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CONTRACT FORM AND PROCUREMENT COSTS: THE IMPACT OF COMPULSORY MULTIPLE CONTRACTOR LAWS IN CONSTRUCTION

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ABSTRACT

It is claimed that many regulatory rules enforce inefficiencies in order to achieve the appearance of cost control. We assess the importance of these claims by measuring the effect of New York state's compulsory multiple contractor law on the cost of public construction in New York City. Multiple contractor laws, which exist in many states, prohibit the use of general contractors in order to promote the appearance of competition. Contrasts of construction costs between buildings with identical blind cost estimates indicate that this law increases public construction costs by 8% and increases construction delays by more than a calendar year.

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In the last several decades there has been a wealth of theoretical work seeking to determine how economic institutions evolve. In the market sector the work of Coase (1937) and Williamson (1985) has spawned a rich literature on the nature of contracts between firms, and, in more recent years, some of the basic ideas have been the subject of empirical tests.[1] In the nonmarket sector the seminal ideas of Stigler (1971) have also spawned a rich literature (surveyed and added to in Laffont and Tirole (1993)) but, with some notable exceptions,[2] there has been very little empirical testing of the implications of these theories for the form that contracts may be expected to take in the government sector or for the impact of governmental regulations on contract performance. Rogerson (1994, p. 87), surveying the study of defense procurement, laments that "economists have played virtually no role in helping shape its regulatory practices and institutions."

In this paper we attempt a modest redress to this situation by reporting the results of a novel empirical analysis of the effect of New York State's multiple contractor law on the cost of the construction of public buildings in New York City.[3] New York's

multiple contractor law, like that in several other states, requires that public agencies must write and supervise a minimum of four separate contracts when a public building is constructed. Multiple contractor laws prevent the potential cost savings associated with the use of a general contractor in order to promote the use of many competitive subcontractors.

As Laffont and Tirole (1993) (and Rogerson (1989), Bower and Osband (1991), Riordan and Sappington (1989), and Taylor (1995)) have so persuasively argued, many regulatory oversight rules may enforce inefficiencies in order to achieve the appearance, but not the reality, of cost control. Compulsory multiple contractor laws are virtually laboratory examples of rules that are intended to promote the appearance of competition. In this paper we assess the effect of compulsory multiple contracting on costs empirically in order to determine whether, as the theories suggest, appearances may sometimes be deceiving.

There are some strong arguments for believing that construction procurement that involves a single contract with a general contractor may be a cost efficient arrangement, especially when the procurement agency is a state or local government. Following an insight due to Kearl (1983) and Quandt (1983), we may expect that the complexity of procurement arrangements between agencies and vendors will create a demand for the use of third parties, such as general contractors. Forbidding the use of such organizations will lead to a larger government bureaucracy than would otherwise exist and thus increase the total (direct and

indirect) costs of procurement.

Our empirical analysis is based on a random sample of data we have collected from the population of all new building and major rehabilitation public construction projects in New York City since 1980. For a variety of reasons, some of these public construction projects were built under exceptions to the multiple contractor law. In these projects the government procurement agency was free to use single or multiple contractor arrangements as they wish. Of course, building projects are not assigned randomly to the single and multiple contractor regimes, so they might differ in cost even in the absence of the compulsory multiple contractor law. It is therefore necessary to find a method to control for the possible correlation of building costs with the granting of an exception to the multiple contractor law. To estimate construction costs in the absence of a multiple contractor law we hired a professional independent construction cost estimator to provide <u>blind</u> estimates of construction costs for each building in our sample. Simple comparisons of the difference between actual and predicted costs in the compulsory multiple contractor and non-compulsory contractor regimes then provides a powerful estimate of the effect of the multiple contractor law on procurement costs. This procedure guarantees that the model used to estimate construction costs cannot be systematically manipulated to generate any particular result. In addition, since independent cost estimators provide very accurate estimates, the sample sizes required to accurately estimate the effect of a multiple contractor law on costs are

considerably reduced.

Our results indicate that the multiple contractor law increases public construction costs in New York City by about 8% on average, but by far more for small projects. The law also doubles construction time, while it provides no measurable improvement in the quality of pubic buildings. These results provide strong evidence, at least in this instance, that enforcing the use of multiple contractors in construction procurement does lead to an appearance of competition that is deceiving.

The remainder of the paper contains a discussion of the origins and economic arguments for and against multiple contractor laws, a description of our evaluation design and data collection, and an analysis of the empirical results.

I. The Origin and Economic Analysis of Multiple Contractor Laws

The origin and legislative intent underlying New York's multiple contractor law is not known since most of the records surrounding its origins have been lost. According to a report supporting repeal of the multiple contractor law it is generally believed that the law was designed to increase competition among subcontractors and to reduce costs by eliminating the general contractor's profit margin on the subcontracts.[4]

There is, in fact, little disagreement about the public intent of the statute. Supporters of the multiple contractor law approvingly cite Governor Thomas E. Dewey's empirical assessment that it is cheaper for the government to provide management

services than it is to buy them: "It is argued that by separate specifications and contracts the general contractor does not add his profit on the subcontracts to his overall bid. The issue seems rather simple. Unquestionably, the handling of more rather than fewer contracts increases administrative problems. On the other hand, I am satisfied that under the provisions of this bill, the construction can be accomplished more cheaply."[5]

In recent years there have been many opponents of the compulsory multiple contractor system. In what appears to be an about face from the past, some public agencies have argued much the way that Kearl (1983) and Quandt (1983) might have predicted: they claim they are ill equipped to handle the complexities of construction management and that it is cheaper to buy these services from a general contractor.[6] It seems likely that the change in the arguments by public agencies is a result of the general change in the way that public sector employees are viewed. As state and local governments face more serious budget constraints they become aware of the real scarcity of the resources they command.

Some have also argued that multiple contractor laws increase the opportunity for construction racketeering by (a) creating competition among subcontractor groups that find it easier to maintain cartels and (b) by permitting greater opportunities for fraud and extortion because public agencies are inferior monitors of construction costs.[7] As Laffont and Tirole (1993) have shown, these arguments can easily be formalized, although it is difficult

to verify their accuracy in particular empirical applications.

It is apparent from these arguments that an empirical analysis of the effect of compulsory multiple contractor arrangements on public construction costs would be helpful both to shed light on the empirical importance of the key theoretical issues and because of the potential importance such an analysis may have for a key issue of government procurement policy.

II. Design of the Study

Over the last several decades, a number of New York City and State agencies have been permitted exemptions from the provisions of New York's multiple contractor law. We take advantage of these exemptions to contrast data for buildings constructed under the single contractor and multiple contractor regimes.

A. Data Collection

The sample frame for the data collection consisted of all new building and major rehabilitation public construction projects in New York City since 1980. The starting date of 1980 was chosen so as to obtain as large a sample size as possible without running into complications created by the disruption of public construction during the New York City fiscal crisis of the mid-1970s. For most New York City agencies we obtained data on every project constructed in the period. For the two housing agencies, however, we obtained random samples of construction projects. Most of the projects available for the study were begun between the years 1984

and 1992. Virtually complete data was eventually collected on 248 projects constructed under the mandatory multiple contractor law and 163 projects that were not constructed under the law.

Data were collected through a series of four extensive questionnaires that were administered to the agency responsible for each construction project. If an agency was not able to provide a particular piece of information, other sources were consulted. Cost information was often only available from the New York City Office of Management and Budget. On occasion, dates or physical details were obtained from architects or construction firms involved with the project. A small number of physical details were obtained by visual inspection by study team members.

C. Variable Definitions

Construction Costs. We measured "fully-loaded" or "all-in" construction costs for this study. These costs include direct contract costs and all other costs associated with the project, including payments for design and construction management. Also included are payments for change orders during the construction process and payments arising from claims and litigation. In addition to direct costs, the "fully-loaded" project costs include all internal and indirect costs for agency personnel involved with the project. These personnel may have been involved in such areas as design or design supervision, bidding and contract negotiation, contract administration, construction management, construction work actually performed by agency personnel, and litigation and settlement of claims. It is especially important to include these

costs in any study of the effect of a mandatory multiple contractor law because it is precisely these costs that might be increased by such laws.

In general, City agencies had little difficulty in providing the amount of direct costs for each project. In contrast to external costs, several agencies had difficulty in providing internal (or agency) costs for each project. This task was easiest for those agencies that participated in New York City's Inter Fund Agreement (IFA) system. This system tracks professional time on construction projects and allocates general agency overhead (for clerical, other support, and supervisory personnel) to this direct professional time in the form of an hourly "burden rate." The city maintains this system because staff time that relates to a particular construction project is considered a part of the cost of the project. It can, therefore, be assigned to the City's capital budget and paid out of bond funds rather than out of general tax levies. Thus, the City's definitions closely parallel those that are conceptually correct for the measure of costs used in analysis.

In those instances where agencies were not able to provide an accounting of their internal costs on a project basis in a form that could be used in this study, an attempt was made to replicate as closely as possible the New York City IFA allocation procedure. In particular, agencies were asked to list all personnel by job title and area of functional responsibility along with the amount of time each devoted to the project. Job titles were screened by the study team and those that would have been treated as overhead

rather than directly billed under the IFA system were eliminated. These direct hours were priced using "burden rate" estimates from the New York City IFA system to allow for appropriate overhead levels.

Although the methods we have used to determine total building costs are, as with all accounting systems, to some extent arbitrary, we think they are reasonable approximations to the relevant economic concepts. However, there are two components of costs that are not included in our measures, and it is important to note the potential for error that this creates. First, the main measure of costs does not include the carrying (interest) charges for funds that have been spent on a project before it is ready for use. Marshall and Navarro (1991) observe in their study of the costs of nuclear power plant construction that the omission of these costs may result in biased estimates of the determinants of construction costs. Second, no allowance has been made for the social costs of programs that are deferred or overcrowded while waiting for construction to be completed. Both of these aspects of costs are difficult to quantify in our study. However, in view of our finding below that construction delays are higher under a multiple contractor law, it seems likely that our estimates of the effect of the multiple contractor law on costs are biased downward.

In the analyses of costs that follow, total costs were converted to a per square foot basis by dividing by the number of gross square feet in the project.

Construction Duration. We also collected data on a number of

key dates for each project, including (a) the date project design was begun, (b) the date on-site construction was begun, (c) the date the project was declared ready for intended use, and (d) the formal date of final completion of the project. From these dates, we calculated various measures of the duration of construction for each project. In fact, the results differ very little across the different measures and so we present only the results of an analysis of the time from the date on-site construction was begun to the formal date of final completion of the project.

Building Quality. Our questionnaires asked whether repairs were required to a building's roof, heating, air conditioning or other systems and facilities during the first two years that the building was in use. These are crude measures of the quality and reliability of the construction work undertaken.[8]

B. Estimated Construction Costs

The ideal evaluation method would randomly assign projects to single and multiple contractor regimes and examine any cost differences that result for a large sample of buildings. With randomization, all other costs of construction would, on average, be the same apart from sampling error. With a large enough sample, the sampling error would be small enough to reliably detect any building costs differences due to the multiple contractor law.

When this ideal procedure is not available, it is common to make adjustments by multiple regression for factors that might affect construction costs and that might be correlated with the

contractor regime to which a project is assigned. This procedure has two different effects: (1) it attempts to eliminate specification errors due to any correlation between the contractor regime and what costs might otherwise have been, and (2) it decreases the sampling error of the estimated effect of the law in proportion to the amount that the observable factors reduce the unexplained variability in construction costs. Despite these desirable effects, the use of regression models in place of randomization is controversial. As others have pointed out,[9] there is the suspicion that many models are constructed from arbitrary assumptions about which variables to include and which to exclude. Some observers may even suspect that assumptions are selected to predetermine the outcome of the analysis.

Construction costs are highly variable and difficult to explain with the available statistical models, and the sample of new construction projects is relatively small. Figure 1 contains a histogram of the cost per square foot (in 1988 dollars) for the 411 public buildings in our sample constructed in New York City between 1980 and 1992. Construction costs vary from a low of $15 per square foot to a high of $966 per square foot. Mean construction costs are around $130 per square foot, but the standard deviation of construction costs is $112 per square foot. This enormous variability is caused primarily by differences in the design of public buildings, some of which are heavily secured new marble covered court houses while others are simple school renovations. This variability makes it difficult to design a study

to detect relatively small differences in construction costs when only small samples are available.

The basic sample design problem may be illustrated if we write the estimated effect of the multiple contractor law on the logarithm of the cost per square foot of a building as θ.[10] For small values, θ is approximately the proportionate effect of the multiple contractor law on construction costs. The sampling error of θ , σ_θ, estimated from a regression of ln costs, c, on a dummy variable, m,indicating the presence of a multiple contractor requirement and other determinants of construction costs, x, is then

$$(1) \quad \sigma_\theta = \frac{\sqrt{(1-R^2)}\,\sigma_c}{\sqrt{(np(1-p)\,(1-R^2_{m.x})}};$$

where σ_c is the standard deviation of c; R^2 is the explained variance from a regression of c on m and x; p is the fraction of buildings subject to multiple contractor provisions; $R^2_{m.x}$ is the explained variance from a regression of m on x; and n is the sample size.

In a best case scenario, where the sampling error of θ is minimized, p=.5, and $R^2_{m.x}=0$. Since few observers argue that θ is greater than .10, it is apparent that we require that $\sigma_\theta < .05$ to detect a statistically significant effect of the multiple contractor law on costs using conventional significance levels. To determine the sample sizes required to obtain this precision we

observe that in our data $\sigma_c = .66$, and the R^2 from a comprehensive model using all the measured characteristics of the buildings we were able to obtain is about .3. It follows that to obtain $\sigma_\theta < .05$, n must be greater than 488, which, even in this best case scenario, is far larger that the sample available. It is apparent that the reliable detection of small differences in construction costs requires either large samples or a better statistical model for the explanation of construction cost variability.

Our solution to both these problems was to employ a professional construction cost estimator to prepare estimates of construction costs for all the projects that entered the analysis.[11] The professionals who developed the cost estimates were given complete physical data regarding the building, but they did not know the contractor regime under which it would be built. The estimators were told to assume that the project was not built under a mandatory multiple contractor law (that is, it could be built under either regime, which ever was cheaper) and that construction was started in the third quarter of 1988. (This was near to the center of the start dates of the projects in our sample.) The cost estimates were then indexed to the year in which construction on the specific project was begun using the standard Means Construction Cost Index for New York City.

This procedure provides a novel and powerful adjustment method in situations where randomized trials cannot be implemented. Since we deliberately concealed any knowledge of the contract regime under which the projects were actually constructed, there is no way

the construction cost estimators could explicitly alter their estimates in order to bias them in favor of one procedure over the other.[12] This method increases considerably the credibility of the estimates of the effect of contractor regime on construction costs that we present below. The predictive accuracy of the construction cost estimates also permits the detection of small cost differences with manageable sample sizes.

Figure 2 provides some evidence on the predictive ability of the construction cost estimates. It plots the logarithm of actual construction costs against the logarithm of estimated construction costs. As the diagram indicates, the explanatory power of the construction cost estimates is considerable. The R-squared of a regression of construction costs on the estimates is about .85. The same regression using the available physical characteristics of the buildings in our sample as regressors has an R-squared that is never above .30. In short, the use of the construction cost estimates reduces the unpredictable variance in our estimates of construction costs from .7 to .15. The effect of this is to reduce the standard error of the estimate of the effect of the contractor law on costs by roughly the same amount as would a five-fold increase in the sample size.

II. Empirical Results

Means and standard deviations of the main variables of interest are contained in Table 1. These data indicate that buildings built under the multiple contractor requirement were

larger, more costly to construct, and took far longer to construct than did buildings built without the requirement. Multiple employer contracts resulted in a cost per square foot that averaged $30 more than single employer contracts. However, our external cost estimates indicate that predicted costs were $13 per square foot greater on multiple employer contracts than on single employer contracts. The difference between these cost differences, $17, is a simple difference-in-differences estimate of the impact of the multiple contractor law on construction costs. With a t-value of 3.2, the estimated difference is determined precisely enough to be judged significantly different from zero at conventional test levels.

Table 2 provides regression estimates of the multiple/single contractor effect on construction costs. In view of the skewness in the distribution of construction costs we have used the logarithm of cost per square foot as the dependent variable, although this has very little effect on the main conclusions of the analysis. Column (1) of Table 2 reports the simplest estimate of the effect of the multiple contractor requirement on costs. Here, the estimated cost variable is constrained to have a coefficient of unity. The estimate implies that the multiple contractor requirement raises costs by 8%. In column (2) we relax (and test) the constraint on the effect of estimated costs on actual costs. As the results indicate, there is no strong evidence against the hypothesis that this coefficient is unity, and the estimated effect of the multiple contractor requirement is changed only slightly.

In the third and fourth columns of Table 2 we test some further hypotheses about the nature of the effect of the multiple contractor requirement on costs. It seems possible that smaller projects may be a major source of the cost disadvantage associated with the multiple contractor requirement. In these projects the fixed costs associated with hiring and firing in the public sector are likely to lead to the greatest inefficiencies. Figure 3 displays some graphical evidence relevant to this hypothesis: the scatter diagram of the difference between actual costs and predicted costs[13] against building square footage for the buildings constructed under the multiple contractor requirement. The apparent negative relationship is confirmed by more formal tests in Table 2.

The results in column (4) of Table 2 indicate that the excess cost of building construction under the multiple contractor law is around 24% for very small (say, 3,000 square foot) buildings, and about 8% for a building of average size (65,000 square feet). The results also indicate that the multiple contractor effect is negligible in buildings with more than 147,000 square feet, which is about the top decile of buildings in our sample. For practical purposes, therefore, the multiple contractor effect is positive over a very wide range of building sizes. It is also worth observing that the variable measuring gross square footage is significant only when buildings are constructed under the multiple contractor requirement. Apparently our simple adjustment of costs for square foot variability is an adequate description of the data.

Table 2 also provides estimates of the effect of the multiple contractor law on the natural logarithm of the time to building completion. Although we have no independent measure of the expected time to completion of each building, we use the estimated construction cost as a regressor in column (6) on the assumption that more costly buildings are likely to require longer construction times. For the mean building, we find that the time to construct is roughly doubled (exp(.755)=2.13) under the multiple contractor requirement. The results in column (7) indicate that, as with construction costs, the impact of the multiple contractor requirement on the time to construct is smaller with larger buildings. This effect becomes negligible only with buildings of around 120,000 square feet, however.

Table 3 provides the data we have collected on the quality and reliability of the buildings constructed under the multiple and single contractor regimes. In general, the data indicate that multiple contractor buildings have more defects than single contractor buildings, but these differences are usually not statistically significant. Regression estimates (not reported here) weaken the statistical significance of the results further. As a result, we conclude that there is little evidence of any difference in the quality or reliability of the buildings constructed under the multiple and single contractor regimes.

III. Conclusion

In this paper we have used a novel procedure to evaluate the

role of a mandatory multiple contractor law on construction costs. We hired professional construction cost estimators to provide blind estimates of these construction costs. Although this does not guarantee that some omitted factor correlated with construction costs is not the cause of the cost differences we have found, and is therefore no substitute for randomized trials, it does provide a credible method for guaranteeing that the estimates cannot be deliberately manipulated. As we show, these professional estimates are powerful predictors of construction cost differences. Our procedure therefore provides a powerful tool for estimating the effects of policies that might otherwise have a difficult to detect effect on noisy outcomes. We think there may be many other areas where the evaluation of legal and social policies could be usefully addressed using these methods.

The substantive results indicate that the presence of mandatory multiple contractor laws increase construction costs from 6% to 10% above what they otherwise would be. We also find that compulsory multiple contractor projects require roughly double the time from the beginning of a design to the completion of a building, which amounts to one to two years of delay for the typical project. Finally, we find no evidence that there are significant differences in the quality of the construction under the two regimes.

1.See Joskow (1988) for an early survey.

2.See, for example, Dubin and Navarro (1988), and the references therein.

3.The multiple contractor law in New York is popularly called the Wicks Law, after the sponsor of a bill which incorporated the multiple contractor requirement into New York's Public Housing Law in 1946. In fact, the original multiple contractor law in New York dates from 1921.

4.See Office of the Mayor, City of New York (1981), p.4.

5.See New York State Council of Mechanical Trade Contractors (no date), p. 3.

6.See Office of the Mayor, City of New York (1981), pp. 8-13.

7.See New York State Organized Crime Task Force (1988), pp. 108-111.

8.A complete list of the buildings included in the analysis, a set of the data used in the analysis reported below, and a detailed appendix describing the data collection in greater detail is available on request from the authors.

9.See Ashenfelter and Card (1985), Lalonde (1986), and Heckman and Hotz (1989) for discussions focused on the estimation of labor market program treatment effects. Leamer (1983), Efron and Feldman (1991) and Freedman (1991), who recounts Snow's (1965) work on the determinants of cholera, are among the few explicit discussions of randomization in the social sciences and medicine.

10.As Figure 1 indicates, the frequency distribution of construction cost per square foot has properties similar to those of a log normal distribution. For statistical purposes it is therefore convenient to analyze the effect of the multiple contractor law on the natural logarithm of costs. In fact, tests for normality of ln costs reject this hypothesis, though at much larger significance levels than for the level of costs.

11.Construction cost estimators at Wolf and Company, Pleasantville, N.Y. provided the cost estimates. Providing such cost estimates for architects and developers (including public agencies) is the business of Wolf & Co, which has considerable experience in making such estimates. The company reported that in 99.7% of buildings, its estimates were between 0% and 5% higher than the actual low bid.

12.Construction cost estimators are hired to act as independent third parties in providing their estimates. There remains the possibility that, based on their historical experience, our

estimators tended to predict multiple-contractor costs for the kinds of buildings typically built in the multiple contractor regime.

13.Predicted costs are constructed using the coefficients from a regression of actual costs on estimated costs among the sample of buildings that were not subject to the multiple contractor requirement. As indicated in Table 1, the mean (and standard deviation) of estimated costs for projects built with and without the multiple contractor requirement does not differ dramatically. As a result, these predictions are not far out of sample.

Table 1

Sample Means and Standard Deviations for New York City Construction Projects, 1980 - 1992

Building Characteristics	Multiple Contractors:		Difference
	Required	Not Required	(Required-Not Required; t-value in Parentheses)
Total (Contract Plus Other) Cost Per Square Foot	142.0 (123.0)	112.0 (90.0)	30.0 (2.69)
Estimated Contract Construction Cost Per Square Foot	103.0 (92.0)	89.5 (66.9)	13.0 (1.60)
Construction Time (months)	34.1 (23.0)	17.6 (14.0)	16.5 (7.70)
Gross Square Feet	65,937 (72,710)	62,429 (78,565)	3,508 (.463)
Number of Observations*	248	163	

*For the data on construction time the sample sizes are 232 and 146, respectively, due to a few missing observations.

Table 2

Regression Estimates of the Effect of a
Multiple Contractor Law on Construction Costs
and Time to Construct, New York City, 1980 - 1992

Dependent Variable:

	ℓn cost				ℓn (Time to Construct)		
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Multiple Contracts Required	.080 (.025)	.078 (.025)	.731 (.195)	.738 (.195)	.755 (.077)	.564 (.057)	2.14 (.43)
ℓn Estimated Costs	1.0	1.027 (.021)	1.019 (.020)	1.0		.192 (.046)	.183 (.045)
ℓn Gross Square Footage			-.0076 (0.13)	-.008 (.013)		.382 (.021)	.455 (.029)
ℓn Gross Square Footage × (Multiple Contracts Required)			-.062 (.019)	-.062 (.019)			-.153 (.042)
R^2	-	.86	.869	-	.20	.58	.59

TABLE 3

Reported Building Defects By Multiple/Single Contractor Status, New York City, 1980 - 1992

	Multiple Contractors	Single Contractors
Number of Projects Analyzed	216	159
Percentage Reporting Roof Leaks	17.6%	6.9% *
Percentage Reporting Heating Defects	6.9%	6.3%
Percentage Reporting Air Conditioning Defects	4.7%	3.2%
Percentage Reporting Other Major Defects	8.3%	6.3%

* Difference between Multiple/Single Contractor projects stat stically significantly different from zero at the 5% significance level.
Regressors are the same as those in Table 3.

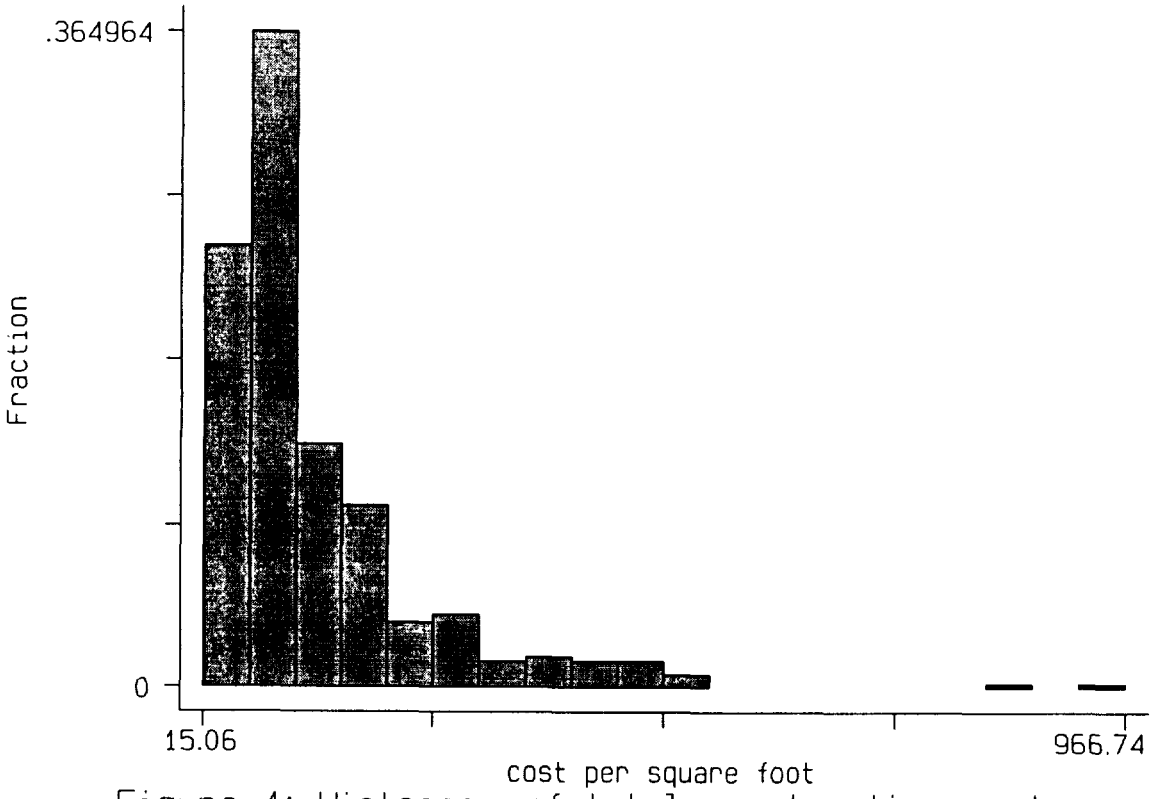

Figure 1: Histogram of total construction cost

STATA™

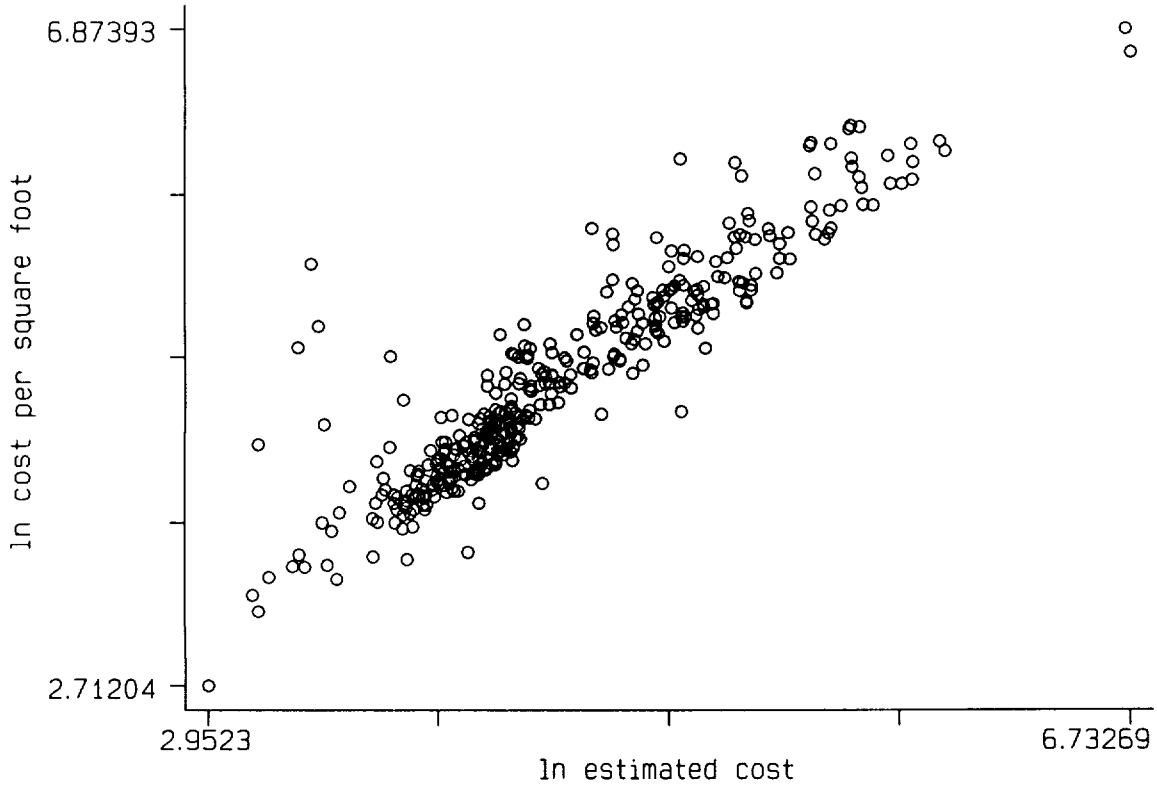

Figure 2: Relationship of Actual to Estimated Costs

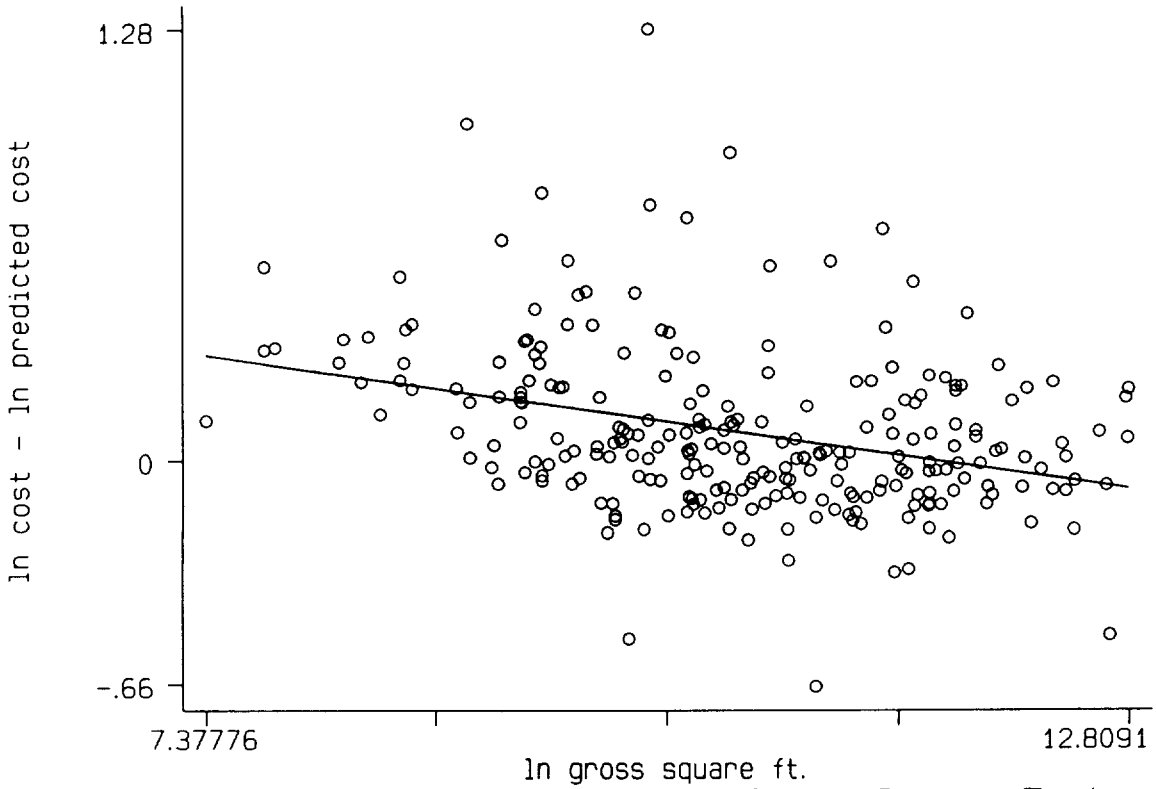

Figure 3: Excess Cost Related to ln Gross Square Footage

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