimated that profit/sales ratios were over four percentage points higher over that decade. Thus, even when we include the white sale year, the conspiracy appears to have raised average returns for sellers in the eight product markets in our sample. 21/

These findings suggest that, in general, electrical equipment sellers were not able to maintain prices as much above costs by non-conspiratorial pricing methods during the white sale and after antitrust investigation ended the conspiracy. The possible exception to this conclusion is turbine generators. The results in equations (1), (2), and (5) suggest that turbine generator price signaling succeeded in raising prices relative to costs. These equations provide estimates indicating that signaling caused an increase in turbine generator profitability ranging from 4 to 11 percentage points. In the remaining

equations, however, we observe no significant increase in turbine generator profit/sales ratios during 1964-70.

CONC2's coefficients provide only partial support for the hypothesis that seller concentration facilitates collusion. CONC2 is positively related to profitability in four of the eight equations in Tables 1 and 2. Although not significant in the OLS regressions, CONC2's coefficient becomes significant after we correct for heteroskedasticity. In the other four equations, however, CONC2 is negatively related to profitability. While inconsistent with the findings of most industry-level concentration-profitability studies, this result is consistent with the results recently obtained by Ravenscraft (1983) using line of business data and by others (see Ravenscraft, 1983, p.26) using LB or company data.

Contrary to Kwoka's findings (1978, p. 33), the third largest firms' shares are positively related to profit/sales ratios. Moreover, this relationship is highly significant in four of the eight equations. Rather than playing a price cutting role, the third largest seller in electrical equipment markets may have assisted its larger rivals in maintaining price above cost.

Of the four other variables expected to affect the ability of sellers to achieve higher prices, three have significant coefficients with the predicted sign. The excess demand variable's coefficient is positive, while those of custom-building and the asset/sales ratio are negative. In other words, strong demand relative to capacity raises returns, while an

increased opportunity for quality competition and a high fixed/variable cost ratio make price coordination more difficult.

Market share also has a significant positive relationship with the profit/sales ratio. In other words, sellers who are large in relation to the market appear to have cost or price advantages over their smaller rivals. The extent of these advantages is an important issue that we address elsewhere. 22/

By contrast with the coefficients of relative size, the absolute company size variable's coefficients are not significant. Earlier studies (FTC 1969 and Imel and Helmberger 1971) obtained similar results with these two variables. The capital/sales and import competition variables had insignificant coefficients that were generally of the wrong sign. These results probably reflect specification errors. For example, our model assumes that the normal return to capital is constant across electrical equipment industries and over time, thus ignoring possible risk differences. The IMPORTS variable is simply a crude proxy due to a paucity of disaggregated data; more precise measurement might change the results.

VI. Summary and Conclusions

By contrast with the findings of some earlier studies, our analysis suggests that collusion can raise rates of return. On average for eight electrical equipment markets during the 1950's. we observe significant effects on profitability of conspiratorial meetings by sellers. Further analysis suggests, however, that higher returns may have been limited to the insulator and circuit breaker markets. While conspiratorial meetings seem not to have raised turbine generator profit/sales ratios, price signaling

appears to have done so. Because the public communication aspect of signaling is probably less effective than face to face communication in meetings, it may be that the facilitating practices element of signaling was the key to its apparent success. 23/

Our analysis suggests that, where collusion has raised sellers' returns, antitrust prosecution can lower them and reduce any social losses that were occurring. However, our analysis also suggests that, if antitrust intervention is limited to traditional forms of conspiracy (e.g. meetings in hotel rooms or other private communications), it may leave other forms of effective collusion untouched. In other words by devoting some attention to public communication and facilitating practices, the antitrust authorities may increase the benefits of their activities to society.

Table 1. OLS Regression Results
(t-statistics are in parentheses).

Independent Variables	Equations			
	(1)	(2)	(3)	(4)
Intercept	-5.00 (-0.83)	-6.02 (-0.86)	14.90 (2.07)	14.26 (1.98)
GROWDEV	4.72* (6.03)	5.00* (5.32)	4.92* (8.53)	4.98* (5.91)
CONC2	8.00 (1.07)	9.75 (1.13)	-16.56 (-2.18)	-15.91 (-2.06)
SELLER3	116.02* (7.16)	114.46* (6.42)	20.36 (0.99)	22.50 (1.09)
COMSIZE	0.45 (1.03)	0.05 (1.05)	0.02 (0.05)	-0.01 (-0.03)
SHARE	30.34* (6.47)	30.31* (6.42)	28.09* (6.06)	28.31* (6.10)
ASALIND	-23.60* (-4.70)	-23.24* (-4.00)	-13.76* (-3.84)	-14.22* (-3.98)
ASALPRLN	-1.03 (-1.29)	-1.03 (-1.27)	-1.26 (-1.62)	-1.29 (-1.65)
IMPORTS	-0.17 (-0.13)	0.06 (0.05)	0.35 (0.25)	0.10 (0.07)
CUSTOM	-8.50* (-5.36)	-9.23* (-5.01)	-3.95* (-2.47)	-3.87* (-2.42)
CON5059				4.46* (3.41)
CON5054			6.77* (3.45)	
CON55			2.78 (0.88)	
CON5659			3.98* (2.89)	
CON5759	2.65* (1.91)			
INSULCON		3.08 (1.24)		

Independent Variables	Equations			
	(1)	(2)	(3)	(4)
CDSRCON		3.31 (0.67)		
TURBNCON		0.56 (0.13)		
METERCON		4.57 (0.88)		
DISTCON		1.21 (0.43)		
PTRANCON		2.59 (0.77)		
BREAKCON		8.62* (1.86)		
CAPCON		1.22 (0.29)		
SIG6470	10.64* (3.15)	9.83* (2.69)	3.03 (0.91)	3.05 (0.92)
DATA50			4.02* (3.15)	4.46* (3.64)
DATA53			14.75* (4.78)	14.74* (4.77)
DATA55			12.54* (3.26)	12.26* (3.19)
DATA56			1.23 (0.35)	1.18 (0.34)
R2	0.39	0.39	0.39	0.39
F	27.13	16.56	20.64	23.17
Sample Size	446	446	527	527
Years	57-70	57-70	50-70	50-70

Note:* Coefficient has the predicted sign and is significantly different from zero at the 5-percent level or higher.

Table 2. GLS Regression Results
(t-statistics are in parentheses).

Independent Variables	Equations			
	(5)	(6)	(7)	(8)
Intercept	-12.09	-17.39	13.00	12.25
	(-3.04)	(-3.62)	(1.89)	(1.78)
GROWDEV	5.42*	6.21*	4.47*	4.56*
	(9.26)	(8.53)	(5.56)	(5.67)
CONC2	13.09*	22.44*	-11.88	-10.83
	(2.33)	(3.33)	(-1.64)	(-1.50)
SELLER3	127.99*	136.67*	13.53	15.93
	(12.51)	(12.06)	(0.68)	(0.80)
COMSIZE	0.20	0.02	0.02	-0.02
	(0.81)	(0.61)	(0.06)	(-0.05)
SHARE	32.59*	34.24*	26.30*	26.60*
	(9.07)	(9.66)	(6.06)	(6.11)
ASALIND	-18.59*	-21.70*	-11.96*	-12.44*
	(-4.51)	(-4.68)	(-3.64)	(-3.79)
ASALPRLN	-1.96	-1.99	-1.55	-1.58
	(-1.67)	(-1.69)	(-1.91)	(-1.96)
IMPORTS	0.47	0.26	1.00	0.66
	(0.50)	(0.26)	(0.74)	(0.49)
CUSTOM	-8.74*	-9.83*	-3.92*	-3.81*
	(-6.47)	(-6.02)	(-2.60)	(-2.52)
CON5059				4.23*
				(3.35)
CON5054			6.71*	
			(3.72)	
CON55			2.84	
			(0.98)	
CON5659			3.66*	
			(2.77)	
CON5759	2.02*			
	(2.28)			
INSULCON		3.78*		
		(2.54)		

Independent Variables	Equations			
	(5)	(6)	(7)	(8)
CDSRCON		0.70 (0.16)		
TURBNCON		-4.39 (-1.72)		
METERCON		0.28 (0.11)		
DISTCON		0.10 (0.06)		
PTRANCON		2.44 (1.13)		
BREAKCON		10.49* (3.45)		
CAPCON		2.28 (0.54)		
SIG6470	7.00* (2.69)	4.73 (1.62)	0.41 (0.13)	0.41 (0.13)
DATA50			3.15* (2.58)	3.77* (3.23)
DATA53			13.84* (4.77)	13.94* (4.80)
DATA55			11.48* (3.11)	11.22* (3.03)
DATA56			-0.54 (-0.16)	-0.59 (-0.17)
R2	0.32	0.32	0.26	0.26
F	20.45	12.58	11.78	13.26
Sample Size	446	446	527	527
Years	57-70	57-70	50-70	50-70

* Coefficient has the predicted sign and is significantly different from zero at the 5-percent level or higher.

Table 3. Definitions of Variables

OPSALE = operating income/net sales

CONC2 = the two firm concentration ratio

GROWDEV = the deviation of real industry sales about trend

ASALIND = industry assets/sales

ASALPRLN = product line assets/sales

CUSTOM = 1 if industry's product is made to order

IMPORTS = 1 if import competition is present

CON5054 = 1 in conspiracy years 1950-54

CON55 = 1 in white sale year 1955

CON5659 = 1 in conspiracy years 1956-59

CON5759 = 1 in conspiracy years 1957-59

CON5059 = 1 in conspiracy years 1950-59

SIG6470 = 1 in turbine generator market signaling years 1964-70

COMSIZE = real company net sales

SHARE = company market share

SELLER3 = third-largest seller's market share

DATA50 = 1 if 1950 is the year of initial data availability

DATA53 = 1 if 1953 is the year of initial data availability

DATA55 = 1 if 1955 is the year of initial data availability

DATA56 = 1 if 1956 is the year of initial data availability

INSULCON = 1 in insulator conspiracy years 1957-59

CDSRCON = 1 in condenser conspiracy years 1957-59

TURBNCON = 1 in turbine generator conspiracy years 1957-59

METERCON = 1 in meter conspiracy years 1957-59

DISTCON = 1 in distribution transformer conspiracy years 1957-59

PTRANCON = 1 in power transformer conspiracy years 1957-59

BREAKCON = 1 in circuit breaker conspiracy years 1957-59

CAPCON = 1 in power capacitor conspiracy years 1957-59

Footnotes

1/ The analysis of this paper has benefited from critical comments by Keith Anderson, John Kwoka, James Langenfeld, William Long, John Peterman, David Ravenscraft, Donald Sant, F.M. Scherer, and Robert Tollison. However, any remaining errors are the authors'.

2/ Market signaling can be thought of as the attempt by rival sellers to increase prices, using public communication (e.g. in the media or in published price books) and facilitating practices such as "most favored buyer" contractual arangements. Signaling, which was also the focus of the FTC's Ethyl case (Elzinga, 1983, pp. 10-12), is thus an alternative form of conduct to conspiratorial meetings. To the best of our knowledge, no previous studies have tried to estimate the effect of market signaling on rates of return.

3/ In this paper, we will use the following terminology: "company" will refer to data for an entire firm, which may include operations in several industries; "industry" data will consist of the sum of all companies' data pertaining to a particular product market; and "product line" will mean the data of a single company that relate to its operations in a single industry. For example, data for General Electric Company are company data, turbine generator data for all companies that make turbine generators are industry data, and General Electric's turbine generator data are product line data.

4/ See Table 3 for brief definitions of these variables, and Lean, Ogur, and Rogers (1982) for more detailed definitions and further discussion of them.

5/ An alternative would be to attempt to construct and estimate a simultaneous equation model in which profitability, collusion, and, perhaps, concentration were endogenous. However, in previous studies (Strickland and Weiss, 1976, and Martin, 1979) which estimated three-equation models, the authors noted that simultaneous equation bias appears not to be important in structure-performance models (Strickland and Weiss. p. 1109), or seems no more important than the bias due to the omission of relevant explanatory variables (Martin, p. 646). With regard to the latter bias, Maddala (1977, p. 231) suggests that OLS estimation is more robust in the presence of specification errors than many simultaneous-equation estimation methods. Hence, single equation estimation of structure-conduct-performance models may be the preferred method and certainly provides useful results.

6/ Some previous studies that included conduct variables are discussed in Lean, Ogur, and Rogers (1982, pp. 14-17).

7/ Examination of data obtained from electrical equipment manufacturers indicates that the structure of the electrical equipment industries was essentially unchanged from 1950 to 1970.

For example, these industries remained highly concentrated throughout that period (see Lean, Ogur, and Rogers, 1982, p. 77).

8/ The names of these variables are listed in Table 3.

9/ The government-utility portion of electrical equipment markets uses sealed bidding.

10/ The assumption that electrical equipment manufacturers projected demand growth at a constant exponential rate is reasonable in the light of the extremely stable growth of demand for electricity during the time period under study.

11/ Using Census and trade publication information, we identified the year for each industry in which import sales first became important. These judgments were necessarily crude, but in the absence of sufficiently disaggregated import data, the best we could make.

12/ Our selection was made primarily on the basis of industry size. However, we omitted such large product groups as industrial controls and low-voltage distribution equipment which contain several industries.

13/ The electrical equipment data are in some ways similar to the Federal Trade Commission's Line of Business (LB) data in that both permit estimation of structure-performance relationships at a lower level of aggregation than the industry (Ravenscraft, 1983, pp. 22-24). The electrical equipment data are, however, even less aggregated than the LB data (Lean, Ogur, and Rogers, 1982, pp. 103-105).

14/ Following the American Institute of Certified Public Accountants' recommendations at that time, most companies in our sample subtracted damage payments (net of taxes) from retained earnings. As a result, income statement items such as sales and operating income were not affected.

15/ In 1977--over a decade after the payments in question--Financial Accounting Standards Board Standard #16 required any legal damage payments to be shown on the income statement in the year paid (telephone interview with technical standards staff of the American Institute of Certified Public Accountants).

16/ Three product line observations were deleted to eliminate the impact on our analysis of the disequilibrium associated with either entry or exit. For the same reason, Ravenscraft (1983) eliminated "births and deaths" from his sample.

17/ Because structure-conduct-performance models often have heteroskedastic errors, the OLS t-statistics may be misleading. Lacking theory to guide us in choosing variables and a functional form to explain heteroskedasticity, we used a testing and correction procedure described in Maddala (1977, pp. 263-64). First, application of a likelihood-ratio test to the OLS

residuals (grouped according to the predicted value of OPSALE) indicated that heteroskedasticity was probably present. Next, dividing the standard deviation of the residuals for each group by the standard deviation for the entire sample, we constructed weights for the data and reestimated the model. This resulted in a substantial reduction in the variation of residual standard deviations across groups. It did not, however, totally eliminate this variation. The results obtained through use of this procedure are presented in the GLS equations.

18/ Several goodness-of-fit measures exist for GLS regressions (see, for example, Judge, Griffiths, Hill, Lutkepohl, and Lee, 1980, pp 251-257). In this study we use the R2 calculated from the F-statistic that tests the hypothesis that all coefficients (except the weighted constant term) are equal to zero. This R2 is bounded by zero and one, and it gives the percentage of dependent-variable variation that is explained by the independent variables.

19/ An F-test comparing the unrestricted model in equation (6) with the restricted model of equation (5) obtained a value of F=2.06 which indicates an approximately significant difference at the 0.05 level [F(0.05,7,120)=2.09; F(0.05, 7,)=2.01].

20/ Sultan presents evidence that the frequency and organization of the meetings increased after the white sale (1974, pp. 54, 64, and 65). By contrast, Judge Feinberg concludes that such evidence merely reflects the loss of information about earlier meetings due to the deaths prior to deposition of three participants and the faulty memory of one deponent (Ohio Valley Electric et al v. General Electric et al, 1965, pp. 923-926).

21/ An F-test comparing the unrestricted model in equation (7) to the restricted model of equation (8) obtained a value of F=1.92 which indicates no significant difference at the 0.05 level [F(0.05,2,)=3.00].

22/ In Lean, Ogur, and Rogers (1982, pp. 66-73), we divided electrical equipment sellers into two strategic groups, leaders and nonleaders, along lines suggested in Porter (1979, p. 215). Our results are consistent with the hypothesis that cost or price advantages of large relative size do not extend beyond that of smallest leading seller.

23/ An alternative explanation for this result is that while turbine generator meetings covered only a small fraction of the machines sold, signaling activities covered every sale.

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