Contractors in Cyclical Economic Environments

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Abstract: This study investigated how the performance of construction firms during different extremes in the business cycle was impacted by a variety of the firms' characteristics. A performance index for a firm's relative market performance was devised and used with a step-wise regression technique to model the relationships between operational variables and the performance index. Ten interviews with senior construction executives were conducted to guide the development of the model. The results show that a firm's relative market performance can be influenced by: Efforts in planning and control; control at firm level; effectiveness of project planning and control; efforts in marketing; effectiveness of marketing; subcontracting; long-range planning; safety; geographic diversification; technological competence; and union/open-shop construction. Significance varied with cycle point and size. Recommendations are made on how to improve a contractor's performance in cyclical business environments.

Introduction

Cyclical fluctuation of construction demand has plagued the construction industry for many decades. In attempts to stabilize construction cycles, numerous efforts have been made to regulate the economy by fiscal and monetary policies. In addition, a number of governmental and quasi-governmental institutions have been formed to moderate the volatility of the housing industry through the mortgage market. Many counter-cyclical public works have also been introduced in almost every recession. However, despite the good intentions of these efforts, a recent study on the construction cycles in the United States since World War II (2) indicates that total construction, especially private construction, is becoming increasingly volatile; and cyclical changes in public construction have not consistently moved in opposite directions to those of private construction. Although there is no doubt that continual efforts will be made to stabilize the construction industry, many economists (e.g., Refs. 2, 3), express a pessimistic outlook for success. It appears that contractors cannot rely on the stabilization efforts to give them a stable business environment, at least not in the near future. A more realistic and positive strategy is to find better ways to adapt to volatile economic conditions.

The focus of this research is on identifying and quantifying the effects of operational variables on a construction firm's performance. Special emphasis is placed on those operational variables that can impede or enhance a firm's performance in cyclical environments. These variables are called resilient variables. More specifically, the resilient variables are defined as the operational variables which hinder or facilitate a firm's

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ability to adapt optimally to changing economic conditions. The levels of the resilient variables do not indicate the degree of difficulty in adjusting their values; rather they represent a set of resilient characteristics of a firm. The information about the resilient variables are particularly crucial for firms to prepare for the fluctuating markets. The findings of this study are useful to construction firms in setting strategies to improve their operations.

Research Methodology

The relationships between a firm's performance and its determinants are viewed as an empirical performance model. This model can be specified as

$$P = f(R, O)$$

where P is the firm's performance measure; R is a vector of resilient operational variables; O is a vector of regular operational variables; and f is a function of R and O. No prior study is available to guide the selection of the functional form. Since the performance measure may have negative value, log-linear specification is not appropriate. The standard simple linear form is used. This exceedingly popular specification is very appealing in terms of tractability and ease of interpretation of regression coefficients. Scattergram and nonlinear specification of each operational variable are examined. The results show no evidence of nonlinear relationship between the operational variables and the performance measure. Thus, the performance model is expressed as

$$P = C + \sum_{i=1}^{n} rR + \sum_{i=1}^{m} oO$$

where n and m are the number of resilient and regular operational variables, respectively; C is a constant; P, R, and O follow the meanings defined in the last equation; and r and o are the coefficients of R and O, respectively. The step-wise regression algorithm is used to select the important resilient and regular operational variables for inclusion in the model. The parameters of the performance model are estimated for both good and bad times so that the impact of the operational variables under different economic conditions can be studied.

The fact that the firms in the data sample range in size requires special attention to the measurement of the variables in the model. For instance, since larger firms have more employees, the number of employees turned over per period of time is normally higher than that of smaller firms. If net profits are used as a performance measure, turnover rate will have a positive correlation with performance. However, this positive correlation is just a reflection of the size effect. To isolate the size, the turnover rate must be normalized by a size measure, such as the number of employees, and compared among firms of different sizes. Similarly, net profits should be normalized. Otherwise, the operational characteristics of the bigger firms will have disproportionate impact on the parameter estimates of the model because of their higher magnitude of net profits. To structure the model correctly, the size effect should be removed from

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both the performance variable and the operational variables.

Several non-size related performance measures are available. The common ones are net profits as a percentage of revenue, net profits as a percentage of assets, and net profits as a percentage of equity. The first one is obviously inappropriate for construction firms because the amount of subcontracting can significantly affect firm's revenue even though the size of the firms are the same. Since the amount of equipment rental and leasing, and the debt to equity ratio vary widely among construction firms, assets and equity are not very good measures of size. Moreover, the value of assets and equity can be substantially affected by accounting methods. A better measure of a firm's size is its production capacity. Since the prime production input in construction is labor, and the labor capital ratio is rather constant, labor capacity defined as the average total number of employees is a good measure of a firm's size. Furthermore, it is also an appropriate size variable for normalizing the operational variables such as turnover rate and number of multi-skilled workers (a measure of human resource flexibility). For the aforementioned reasons, average number of employees is used as the size variable to remove the size impact on the performance measure and the operational variables.

Direct normalization of net profit has one shortcoming. Firms of various sizes may have different profit margins and may be subjected to a different influence of a construction cycle. For example, larger firms may have higher profit margins and be less affected by construction slumps. Therefore, the data of larger firms will still carry a disproportionate weight. To solve this problem, a two-step normalization procedure is used. The first step is to establish a market profit line as a function of size (see Fig. 1). The market line represents the prevailing profit levels for a given

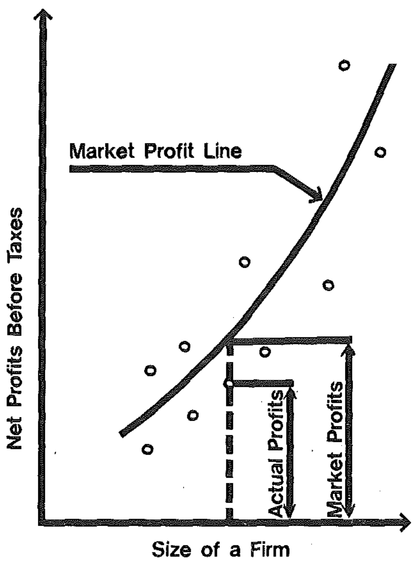

FIG. 1.—Market Profit Line

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TABLE 1.—Measure of Variables

Variable (1)	Measure (2)	Unit (3)
Performance index	Ratio of a firm's actual profits to market profits	Unit free
Union/openshop	Binary variable, one for union firms	Zero and one
Fixed capital	All fixed assets per employee	Dollar per employee
Flexibility in human resources	Ratio of multiple-skilled salaried employees to all employees	Unit free
Flexibility in cost structure	% of variable payments to salaried employees in a good year	%
Flexibility in financial structure	Debt to equity ratio; working capital as a percentage of revenue	Unit free %
Diversification by line of business	Correlation coefficient of a firm's job portfolio and the market portfolio	Unit free
Diversification by geographic area	% of revenue from non-home states	%
Quality of output	% of business from repetitive clients	%
Experience of management	Average years of construction experience for all key employees	Year
Labor-management relation	Average turnover rate of salaried employees	Salaried employee per year
Technological competence	Binary variable, one for firms having in-house computers	Zero and one
Accident level	Experience modification rate	No units
Subcontracting	Total payments to subcontractors as a percentage revenue	%
Work load intensity	Office hours of an average workweek	Hours
Tracking market trends	Binary variable, one for tracking market trends	Zero and one
Long-range planning	Binary variable, one for firms having specific long-term business goals	Zero and one
Operational planning at firm level	Binary variable, one for firms having specific annual business goals	Zero and one
Operational control at firm level	Binary variable, one for firms having monthly performance review	Zero and one
Effectiveness of project planning	% of a firm's projects using bar charts or CPM	%
Effectiveness of project planning and control	% of projects with updates of bar charts or CPM	%
Efforts in planning and control	Weekly man-hours per employee on planning and control activities	Man-hours per employee
Effectiveness of marketing	% of business volume from negotiated contracts	%
Efforts in marketing	Weekly man-hours per employee on marketing activities	Man-hours per employee

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economic condition and is determined by regressing net profits against the number of employees. The second step of the normalization process is to compute the value of a performance index by dividing each firms actual profits by its corresponding market profits. A firm's performance index value is equal to one if its actual profits are the same as the market profits. The performance index, in short, is a normalized profit variable which measures relative performance deviation from the market profit line.

The regression results show that the market profit lines are indeed significantly nonlinear. With the preceding formulation, the firm's relative performance can be effectively measured. The explanatory variables of the performance model in effect explain the variation of a firm's performance relative to the market. The final form of the model is

$$\frac{Pa}{Pm} = c + \sum_{i=1}^{n} r_i R_i + \sum_{i=1}^{m} o_i O_i$$

where Pa is the firm's actual net profits before taxes; Pm is the market profits corresponding to the firm's size; and other notations have the meanings defined in the last equation.

The list of operational variables is generated from ten in-depth interviews with senior construction executives, an extensive literature review, and additional analysis based on the theories in management and economics. While it is impossible to model every aspect of a firm's operation, the set of variables included covers many vital areas suggested by practitioners, such as quality of output, technological competence, planning and control, marketing, management quality, operational flexibility, labor relations, and safety. A summary of these variables and their measures are listed in Table 1. While measures for variables appear subjective in several cases, they appear suitable for differentiation and are analyzed in detail by Wong (4).

The data of this study were collected by mail questionnaire survey of nonresidential building construction firms in the Greater Boston area for 1982 and 1977. For the nonresidential building contractors in Boston, 1982 was a good year, while 1977 was a bad one. The level of nonresidential building activity in 1977 was roughly half of that of 1982. The survey included about 1,000 contractors and the response rate was 11%. This low response rate can be attributed to the unusually high level of construction activity in Boston when the survey was conducted, and to the extremely demanding nature of the questionnaire.

Research Findings

Many operational variables were considered in the study; in order to focus on the more important ones, a correlation analysis was conducted. The results of the correlation analysis are shown in Table 2. It is appropriate to point out that a significant correlation between an operational variable and the performance index does not necessarily mean that the operational variable has some effect on a firm's performance. In contrast to a regression coefficient, the correlation coefficient of an "explanatory" variable does not reflect the net impact of the variable on the "depen-

TABLE 2.—Correlation of Operational Variables and Performance

Operational variable (1)	Good year (2)	Bad year (3)
Union/openshop	−0.0374	−0.1895[b]
Fixed capital	−0.1042	0.0243
Flexibility in human resources	−0.0132	0.0946
Flexibility in cost structure	0.0038	0.0840
Flexibility in financial structure		
Debt to equity	0.1376	−0.0730
Working capital	−0.0558	−0.0483
Diversification by line of business	−0.0486	0.0883
Diversification by geographic area	0.4004[a]	0.3637[a]
Quality of output	0.0384	0.0539
Experience of management	−0.0319	0.0520
Labor-management relation (turnover rate)	−0.0694	−0.0213
Technological competence	0.1537	0.1914[b]
Accident level	−0.2418[a]	−0.2633[a]
Subcontracting	0.4221[a]	0.3002[a]
Work load intensity	0.0029	0.1401
Planning and Control		
Tracking market trends	0.1858[b]	0.2788[a]
Long-range planning	0.2009[b]	0.3065[a]
Operational planning at firm level	0.1469	0.2776[a]
Operational control at firm level	0.0033	0.2232[a]
Effectiveness of project planning	0.4164[a]	0.3184[a]
Effectiveness of project planning and control	0.4752[a]	0.4396[a]
Efforts in planning and control	0.3844[a]	0.3983[a]
Marketing		
Effectiveness of marketing	0.2655[a]	0.3174[a]
Efforts in marketing	0.0896	0.2421[a]

[a]Statistically significant at 5% level.
[b]Statistically significant at 10% level.

dent" variable. The ultimate step is to determine the individual effect of each relevant operational variable on a firm's performance through regression analysis.

Only a small set of the operational variables listed in Table 2 is statistically significant. It is, however, also informative to know what variables are not important. The correlation results of each operational variable will be considered in turn. In good times, union construction had little correlation with performance, implying union firms did not appear to be at a competitive disadvantage. However, in bad times, union construction was negatively correlated with performance. The "iron-rich-cash-poor" policy as represented by the amount of fixed capital had no correlation with performance in the bad time, but had a small negative correlation in the good time. It is interesting to note that flexibility in human resources, cost structure, and financial structure did not correlate with performance of a firm.

Theoretically, diversification may reduce the inefficiency which results from insufficient workloads, but it may also reduce the efficiency of spe-

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cialization. During construction slumps, a diversified firm is therefore likely to perform better. But during boom times, diversification may have a negative effect on a firm's performance. The coefficients of diversification by line of business did indicate the aforementioned effects, but they were not statistically significant. However, if slumps only occur in some market segments, diversifications by line of business should have greater positive impact on a firm's performance. Diversification by geographic area had a strong positive correlation with performance in both the good and bad times. This may result from the fact that diversification by geographic area has several advantages over diversification by line of business:

1. A firm can use the same technical expertise, experience, and key personnel. Thus the loss of specialization efficiency from geographic diversification is small.
2. A firm can select the most profitable market locations and relocate its resources rather easily to those areas.
3. The risk of loss and learning costs are substantially lower than branching into different lines of business.

The quality of output had only weak positive correlation with a firm's market performance. One of the possible reasons is that the quality of construction output is specified in contract documents and contractors are liable to meet the quality requirements. Moreover, the measure of output quality was the percentage of business volume from repeat clients, which might not be a good measure. In the bad time, output quality had a slightly stronger correlation with performance, but the coefficient was still too small to be statistically significant.

The construction experience of key employees did not correlate with a firm's performance. This appeared to result from the fact that the key employees of almost every firm in the sample had many years of experience. The amount of experience appears to be sufficient to not allow differentiation.

Labor-management relations as measured by the turnover rate of salaried employees had a negative, but insignificant correlation with performance. The turnover rate was the average rate over a period of three years so that bias due to extreme events could be reduced. During the design of the questionnaire, it was found that very old turnover rate data were difficult to obtain. Hence the turnover rate of 1982 is also used for 1977. To the extent that the labor-management relations of the firms remained relatively stable, the errors introduced into the correlation estimate in 1977 is small. The estimated coefficient of 1982 turnover rate clearly showed little negative correlation with a firm's performance.

The remaining correlation coefficients were very close to expectation. The correlation coefficient of technological competence was significant in the bad time, but not high enough to be significant at 10% level in the good time. While accident level had significant negative correlation with performance, subcontracting exhibited strong positive correlation in both demand conditions. Workload intensity was clearly not correlated with performance in the good time, but had weak positive correlation in the bad time. The basic operational variables—planning, con-

TABLE 3.—Performance Models in Good Times

Explanatory variables (1)	All firms (2)	Big firms (>30 employees) (3)	Small firms (<31 employees) (4)
Constant	0.6624	0.0758	1.2235
	(1.9780)	(0.2582)	(2.6948)
Long-range planning	0.2938	0.3633	0.3556
	(1.6858)	(1.1779)	(1.7653)
Effectiveness of project planning and control	0.006	0.0047	0.0063
	(2.4558)	(1.3022)	(1.9697)
Efforts in planning and control	0.1523		0.1733
	(3.5054)		(2.8274)
Effectiveness of marketing	0.005	0.0046	0.0028
	(2.0853)	(1.1519)	(0.8990)
Subcontracting	0.0101	0.0118	0.0073
	(3.2202)	(2.4604)	(1.8082)
Accident level	−0.0112		−0.0169
	(−4.2099)		(−4.9304)
Geographic diversification	0.0112		0.0179
	(3.8465)		(4.0380)
R-squared	0.5699	0.3439	0.7477
F-statistic	15.7095	3.6689	17.7834
Number of observations	91	41	50

Note: Figures in parentheses are *t*-statistics. Dependent variable is performance index (defined in Chapter 3).

trol, and marketing—are significantly correlated with performance with the exceptions of operational planning and control at the firm level and efforts in marketing in good times.

Based on the information of the correlation analysis, a step-wise regression algorithm was used to select the operational variables for inclusion in the performance models. In order to study the differences between large and small firms, both of their performance models were estimated. Since there were many parameters in the performance models, the sample size could not be too small. The sample of each time period was broken down into two groups. The small firm sample contained all the firms with fewer than 31 employees. The rest of the firms were grouped into the big firm sample. The estimation of the performance models for big and small firms followed the same procedure mentioned before. The results are shown in Tables 3 and 4.

The regression results showed that the effectiveness of the project planning and control variable was slightly better than the effectiveness of project planning alone. The two variables had exceedingly high correlation. The choice of either variable did not affect the parameter estimates of the other variables in the models. The effectiveness of the project planning and control variable was used for all the performance models.

The performance models in the good time are shown in Table 3. The following are some examples of interpreting the meaning of the regression coefficients estimated from the all firms sample. If a firm has long-range planning, the performance model predicts that its net profits be-

TABLE 4.—Performance Models in Bad Times

Explanatory variables (1)	All firms (2)	Big firms (>30 employees) (3)	Small firms (<31 employees) (4)
Constant	1.0703	1.2784	0.5774
	(2.7699)	(2.5226)	(1.0114)
Effectiveness of project planning and control	0.0075	0.0059	0.0096
	(2.7031)	(1.3787)	(2.5608)
Efforts in planning and control	0.0605	0.1493	
	(1.1275)	(1.7180)	
Effectiveness of marketing	0.0095	0.0083	0.0096
	(3.0543)	(1.6558)	(2.6104)
Efforts in marketing	0.0914		0.1111
	(1.8663)		(2.2042)
Accident level	−0.0122	−0.0147	−0.0072
	(−3.3981)	(−2.7475)	(−1.3816)
Geographical diversification	0.0137	0.0070	0.0139
	(3.4910)	(1.3619)	(1.7484)
Technological competence	0.531		1.6713
	(2.0822)		(1.6677)
Union construction	−0.4162		−0.4903
	(−2.2099)		(−1.8723)
Control at firm level		0.4368	
		(1.4277)	
Subcontracting		−0.0050	
		(−1.0192)	
R-squared	0.5961	0.5873	0.6918
F-statistic	11.8061	4.8786	7.7325
Number of observations	73	32	41

Note: Figures in parentheses are t-statistic. Dependent variable is performance index.

fore taxes can be 29.4% higher than the market profits corresponding to its production capacity. By increasing the use of bar charts or the critical path method on a firm's projects by 1%, its relative market performance can improve by 0.6%. If a firm increases 1 man-hour/wk/employee in planning and control, its relative market performance will increase 15.2%. The reliability of these estimates is highest when the values of the operational variables are close to their mean values. Thus if a firm increases its effort in planning and control by 10 man-hours/wk/employee (the mean value is 1.9), its market performance may not improve by 152%.

Table 3 shows that the performance model of small firms is quite close to the one for all firms. But for big firms, efforts in planning and control, accident level, and geographic diversification are not significant in explaining the variation of big firms' relative market performance. As indicated by the R-squared value, the explanatory power of the performance model for big firms is much lower than those for small firms and all firms. Despite the comprehensive list of variables considered, there may be mising variables, or the existence of large random effects in the performance variation of big firms. To the extent that the random effects

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and missing variables, if any, are not correlated with the explanatory variables in the model, the regression coefficients are not biased.

The performance models for bad times are shown in Table 4. The model for small firms is fairly similar to that for all firms, except that efforts in planning and control are not significant for small firms. The model for the big firm is again significantly different from the other two. Efforts in marketing, technological competence, and union construction are not significant explanatory variables, while control at firm level and subcontracting increases the explanatory power of the model. The R-squared values of all the models in bad times are rather high. Except for the performance model for the big firm in good times, all the models can be considered very successful as compared to other research studies of a similar nature.

Table 5 compares the performance models in good and bad times. The results show that the important regular operational variables are the basic, fundamental measures of good business practice in building construction, i.e., planning, control, marketing, and subcontracting. Efforts in planning and control are important to big firms in bad times and are important to small firms in good times. One possible reason for this pattern is that a small firm usually relies on the entrepreneur to oversee and control the firm's operations and often lacks a control system to

TABLE 5.—Comparison of Performance Models in Good and Bad Times

	ESTIMATED COEFFICIENTS					
	All Firms		Big Firms (>30 Employees)		Small Firms (<31 Employees)	
Variable (1)	Good year (2)	Bad year (3)	Good year (4)	Bad year (5)	Good year (6)	Bad year (7)
(a) Regular Operational Variables						
Efforts in planning and control	0.1523	0.0605	SI	0.1493	0.1733	SI
Control at firm level	SI	SI	SI	0.4368	SI	SI
Effectiveness of project planning and control	0.0060	0.0075	0.0047	0.0059	0.0063	0.0096
Efforts in marketing	SI	0.0914	SI	SI	SI	0.1111
Effectiveness of marketing	0.0050	0.0095	0.0046	0.0083	0.0028	0.0096
Subcontracting	0.0101	SI	0.0118	−0.0050	0.0073	SI
(b) Resilient Operational Variables						
Long-range planning	0.2938	SI	0.3633	SI	0.3556	SI
Accident level	−0.0112	−0.0122	SI	−0.0147	−0.0169	−0.0072
Geographic diversification	0.0112	0.0137	SI	0.0070	0.0179	0.0139
Technological competence	SI	0.5310	SI	SI	SI	1.6713
Union construction	SI	−0.4162	SI	SI	SI	−0.4903

Note: SI = statistically insignificant.

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cope with high business volume. When the workload increases, the efforts in planning and control become critical. On the other hand, reducing inefficiency is probably a key to the success of big firms in bad times. Thus efforts in planning and control and control at firm level become important operational variables for big firms. Effectiveness (as opposed to effort) of project planning and control is an important variable for all performance models; it is particularly crucial for small firms, and during bad times. The coefficients of efforts in marketing show that more marketing efforts can improve a small firm's performance in bad times, but are not significant in other performance models. Effectiveness of marketing is another variable that is significant in all models; it is about twice as important in bad times for big firms and about three times more important in bad times for small firms. Although subcontracting has beneficial effects in the good time models, it also has a small negative effect in bad times for big firms. It should be mentioned that the subcontracting variable increases the explanatory power of the model for big firms in bad times, but its *t*-statistic is only marginally significant.

The results show that long-range planning can improve the performance of big and small firms in good times, but it is irrelevant in bad times. Except for big firms in good times, the accident level has significant negative coefficients in all models. Why safety was not important to big firms in good times is not clear. It is not surprising that geographic diversification is not important in good times for big firms because the high business volume reduces the potential benefits of diversification. However, it is also not clear why geographic diversification has a significant coefficient in good times for small firms. In general, the results show that the importance of geographic diversification is greater for small firms than big firms. The in-house-computer variable is probably not a very good measure of technological competence of very big firms because the computer is almost a necessity. This may explain partly why the variable is not significant in the big firm models. In bad times, technological competence is one of the most important operational variables for small firms. The union/openshop variable is clearly insignificant in good times. In bad times, the estimated union coefficient for big firms is not small (−0.168), but its *t*-statistic (−0.490) is clearly not large enough to be statistically significant. But for small firms in bad times, the negative impact of union construction is very large.

Conclusions and Recommendations

The management implications of the preceding results are many, but rather straightforward. Firms should focus their efforts on the operational variables that can yield the highest benefit to them. However, it should be warned that the performance models have limitations in showing the impact of the operational variable at extreme values. For example, the models do not show that the level of working capital and labor-management relations are significant variables. But if a firm does not have sufficient working capital or the labor-management relations are extremely poor, it is very likely that adverse effects on performance will result. Some of the irrelevant variables may become important at their extreme values. One should not ignore the operational variables

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that play a supportive role. They are collectively important in keeping an organization running in harmony and to provide cushions for uncertainties and mistakes.

In good times, the results show that only effectiveness of project planning and control, effectiveness of marketing, subcontracting, and long-range planning have a significant effect on performance for big firms. For small firms in good times, three more variables are significant: Efforts in planning and control, safety, and geographic diversification. In bad times, the relevant operational variables for big firms are efforts in planning and control, control at the firm level, effectiveness of project planning and control, effectiveness of marketing, subcontracting (has negative effect), safety, and geographic diversification. The list of significant variables for small firms in bad times is quite different. They are effectiveness of project planning and control, efforts in marketing, effectiveness of marketing, safety, geographic diversification, technological competence, and union construction (has negative effect). Only two variables are significant for all types of firms in both the good and bad times. They are the effectiveness of project planning and control, and effectiveness of marketing.

Since modifying the regular operational variables can have a quick impact on performance, firms can selectively place extra efforts on these variables when they are deemed important. However, it takes time to modify the values of the resilient variables, and firms should be prepared in advance. To prepare for bad times, contractors should invest efforts in modifying the values of the resilient variables. Such investments will improve their competitive positions during construction slumps. For instance, high safety level and geographic diversification can improve a firm's performance in bad times. These two resilient variables are important to both big and small firms. For small firms, two other resilient variables—technological competence and union/open-shop—are influential to performance in bad times. Note that most of the important operational variables for small firms in the bad time models are resilient variables, implying small firms should be particularly well prepared before the coming of construction slump to gain competitive advantage.

Strictly speaking, long-range planning is not a resilient variable, but its effects on performance are the same. It was the only resilient variable that could improve the performance of both big and small firms during the good time. It should be noted that a firm's reputation and the past successful projects are among the most important keys to effective marketing. These two important attributes cannot be developed overnight. Hence, effectiveness of marketing has some resilient characteristics.

Despite the fact that a comprehensive list of operational variables has been examined, there may still be variables which are important to a firm's performance but have not been studied. Due to the lack of appropriate measures, a firm's project estimation accuracy has not been modeled. But this is obviously a critical operational variable for all firms in all economic conditions. In fact, one can easily compute the impact of estimation error on a firm's net profits. Another obviously important variable is bidding strategy. However, it is not appropriate to study this variable with the deterministic framework of this study; rather proba-

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bilistic modeling should be used. To the extent that the omitted variables are not significantly correlated with the explanatory variables, the estimated regression coefficients are not affected. Since the size of the data sample is small, the findings of this study can only be considered as exploratory in nature. To make more general conclusions, analyses based on a large data set are necessary.

Table 6 compares the findings of the performance models with the suggestions from the construction executives interviewed and the responses to the questionnaire survey for improving contractors' performance in cyclical market environments. Note that the operational variables listed are not always significant. The conditions at which they are important as well as their magnitude of influence on contractors' relative market performance has been presented in Table 5. The operational variables are consolidated in Table 6 just for the ease of comparison.

Since the number of suggestions from the ten interviews and the number of responses to the optimal question for suggesting performance improvement are small, they are not statistically analyzed or broken down into different types of firm. It should be mentioned that the companies interviewed are successful companies and the executives have many years of construction experience. The suggestions are abbreviated for tabulation, but are followed closely to their original wordings. A majority of the suggestions agree closely with the findings of the performance models. In fact, some suggestions from the interviews actually describe the implementational details related to the relevant operational variables. While the frequence of suggestions from the interviews related to subcontracting, safety, and technological competence is the lowest, the frequency is high (over three times) for the other variables. No suggestions from the questionnaire survey are related to efforts in marketing, subcontracting, safety, and technological competence.

The following summary of recommendations is an elaboration of the results presented in Table 5 and the suggestions of the construction executives interviewed.

What Should Contractors Do to Prepare for Bad Times?

During construction booms, many contractors are too busy to do anything. It is, however, the most suitable time to prepare for the next slump. They should pay attention to the resilient variables that are important in bad times (see Table 5). These suggest:

- Moving into new market areas times;
- trying new methods and technologies for improved productivity; and
- improving safety records.

It should be noted that the performance models have limitations in identifying the "cushion" variables which do not improve a firm's profit, but are important to reduce a firm's risk exposure. In the uncertain construction business environment, maintaining sufficient cushion for uncertainty is crucial. For example, several construction executives interviewed suggest increasing the amount of working capital to prepare for bad times. The results of this study show that although the higher cash position does not improve a firm's relative market performance, the higher

TABLE 6.—Suggestions for Improving Contractors' Performance in Cyclical Market Environments

Significant operational variables (1)	Suggestions: Interviews with construction executives (2)	Suggestions: Questionnaire survey (optional question) (3)
Efforts in planning and control	A lot of planning Tight control	Planning Run a tight ship
Control at firm level	Budget Control overhead	Maintain as low an overhead position as possible Run a tight ship
Effectiveness of project planning and control	Be very careful at bad times Cut out "fat" and be efficient Know costs clearly to reduce estimation variance Tight control with good reporting system Recognize hard core people and lay off unproductive ones as fast as possible Stick to own qualification	Planning Run a tight ship
Efforts in marketing	Beef up marketing efforts More marketing efforts at bad times	
Effectiveness of marketing	Learn about new markets Get jobs in markets with less competition Be aggressive Determine where the best markets exist	Develop a track record of quality and honesty Not ignoring any segment of marketplace
Subcontracting	Subcontracting out less at bad times	
Long-range planning	Don't overexpand Make sure can get enough work before hiring new people or buying equipments Know the capabilities of employees Have long-term planning for recruiting and capital expenditure	Planning
Safety	Make a safe work environment	
Geographic diversification	Be versatile Diversify geographically	Diversification
Technological competence	Develop new methods to improve competitiveness Use creative ways to do jobs Keep up with the state-of-the-art in technology	

TABLE 6.—*Continued*

(1)	(2)	(3)
Union/ openshop	Go openshop	Bring back competition within the unions
Variables studied but found not important	Diversify to other lines of business Good cash position Reduce debt	Flexibility Adaptability Obtain clients with repeat work Multi-talented employees
Not studied	Avoid bad jobs Don't bid unrealistically Shift profits legitimately to minimize taxes	Stabilize interest rate Take self-pride in one's own work Teach owners and designers proper lead time Send people to school instead of laying them off

cash position does provide more cushion which lowers a firm's risk exposure when entering periods of uncertainty. In fact, the resilient variables which do not have significant negative impact on a firm's performance but offer contractors some flexibility of cushion in their operations, deserve attention. These resilient variables include the following:

- Flexibility in human resources;
- flexibility in cost structure;
- flexibility in financial structure; and
- diversification by line of business.

Methods of developing such cushions and associated costs are not obvious from this study.

What Should Contractors Do in Bad Times?

There are two key regular operational variables which are critical in improving contractors' performance during bad times:

- Effectiveness of project planning and control; and
- effectiveness of marketing.

With smaller profit margins available, the margin for error is reduced. The importance of planning and control increases both because of the need for lower risk and higher productivity. Both factors help also for marketing purposes.

In addition, the study suggested that small firms should increase marketing efforts while large firms should increase efforts in planning and control. Lastly, interviewed executives pointed out the need for avoiding bad jobs and low markups.

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What Should Contractors Do to Prepare for Good Times?

It seems that there is no need to prepare for construction booms. Almost every contractor makes money in upswings. Nonetheless, the research study by Wong (4) indicates that the technical efficiency of contractors declines in good times and the results of the interviews show that the major reason for such decline is the shortage of skilled labor. The resilient variable, long-range planning on human resources, accordingly was found to be very significant for both big and small firms in good times.

What Should Contractors Do in Good Times?

The model showed that in good times the following variables are important for both small and large firms:

- Effectiveness of project planning and control;
- effectiveness of marketing; and
- increased subcontracting.

In addition, for small firms, efforts in planning and control were significant.

Appendix.—References

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