CONTROLLING COLLUSION IN THE CONSTRUCTION INDUSTRY: SOME LESSONS FROM RECENT U.S. EXPERIENCE *

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* This research was funded in part by the National Institute of Justice grant 81-IJ-CX-0062 and 83-IJ-CX-4055. Points of view or opinions stated in this document are those of the authors and do not necessarily represent the official positions or policies of either the National Institute of Justice of the U.S. Department of Justice or the United States Sentencing Commission.

** Michael K. Block is a member of the United States Sentencing Commission and Jonathan S. Feinstein is a Ph.D. candidate at Massachusetts Institute of Technology. Frederic C. Nold, who is now deceased, was a major contributor to an earlier and longer version of this paper which was published in Internationale Forschungsergebnisse Auf Dem Gebiet Der Wirtschaftskriminalitat (ed. K. Leibl).

ABSTRACT

In this paper, we assess the impact of recent criminal antitrust enforcement in the construction industry. We develop an indicator of collusion in highway construction and use this indicator in estimating the effect on bid-rigging of the recent explosion of antitrust activity in highway construction. We find that recent efforts designed to suppress the level of bid-rigging did in fact work. Surprisingly, however, it appears as if it was the greatly enhanced penalties for violating the antitrust laws that were most effective in controlling the level of bid-rigging. We were unable to find any consistent evidence that the increase in the number of cases brought was, by itself, a very important factor in reducing collusion in highway construction. The most relevant lesson from the U.S. experience in the area is that enhancing penalties for antitrust violations is the most effective method of reducing collusion.

INTRODUCTION

In recent years, price fixing in the construction industry has become a particular concern of U.S. antitrust authorities. Of all of the criminal indictments filed by the Antitrust Division since 1955, nearly a quarter have been in the construction industry. Perhaps more striking is the fact that since 1978, over 60% of all criminal indictments filed by the Division were against firms in the construction industry. As the data in Table 1 makes abundantly clear, recently there were some years where the construction industry was almost the exclusive concern of the Division as far as criminal cases were concerned.[1] In addition, since most of the recent cases in construction have been brought under the 1974 penalty provisions, fines and imprisonment rates for these cases are quite high by historical standards.[2]

Undoubtedly, part of the reason for the Antitrust Division's concentration on collusion in the construction industry is the success the Division has had in identifying violations in the industry. Virtually all of the price fixing alleged by the

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[1]Of course since indictments for price fixing in construction are usually for bid-rigging and these are ordinarily more narrowly drawn than other price fixing indictments, the number of indictments in construction may tend to overstate the Division's concentration in the area.

[2]In 1980, the fines levied against construction firms were three times the average of all fines from 1955-1980. Moreover, while from 1955 to 1959 there were 19 cases where jail sentences were imposed and not reversed, in a single year, 1980, in the construction industry there were 24 such cases.

TABLE 1

CRIMINAL INDICTMENTS FILED BY THE ANTITRUST DIVISION OF THE U.S. DEPARTMENT OF JUSTICE: 1955-83[1]

	Sherman Act Indictments[2]		
Year(s)	Total	Construction[3]	% Construction
1955-1977	618	42	6.8
1978	44	8	18.2
1979	24	5	21.1
1980	84	67	79.8
1981	38	22	57.9
1982	47	43	91.5
1983	45	26	57.8
1978-1983	282	171	60.6
1955-1983	900	213	23.7

Notes: (1) Source: Clabault and Block (1982) and Economic Policy Office, Antitrust Division, U.S. Department of Justice.

(2) These are indictments for criminal antitrust cases brought under Sections 1, 2 and 3 of the Sherman Act (Public Law No. 190, Ch. 647, 51st Cong., 1st Sess.), filed by the Antitrust Division, Department of Justice subsequent to the 1955 amendment to the Sherman Act. (The Amendment substituted the words "fine not exceeding fifty thousand dollars" for the phrase "fine not exceeding five thousand dollars". In 1974, the Act was further amended and the maximum fine for an individual was raised to $100,000 and the maximum for a corporation was raised to $1,000,000.)

(3) This category includes: SIC 1611 - Highway and Street Construction; SIC 1622 - Bridge, Tunnel and Elevated Highway Construction; SIC 1623 - Water, Sewer and Utility Line Construction; SIC 1629 - Misc. Heavy Construction; SIC 1711 - Plumbing, Heating and Air Conditioning; SIC 1731 - Electrical Work; SIC 1741 - Masonry; SIC 1742 - Plastering; SIC 1752 - Floor Laying; SIC 1761 - Roofing; SIC 1771 - Concrete Work; SIC 1794 - Excavating, and SIC 1799 - Special Trade Contractors.

government in these cases has involved bid-rigging, i.e. the collusive setting of prices by contractors on projects put out to public bid.[3] Early on in the present wave of indictments (1979) the antitrust authorities refined their methods of using the information from one bid-rigging prosecution to unearth additional, often quite geographically distant, bid-rigging violations. By the end of 1980, the scope of the government's activity in highway construction had expanded from a single state, Illinois, in 1979, to seven states including states as remote from Illinois as South Carolina.

The construction industry has clearly been of singular interest to the Antitrust Division in recent years and at this point we ought to be asking the question: Has the bringing of a record number of antitrust actions in a specific industry and the unprecedented widespread use of prison terms as well as large fines had a significant effect on the volume of bid-rigging in construction? After all, the primary reason for bringing these cases and punishing the individuals involved is to dissuade both these and other contractors from rigging bids in the future.

Assessing just how successful the Antitrust Division has been in suppressing bid-rigging should also provide some information on the general question of how effective various enforcement techniques are likely to be in controlling collusion in general. Moreover, it might provide some insight into whether

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[3]According to the Economic Policy Office of the Antitrust Division, of the 154 cases brought against construction firms during the period 1978-1983 that listed a specific violation, (20 listed no specific violation) 150 listed bid-rigging as one of the alleged violations.

it is the certainty of detection or severity of the sanctions that matters most in controlling antitrust violations such as bid-rigging.

Measuring the Amount of Bid-Rigging

Before we can answer the question of how effective recent efforts by the Antitrust Division to control bid-rigging have been, we have to be able to measure the volume of bid-rigging in the construction industry. Unlike other antitrust violations that involve highly visible actions such as mergers, in bid-rigging the violation only comes to light when its discussed. There are no direct measures of the total number of rigged bids. The situation is, however, far from hopeless.

The objective of bid-rigging, after all, is to raise the lowest price available to the purchaser and, hence, increase the profit level of suppliers. A contract or bid that is rigged will have a higher markup or profit level than one that is not. Moreover, there is likely to be a relationship between the time and effort the contractors put into rigging a bid and the profit level. Consistently high levels of effort devoted bid-rigging should be associated with higher margins or markup on contracts. Obviously, one way to measure the volume of bid-rigging in the industry is to measure the profit levels on various contracts. Hence, if the Antitrust Division's recent efforts to control bid-rigging in the construction area have been successful, then profit levels in construction contracts put to bid in recent

years should have declined. They should have declined both because fewer contracts are rigged and less effort was devoted to those that were rigged.

While the profit or markup on a specific contract is likely to be an unambiguous indicator of the presence of collusion, actually measuring the profit level on a contract is problematic. The most obvious approach would be to estimate costs on each contract and thus derive a direct estimate of profit for each contract.[4] However, in the case of highway construction, estimation of costs requires a detailed listing of the line items on each contract let. Not only is such a listing often large (over 100 items) and hence unmanageable and expensive to work with, but the presence of unbalanced bidding makes the relationship between cost estimated and actual costs on particular items problematic.[5] There are also serious empirical problems in trying to estimate cost functions for markets where collusion is common. Consequently, we have decided not to attempt direct estimation of cost functions for highway construction. Instead of actually estimating costs, we have chosen to construct an indicator of profit level using the engineer's estimate (or more precisely the highway department's) for a specific project. What we have done is develop a two step

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[4]We have adopted this cost function approach in studies of antitrust enforcement in bread and concrete industries. See M. Block, F. Nold and J. Sidak, "The Deterrent Effect of Antitrust Enforcement," Journal of Political Economy, June 1981.

[5]Unbalanced bidding involves making the line items of the bid reflect factors other than the costs of the various items. Often times, unbalanced bidding is used by contractors to arrange the cash flow from a contract in the most advantageous manner.

procedure that uses the engineer's estimate and the low bid for estimating the profit level on any contract. The procedure is as follows:

First, to calculate the margin indicator on a specific contract we divide the low bid by the engineer's estimate of the project, creating a variable called MARKUP:

$$\text{MARKUP} = \frac{\text{Low Bid}}{\text{Engineer's Estimate}} \qquad (1)$$

The engineer's estimate used in constructing the variable MARKUP is the state highway department's estimate of how much the job that is put out for bid should cost, i.e. it is the low bid expected by the highway department. It is prepared before the contract is put out for bid and is not commonly revealed to the bidders prior to the submission of bids. While the various states differ as to the methods they use to construct such estimates, in almost all cases, the estimate reflects, to some degree, past low bids for similar contracts. Our assumption in using MARKUP as an indicator of the profit margin on a contract is, that bid-rigging is not perfectly stable and that the ratio of low bid to engineer's estimate (our variable MARKUP) will vary systematically with the degree of collusion. If this is the case, then increases in MARKUP will on the average be associated with increases in collusion.[6]

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[6]Obviously, if the degree of collusion were stable over time, the variable MARKUP would have no trend.

Second, we correct MARKUP for economic conditions in the paving industry. This is a particularly important correction for this industry, which is notoriously cyclical. The rationale for this correction is that in "good" times profits of all contractors will rise, and hence truly competitive contracts may appear to have inflated profit margins, and therefore may be incorrectly labelled collusive by a procedure which relies solely on MARKUP. Conversely, in depressed times, collusive contracts may have below average markups (which are nonetheless still above depressed competitive markups) and be incorrectly labelled competitive. The variable created by this process of adjusting for economic conditions is called RESIDE.[7] [8]

Data

The empirical work reported on below was carried out with two distinct data sets. The data set we use for actually analyzing profit levels on contracts was provided by the Federal Highway Administration (FHWA) and contains information on the winning contractor, his low bid, the engineer's estimate, data on the project, the state, as well as some other facets of the contract for all 50 states over the years 1975-81. This source does not identify any bidders or their bids other than the low bidder on the contract.

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[7]This variable is actually the residual of the ordinary least squares regression of MARKUP on a variable that measures economic activity in the construction industry.

[8]A quite robust test of the efficacy of this proxy appears in BLock, Feinstein and Nold (1985).

Our second data set was provided by the Antitrust Division of the Department of Justice (DOJ) and contains information on all DOJ cases in highway construction over the period 1975-82. For each case, the data set contains the state of indictment, the violation(s), the contractors indicted, and the penalties in terms of fines and jail sentences of the convicted contractors.[9]

Estimating the Level of Bid-Rigging in the Construction Industry

We begin our empirical analysis by estimating the level of bid-rigging in the highway industry over the period 1975-81. As we discussed above, we use as an indicator of collusion the actual profit level on a contract. The higher the profit level, the more likely it is that the contract involves collusion, or in the case of highway construction, bid-rigging.

In theory, the variable MARKUP that we defined in equation 1, is an indicator of the presence of collusion. However, as we pointed out above, there are several practical problems with the variable. Hence, our first step is to correct MARKUP for the level of economic activity. The indicator for economic activity that we actually use in adjusting MARKUP is the percentage of the

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[9]A trend data set was used to verify the efficacy of our proxy for collusion. This data set provided information only for the state of North Carolina, covering the years 1975-81, and included all bidders on a contract and their bids, as well as much additional information. Nearly all states keep such records, but we chose North Carolina for a very practical reason: North Carolina Department of Transportation (NCDOT) had identified whether a specific contract represented collusive bidding on the basis of discussions conducted with apprehended bid-riggers. This information provided us with the data for a very direct test of the usefulness of our proxy for collusion, RESID.

construction labor force employed, denoted CYCLE. This measure of economic activity is actually the number employed monthly in construction in a state divided by the ratio of annual average employed in that state's construction sector to one minus the annual unemployment rate.[10]

Using the national FHWA data set, we obtained the results in Table 2 which show a statistically significant relationship between CYCLE and MARKUP. Apparently, the higher the level of activity in construction vis a vis the recent past, the higher the markup on highway construction jobs.[11] Also, included in the regression reported in Table 2 are dummy variables for each state. These are included because differences amongst state engineers' methods of estimating contracts, as well as differences in both conventions regarding accounting profits and in historical levels of collusion, are likely to introduce systematic differences across states in the ratio of low bid to the engineer's estimate.

Now, the adjustment of MARKUP for systematic differences across states and the level of economic activity is accomplished by calculating the residuals from the regression in Table 1. For each contract we create the variable RESID which represents that

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[10]Several different series could be used as measures of economic activity. The series we chose is employment in the construction industry by state. This series is a compilation of several Bureau of Labor Statistics publications, and is monthly employed (by state and industry) divided by the annual average labor force (state and industry).

[11]We used several other specifications which considered lagged as well as contemporaneous values of CYCLE. The results were essentially the same.

TABLE 2

REGRESSION OF MARKUP ON ACTIVITY

Estimate of CYCLE Test Statistic	.138 (5.57)
Estimates of State Dummies	Alaska .778; Connecticut .685; Delaware .729; Florida .826; Georgia .856; Illinois .818; Indiana .737; Kentucky .800; Louisiana .818; Maine .820; Maryland .742; Massachusetts .776; Michigan .774; Mississippi .898; New Hampshire .743; New Jersey .791; New York .750; North Carolina .775; Ohio .713; Pennsylvania .841; Rhode Island .750; South Carolina .851; Vermont .824; Tennessee .814; Virginia .790; Wisconsin .704; West Virginia .804; Washington, DC .688; Alaska .729; Arizona .766; Arkansas .889; Hawaii .756; California .817; Colorado .799; Iowa .807; Idaho .750; Kansas .754; Minnesota .806; Montana .804; Missouri .796; Nebraska .776; New Mexico .797; Oregon .739; South Dakota .834; Utah .824; Texas .854; Washington .777; Wyoming .777; North Dakota .862; Oklahoma .833.
Sum of Squares	3399.9
R^2	.075
MARKUP Mean	.928
Number of Observations	3940

part of MARKUP which cannot be explained by the systematic state differences or variations in CYCLE, our indicator of general construction activity. As noted above, RESID provides us with a way of assessing the extent that the low bid on the contract reflects extraordinary profits for the winning contractor.[12] While RESID may be an imperfect measure of profitability, it does provide us with an operational, and quite robust indicator of collusion.[13]

Measuring Federal Bid-Rigging Enforcement Efforts

Having developed an empirical measure of bid-rigging, we now turn our attention to the problem of constructing relevant measures of enforcement activity. In order to test the deterrent effect of recent efforts to suppress bid-rigging, we need to construct a set of enforcement variables that reflect the contractor's perception of DOJ enforcement efforts.

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[12]Although an improvement over MARKUP, RESID suffers from a number of problems as an accurate measure of highway contractor's profits. The most important of these arises because engineer's estimates are based on bids for previous contracts. In this case, when collusion has occurred in the past, past jobs will contain inflated profit margins which will tend to inflate the engineer's estimate above a project's true competitive cost. Hence, RESID may systematically understate contractors' profits, and so may less accurately indicate collusion. Another difficulty with RESID is the heteroscedasticity which might arise if engineer's estimates vary in accuracy across states. We have not been able to devise a way to correct for these potential errors in the RESID variable. Development of reliable and independent cost estimation techniques would seem to be the best approach for solving this problem.

[13]See Block, Feinstein and Nold (1985) for a report on an empirical test of RESID as an indicator of collusion.

As the data in Table 1 clearly indicates, the number of cases brought by DOJ in the construction industry has increased dramatically in recent years. Even more striking is the recent increase in highway construction cases. In the eighty-five years prior to 1975, DOJ brought only three cases in highway construction. However, since that date, DOJ has brought nearly 160 such cases. In 1980 alone, DOJ brought 61 cases in highway construction. Translating this increase in the number of cases brought into an empirical measure of the change in the probability of a colluding contractor being detected is, however, problematic. In order to construct a measure of the probability of being detected for price fixing, we must have, in addition to the number of contractors that are detected colluding, the total number of contracts that are being colluded upon at any point in time. Since we have no direct measure of the number of contractors that are actually colluding, we have no immediately available information on the detection rate for bid-rigging.

In constructing a proxy for the probability of detection, what we have had to do is estimate the number of colluders. To approximate the number of contractors likely to be colluding, we have calculated the fraction of contracts in a given year with a positive RESID value, which indicates excess profits and possible collusion, and multiplied this fraction by the number of active contractors in the specified year. This indicator of collusive bidding was then used as the denominator, and the number of contractors named in Department of Justice actions in a particular month was used as the numerator, to produce an

estimate of the probability that a colluder might be indicted, PCHARGE.[14]

Along with PCHARGE, we were able to develop a relatively full complement of monthly measures of the level of antitrust enforcement and sanctioning. The elemental measures that we developed were: CPCONVICT, the conditional probability that a highway construction contractor charged with an antitrust violation will be found guilty; CCPFINE, the conditional probability that a charged contractor will be fined if convicted; CCPJAIL, the conditional probability that an individual charged and convicted will be sentenced to jail;[15] and AVEFINE and AVEJAIL, the average fines and jail sentences imposed by the courts for those fined and/or jailed.[16] More detailed definitions of these enforcement variables are given in the Appendix.

As we indicated in the Introduction, not only have the number of cases been unprecedented in the highway construction area, but so have been the punishments meted out. The recent highway construction cases represent the first time that the

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[14]Alternatives to PCHARGE might include measures that involved more sophisticated methods of estimating the number of collusion contracts as well as measures that assumed all contracts involved some collusion and simply used the ratio of indictments to contracts as a measure of enforcement.

[15]Fines and jail sentences are not mutually exclusive. Both penalties are used quite often.

[16]AVEFINE includes fines to both firms and individuals. AVEJAIL includes non-suspended jail sentences to individuals. We do nota know how much time individuals actually spend in jail. None of these variables reflect fines, jail sentences, or damage recoveries imposed by state governments.

courts in the United States have more or less consistently imposed imprisonment as a sanction for an antitrust violation. These cases also involve the imposition of fines that are quite high by historical standards. In order to actually measure the overall severity of sanctions for bid-rigging, we constructed the following indicator of expected punishment:

$$\text{PUNISH} = (\text{CCPFINE AVEFINE} + \text{CCPJAIL AVEJAIL \$137}) \qquad (2)$$

where $137 is the daily rate that monetizes prison time at the rate of $50,000/year. Obviously, any monetization rate is somewhat arbitrary.[17] With this qualification in mind, the variable PUNISH is intended as an indicator of the expected monetary loss imposed by a conviction for bid-rigging.

Combining this measure of expected punishment with our measure of apprehension probability (PCHARGE) and conviction probability (CPCONVICT) yields an overall measure of the expected monetary costs of rigging a bid in highway construction:

$$\text{ELOSS} = \text{PCHARGE CPCONVICT PUNISH} \qquad (3)$$

ELOSS is an indicator of the expected monetary cost of antitrust enforcement facing a contractor that rigs a bid in highway construction. It is intended to represent the expected monetary consequences of bid-rigging that a contractor considers when

[17]Monetizing these sanctions at quite different rates does not appear to substantially alter the results of the analysis. For a more complete discussion see Block and Feinstein (1986).

deciding to collude on a bid. A monthly series for this variable is given in the Appendix.[18]

According to our indicator of expected loss, a potential bid-rigger in 1975 would have considered that the expected costs of fixing a bid due to antitrust liability would have been a trivial 78 cents, while in 1982 the same bid-rigger would have reckoned that rigging a bid had an expected cost of $48,861. Whatever the problems are with the details of our calculations, one thing is clear: the expected cost of antitrust violations, at least in the bid-rigging area, have increased dramatically in the past several years. During the period that our proxy for expected cost is probably most reliable, 1980-82, our indicator of these costs (ELOSS) was growing by over 11% per month.

It is significant to note that, in terms of severity, not only did prison terms (which had been very rare prior to 1980) increase from an average of 50 days in the early months of 1980

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[18]Our series suffers from several problems: the first problem relates to the relative scarcity of cases in highway construction over the period 1975-79, as opposed to the larger number of cases from 1980 on. As a result of this disparity, our monthly series are missing values for the majority of months prior to 1980. We have assigned zeroes to enforcement variables in months when there was no federal enforcement activity, but we do not believe this is entirely satisfactory. Presumably, contractors' perceptions of enforcement probabilities do not fall all the way to zero in months of federal inactivity, particularly when antitrust actions have occurred in months immediately preceding the federal inactivity. This is particularly true of certain aspects of antitrust enforcement. For example, the probability of conviction given apprehension for antitrust violations is generally regarded to be near one. A second problem closely related to the first is the erratic behavior of our series prior to 1980. We expect contractors' perception is to be much less erratic than the actual series. Thus we have smoothed our enforcement series by calculating twelve month moving averages with missing value set to zero.

to over 160 days by mid-1982, but average fines increased from about $23,000 in early 1978 to over $230,000 by mid-1982. In fact, while expected prison terms (CCPJAIL AVEJAIL) increased by a factor of six between 1980 and 1982, expected fines (CCFINE AVEFINE) increased by a factor of eight over the same period. Prison sentences might have been making headlines in the trade journals, but increases in fines were actually somewhat more important in recent years in raising the expected monetary costs of bid-rigging.

There are of course some problems with our enforcement data. Specifically, the density of enforcement activity is not very high prior to 1979. Hence, because we set missing values equal to zero and use twelve month moving averages for non-zero entries, our indicator is really not very reliable prior to 1980. In addition, DOJ enforcement activity has been concentrated in a few states. The states of Georgia, Illinois, Mississippi, North Carolina, Tennessee, and Virginia are what we term <u>active</u> states in that they account for roughly 90 percent of DOJ highway bid-rigging cases between 1975 and the end of 1981.[19]

To partially overcome these difficulties we have analyzed the effect of our enforcement series on three separate samples: a random sample of all our contracts, which cover all 50 states, over the time period 1975-82; a random sample, over all 50

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[19]For a more formal treatment of the implications of this concentration in indictments for deterrence, see Block and Feinstein (1986).

states, restricted to post 1979 data; and the post-1979 data restricted to the active states.

Empirical Results

In Table 3, we present the results of estimating the impact of recent enforcement efforts on the amount of bid-rigging in highway construction. As noted above, column represents a different sample: in the first column, the deterrent effect of antitrust enforcement is tested on a random sample of all highway contracts since 1975; the samples in Columns 2 and 3, on the other hand, include only contracts after 1979 and in Column 3, the sample is further restricted to contracts in active states.

When the enforcement measures are combined into an expected loss formulation and we estimate the impact of changes in ELOSS on bid-rigging, the results are clear and quite uniform. In all cases, an increase in the expected costs of rigging a bid due to antitrust liability (ELOSS) reduces the amount of bid-rigging actually going on in the highway construction industry. Our empirical results are clear and they indicate that the enforcement policies that have increased the costs that a potential bid-rigger can expect to incur as the result of fixing a bid have reduced markups in the highway construction industry. Since these markups are adjusted both for the idiosyncratic aspects of each state and the level of economic activity in the construction industry, the reduction in markup levels is likely to be a reliable indicator of a reduction in the amount of collusion in the industry.

Disaggregating the analysis somewhat and inquiring as to the independent effects of increases in the probability of being indicted and convicted (PCHARGE and CPCONVICT) and severity of punishment (PUNISH) reveal several quite interesting phenomena. Perhaps most significant is our inability, once we control for the severity of the recent sanctions, to find any evidence that recent increases in the indictment rate (or discovery rate) had an impact on markups or bid-rigging activity. The fact that the number of cases brought against highway bid-riggers increased dramatically in the late 1970's and early 1980's seems not to have had any independent effect on the level of bid-rigging.[20] The coefficient in PCHARGE is of the wrong sign and statistically insignificant in all of the regressions in Table 3. Only when we fail to control for severity, as in the bi-variate regressions in Table 4, is the relationship between RESID and PCHARGE negative and statistically significant. Of course, all of the bi-variate results are significant. This is to be expected since all of the enforcement variables are highly correlated and one variable tends to proxy for all of the enforcement variables, when only it is included in the regression.[21]

In terms of the other measure of certainty of punishment, CPCONVICT, the conditional probability of being convicted for bid-rigging given you are indicted for the crime, the evidence is

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[20]The probability of being apprehended for bid-rigging, according to our indicator, increased from less than .10 in 1975 to over .35 in 1982.

[21]See Feinstein et. al. (1983B) for details in the correlation between enforcement measures.

TABLE 3

MULTIPLE REGRESSION RESULTS

	Dependent Variable RESID		
	Sample		
Independent[1] Variable	All States Post-1975 (N = 3544)	All States Post-1979 (N = 1263)	Active States Post-1979 (N = 238)
ELOSS	-.188[2] (11.5)[3]	-.055 (2.46)	-.086 (1.86)
R^2	(.036)	.005	.015
PCHARGE	.040 (.615)	.076 (.702)	.169 (.673)
CPCONVICT	-.025 (3.75)	.099 (.734)	.030 (.111)
PUNISH	-.070 (3.70)	-.078 (2.27)	-.122 (1.66)
R^2	.056	.011	.030

Notes: (1) Intercept not reported in these regressions.

(2) Per $100,000.

(3) t-ratio, in parentheses, is signed identically to its associated coefficient.

TABLE 4

BIVARIATE REGRESSION RESULTS

	Dependent Variable RESID		
Independent[1] Variable	All States Post-1975	All States Post-1979	Active States Post-1979
PCHARGE	-.227 (12.0)[2]	-.082 (2.93)	-.123 (2.07)
CPCONVICT	-.055 (9.94)	-.134 (2.50)	-.192 (1.73)
PUNISH	-.070 (13.7)	-.035 (3.40)	-.053 (2.47)
N	3544	1263	238

Notes: (1) Estimate of intercept not reported in any of the regression.

(2) The t-ratio, in parentheses, is signed identically to its associated coefficient.

mixed. Again, only if we delete the controls for severity (PUNISH) and certainty of indictment (PCHARGE) as in Table 4 do we obtain unambiguous results. In the more general case, only if we consider the entire period from 1975 on do increases in CPCONVICT appear to reduce bid-rigging activity. The coefficient on CPCONVICT is negative and statistically significant in Column 1 of Table 3. It is, however, neither negative nor significant for the period after 1979.

Our empirical results suggest that Elzinga and Breit (1976) were correct in asserting that it is severity of sanctions and not certainty of detection that is most important in controlling collusion.[22] We were unable to find any consistent, independent, deterrent effect of the increase in the number of cases brought in highway construction by DOJ in recent years. There has been an explosion both in terms of the absolute number of bid-rigging cases brought and in the number of such cases relative to the number of collusive contracts in recent years. Yet there is no consistent evidence that this increase in activity level has, by itself, reduced the level of bid-rigging in the industry. Instead, it appears as if the government action that has been most successful in reducing the level of bid-rigging is the increase in expected penalty for bid-rigging. Recent efforts aimed at increasing the severity of punishment for bid-rigging appear to have been successful at reducing the level

[22]It is relevant to note that the results with respect to certainty of detection (PCHARGE) are basically unaltered if we replace PCHARGE with a variable that assumes all contracts involve some collusion and simply uses the number of contracts as the denominator in constructing the apprehension variable.

of bid-rigging. The evidence is quite consistent on this point. Across all of the samples and over both time periods, the severity of punishment for bid-rigging estimates show a negative and significant relationship between the markup on specific contracts and the level of punishment expected by a convicted bid-rigging.

Our results suggest that the increase in the number of cases brought by DOJ may have been neither as important nor possibly as unanticipated as has often been asserted.[23] The dramatic increase, however, in the costs of a conviction for bid-rigging, have proved to be extremely important in controlling the level of bid-rigging. The apparently unanticipated shift in penalties for bid-rigging that began in the late 1970's appear to have had a profound effect on the willingness of contractors to rig bids.

Some caution should, of course, be advised at this point. Our indicator of the chances of detection, PCHARGE, is problematic. We have only the crudest method of approximating the number of collusive contracts in any period and our results might be sensitive to this measurement problem. Also, it is quite likely that information other than the number of cases brought in highway construction are important in determining contractors expectations as to their chances of capture. It may be that the explosion in highway cases seriously overstates the

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[23]Unlikely as it may seem, given the level of bid-rigging in the industry, the number of cases, or for that matter the proportion of apprehensions, may have come as no real surprise to those in the industry. It is, perhaps, severity that really shifted upward since the widespread use of imprisonment and large fines was really unprecedented for price fixing violations.

increase in expected apprehension rates. The increase in the punishment meted out in the highway cases may have, on the other hand, really been "something new under the sun." Finally, as we have noted before, all of the punishment variables move together and they have all been basically increasing over time. Moreover, our enforcement measures are national variables with no state to state differences. Just how much independent variation we actually have in the sample is questionable. For all of these reasons we need to exercise some care in interpreting our results.

Concluding Comments

We set out in this paper to assess the effectiveness of recent efforts by the U.S. Government to control bid-rigging in the highway construction industry. Our results clearly indicate that recent U.S. enforcement efforts have been successful at reducing the level of bid-rigging. Surprisingly enough, however, we find that it is not the explosion in the number of cases brought in highway construction that is most important in controlling bid-rigging. Rather, we find that it is the very dramatic increase in the penalties that were assessed against convicted bid-riggers that appears to have been the most significant factor in reducing collusion in the highway construction industry.

Our results have several important implications. They suggest that getting tough with antitrust violators may pay significant dividends. In a sense, there may be an opportunity for, if not a free, at least a cheap lunch here. It would appear

from our analysis of the highway construction industry in the United States that raising the penalties and raising them substantially for antitrust violations such as collusion bidding will, in fact, reduce the level of such crimes. Now, it is a cheap lunch and not a free one because the penalties actually have been meted out before they show any effect. Simply announcing new penalties doesn't seem to work. After all, the Congress, in the Antitrust Procedures and Penalties Act, raised the legal penalties for price fixing quite substantially in late 1974, but this did not seem to influence behavior until the new penalties were actually used in highway construction cases in the late 1970's and early 1980's.[24]

The companion implication to this suggestion that we raise penalties substantially is that we ought to go slow on increasing our enforcement efforts in the antitrust area. We ought to wait and see if the increased penalties alone are effective, before we rush out and increase our enforcement efforts. If our results in bid-rigging are accurate, then it should be possible to make substantial gains against antitrust violations such as collusive bid-rigging without actually increasing greatly the number of violators apprehended. Our initial efforts should be directed towards getting substantially enhanced penalties meted out for those violators that we presently indict and convict. For as long as increasing punishment remains cheap relative to increasing detection and conviction probabilities, we ought to

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[24]For a discussion of the impact of The 1974 Penalties Act, see Block, Nold and Sidak (1978).

concentrate on increasing punishment. We ought not go out and substantially increase the number of bid-riggers that we indict or convict until we have exhausted all of the economies of substantially raising the punishment for these violations.

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APPENDIX TABLE I

DETERRENCE IN THE HIGHWAY CONSTRUCTION INDUSTRY VARIABLE DEFINITIONS

PCHARGE: the probability a contractor will be charged with an antitrust violation. It is the number of contractors apprehended by open date of the case divided by an indicator of the number of collusive firms. The indicator is the product of the number of active highway contractors times the number of contracts that month with a positive RESID divided by the total number of contracts let that month.

CPCONVICT: the probability of conviction, given apprehension. The number of contractors convicted that month divided by the total number of defendants in cases closed that month.

CCPFINE: the probability a defendant will be fined, given that the defendant is convicted. Number of defendants fined that month divided by total number of defendants in cases closed that month.

CCPJAIL: the probability a defendant who is an individual (as opposed to a firm, which cannot go to jail) is sentenced to jail, given conviction. Number of individuals sentenced to jail that month divided by total number of individuals in cases closed that month.

AVEFINE: the expected value of a defendant's fine, given that the defendant is fined. Average value of the fine for all defendants fined that month.

AVEJAIL: the expected value of an individual's jail sentence, given that the individual is jailed. Average value of the jail sentence for all individuals jailed that month.