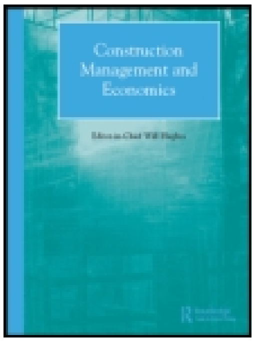


Construction Management and Economics

ISSN: 0144-6193 (Print) 1466-433X (Online) Journal homepage: www.tandfonline.com/journals/rcme20

Relationship between value and duration of construction projects

Ammar Kaka & A. D. F. Price

To cite this article: Ammar Kaka & A. D. F. Price (1991) Relationship between value and duration of construction projects, Construction Management and Economics, 9:4, 383-400, DOI: 10.1080/01446199100000030

To link to this article: https://doi.org/10.1080/01446199100000030

Published online: 28 Jul 2006.

Construction Management and Economics, 1991, **9**, 383–400

Relationship between value and duration of construction projects

AMMAR KAKA and A.D.F. PRICE
Department of Civil Engineering, Loughborough University of Technology, Loughborough LE11 3TU, UK

A strong relationship exists between the cost and duration of construction projects. This relationship can be used in contractors' budgeting systems and the corporate financial model developed at Loughborough University (Kaka, 1990). The client can use this relationship to estimate the approximate duration of a project and compare it with the proposed ones.

Two samples were collected to model this relationship. Sample 1 contained 661 building projects with a total value exceeding £695 million, which included all types of commercial, industrial, residential and public projects. Sample 2 included 140 road contracts with a total value exceeding £120 million.

The average ratio of actual time to the agreed time for road work is 1.0351. The ratio varies between a maximum value of 2 and a minimum of $\frac{1}{3}$. The following stage of the analysis involved modelling the relationship for civil engineering and different types of building contracts. The two samples were classified according to type of project, form of contract and type of competition. Seven groups were modelled and tested visually for the difference in these relationships. The type of competition was found to have no effect on the relationship. Finally, six groups were modelled and the results of the constants of the relationships are listed. Public buildings and civil engineering projects were shown to fit accurately, while private buildings varied considerably. Interesting conclusions were drawn on the logic behind these differences.

Keywords: Cash flow, construction, time, performance, duration, regression, budget, cost.

Introduction

The corporate financial model developed at Loughborough University predicts future cash flow by simulating the number of contracts expected to be won during the coming years. The contracts are defined by several criteria, including the total value and duration.

A strong relationship exists between the cost and duration of a construction project. This relationship has been investigated and is used in the corporate financial model. The relationship is also useful for the budgeting system of any construction company. The contractor can classify projects based on value and the model will evaluate duration based upon the corresponding factor.

There are other potential applications for the relationship between the cost and duration of construction projects. Investors can utilize this relationship in their financial appraisal and budgeting. Also, estimates of project cost could be used to derive the expected duration and vice versa. These can then be compared with proposed durations and used as a basis for negotiations.

Finally, it is interesting to compare the duration performance of different types of projects and possibly identify the causes of delays.

0144–6193/91 $03.00+.12

Previous work

The need for the evaluation of performance of building contracts arose in the late 1960s. In 1967, the Commonwealth Scientific and Industrial Research Organization undertook a pilot study on the performance of building contracts. This was the first step in a larger programme of research into the structure of the building industry. The results published in the Annual Report of the Division of Building Research (1968) showed that the extent of change, as measured by construction duration, cost, number and value of variations, was in fact larger than had previously been supposed. A fuller investigation, using a larger number of projects, was subsequently performed. In 1969, Bromilow published the results, and the first relationship between cost and duration of building contracts appeared. A total of 329 building projects with a total value exceeding 270 million Australian dollars (A$) were analysed. These projects were conducted in Australia during the period between June 1964 and June 1967. First, the expected duration of each project was compared with the actual. The projects were classified according to the type of building and the area in which they were to be built. The results showed that only one contract in eight was completed on or before the date originally expected and the overall average extra time taken exceeded 40% of the original. This was far worse than expected. The second part of the work was the build-up of the relationship between the actual construction cost of the building and the time taken. The equation describing the average construction duration as a function of project value was found to be:

$$T = KC^B$$

where T = duration of construction period from possession of site to practical completion measured in working days; C = final project value in A$ millions adjusted to a cost index; K = a constant describing the general level of duration performance for a A$1 million project; and B = a constant describing how the duration performance is affected by project size as measured by value. All of the projects were analysed together and K was found to have a value of 350 working days. B had a value of 0.30.

A measure of the extent to which the performance of individual projects has departed from the mean trend was shown in the form of quartile limits. By definition, 50% of projects fall within this band. Of the remainder, half took less than 0.8 of the average duration and half took 1.3 times longer than the average duration. The effect of the type of building or the location of the buildings was evaluated by analysing the results in more detail. It was concluded that the time actually taken to construct buildings of a given value did not depend very strongly on the type of building or its location. However, this conclusion conflicts with the report *Faster Building for Commerce* (NEDO, 1988), which showed that for commercial projects of the same value, the duration performance for different types of projects varied significantly.

Bromilow *et al.* (1980) re-studied the relationship between the value and duration performance of building contracts in order to determine whether the above relationship held. The survey, conducted by the Australian Institute of Quantity Surveyors, was carried out on building projects completed in the period 1970–76. The number of projects analysed was 408, of which 290 were government projects and 118 were private ones. The results showed that the relationship between construction duration and project cost in the 1960s still holds.

The amount of time required, as measured by values of K, increased markedly from an average of 248 working days before 1969 to 288 during 1970–76; C was measured in A$ millions at 1979 prices. The time required for government projects as a whole averaged 22% longer than expected and private projects averaged 10% longer.

Values of B did not change significantly, indicating that the rate of change in duration as projects got bigger was still much the same as it was previously. The extent to which projects varied above and below the trend lines did not change significantly, although there was some suggestion of greater variability than before.

Bromilow *et al.* (1980) concluded that the industry should take note of the reported changes, but the high degree of industrial instability over the observed period suggests that their practical use calls for some care in their interpretation.

New information

In order to build the corporate financial model to a standard that could be applied and tested in a present British construction company, a new relationship was required. The outdated information involved in the aforementioned work and the problem of different countries and currencies, undermine the use of these models. In order to reduce the possibility of systematic errors in the model, other criteria were proposed to classify projects into several groups. The effect of these criteria on the relationship was evaluated and several relationships were modelled. Four criteria were proposed:

1. *Type of client*
   - public,
   - private.
2. *Type of project*
   - building,
   - civil engineering.
3. *Type of tender*
   - open competition,
   - selected competition,
   - negotiated competition.
4. *Form of tender*
   - fixed price tender,
   - fixed adjusted tender.

There were no data available on cost plus tenders and no further classifications were needed, as the corporate financial model does not classify contracts in more detail. For the other explicit uses of the value *vs* duration relationship, the data may be classified further, but with the cost of having less numbers of contracts in each group. The decision on where to collect the data from took some time. There was a large and tempting source of data available through the Building Cost Information Service produced by the Royal Institute of Chartered Surveyors. More than 600 different building projects were available and classified according to several criteria including the four proposed above. However, these data were based on the stipulated and agreed durations of the contracts but not the actual durations. All the figures presented were based on tender values. Further study was required in order to decide whether to use these data or to choose another source that could take more effort while achieving smaller samples and possibly similar results. Investigations of the two previous studies showed that the major cause of the high variation between actual and expected duration performance was associated with clients failing to make up their minds quickly enough. Obviously, most variations involved time delays, in addition to higher costs. Thus, as time increases, the other side of the equation (value) will also increase.

Consultations with quantity surveyors indicated that the agreed duration of a contract will not change unless there are significant variations to the project. Time delays that are caused by the contractor or the subcontractors are usually liable to penalties. There were also suggestions that time delays, such as those associated in the past with claims and disputes, are not as serious today.

It was decided to use this source of data but at the same time collect another sample that included the actual and the agreed (tender) values. As the present sample included only building projects, civil engineering projects were collected for the second sample. A test on the difference between actual and estimated values for civil engineering projects should evaluate the reliability of using estimated values and durations for both samples. Building projects are more accurate to predict than civil engineering projects, which are more badly affected by weather and ground conditions.

The survey was conducted on projects starting within the period 1984–89. Actual values may not reflect the true total cost of some projects due to outstanding claims, etc. Hence, only contracts completed without major outstanding claims were collected. This reduced the size of the sample, as the collected projects were all recent.

Ten county council offices participated in providing the required data. A total of 140 projects were collected from their departments of Highways and Planning or Planning and Transportation, with a total value exceeding £120 million.

The first sample contained 661 building projects with a total value exceeding £695 million, which included all types of commercial, industrial, residential and public works. Projects starting before January 1984 were rejected. The structure of the two samples in terms of value and number of projects by type of client and type of tender is shown in Table 1. They are also shown in percentage form in Table 2 and Fig. 1. Negotiated tenders also included two-stage tenders, as the processes are similar and the number was too small to be considered separately.

The adjusted forms of contract included all types of formulae of full and single indices. Comparing this with the Wood Report (NEDO, 1975) (Table 3) reveals that in both periods the most common way for tender is the selected tender, especially for civil engineering projects. This is not surprising, considering all public sector clients follow the code of tendering practice issued by the NJCC, which recommends selective tendering. However, negotiated and two-stage tenders are shown to have been more common in the 1970s than in the 1980s.

The value of the projects investigated has been totalled for each type and the results compared with the value of all orders for that type over the same period (Royal Institute of Chartered Surveyors, 1984–88). Table 4 shows that sample 1 includes a higher proportion of public projects than private. The survey conducted on sample 2 achieved a reasonable portion of the industry. Although the total number of projects investigated represents approximately 0.81% of contractors' total orders, the samples are random and considered to represent a wide variety of types and locations throughout the UK.

Table 1. Values and numbers of projects for different forms and types of tender

Type of client	Value (£m)					No. of projects				
	Form of tender		Type of tender			Form of tender		Type of tender		
	Fixed	Index	Open	Select.	Negot.	Fixed	Index	Open	Select.	Negot.
Public buildings	162.0	121.3	74.5	200.1	8.7	240	73	93	211	9
Private commercial	118.2	16.0	41.2	54.3	38.8	102	3	30	64	11
Private industrial	43.2	0.0	11.1	26.0	6.1	68	0	20	44	4
Public housing	57.2	35.1	29.1	59.8	3.1	98	29	46	77	4
Private housing	21.5	6.4	7.7	18.5	1.6	39	9	10	36	2
Public civil (roads)	114.0	6.0	7.2	109.2	3.6	136	4	9	127	4

Table 2. Values and numbers of projects (percentages) for different forms and types of tender

Type of client	Value (£m)					No. of projects				
	Form of tender		Type of tender			Form of tender		Type of tender		
	Fixed	Index	Open	Select.	Negot.	Fixed	Index	Open	Select.	Negot.
Public buildings	57.2	42.8	26.3	70.6	3.1	76.7	23.3	29.7	67.4	2.9
Private commercial	87.9	11.9	30.7	40.5	28.9	97.1	2.9	28.6	61.0	10.5
Private industrial	100.0	0.0	25.7	60.2	14.1	100.0	0.0	29.4	64.7	5.9
Public housing	62.0	38.0	31.9	64.8	3.4	77.2	22.8	36.2	60.6	3.2
Private housing	77.1	22.9	27.6	66.3	5.7	81.3	18.8	20.8	75.0	4.2
Public civil (roads)	95.0	5.0	6.0	91.0	3.0	97.1	2.9	6.4	90.7	2.9

Analysis

As the projects analysed were all tendered for during the period 1984–88, the effect of inflation and competition had to be eliminated. The tender price index available in the Building Cost Information Service manual was used to adjust the values of contracts to 1988 prices.

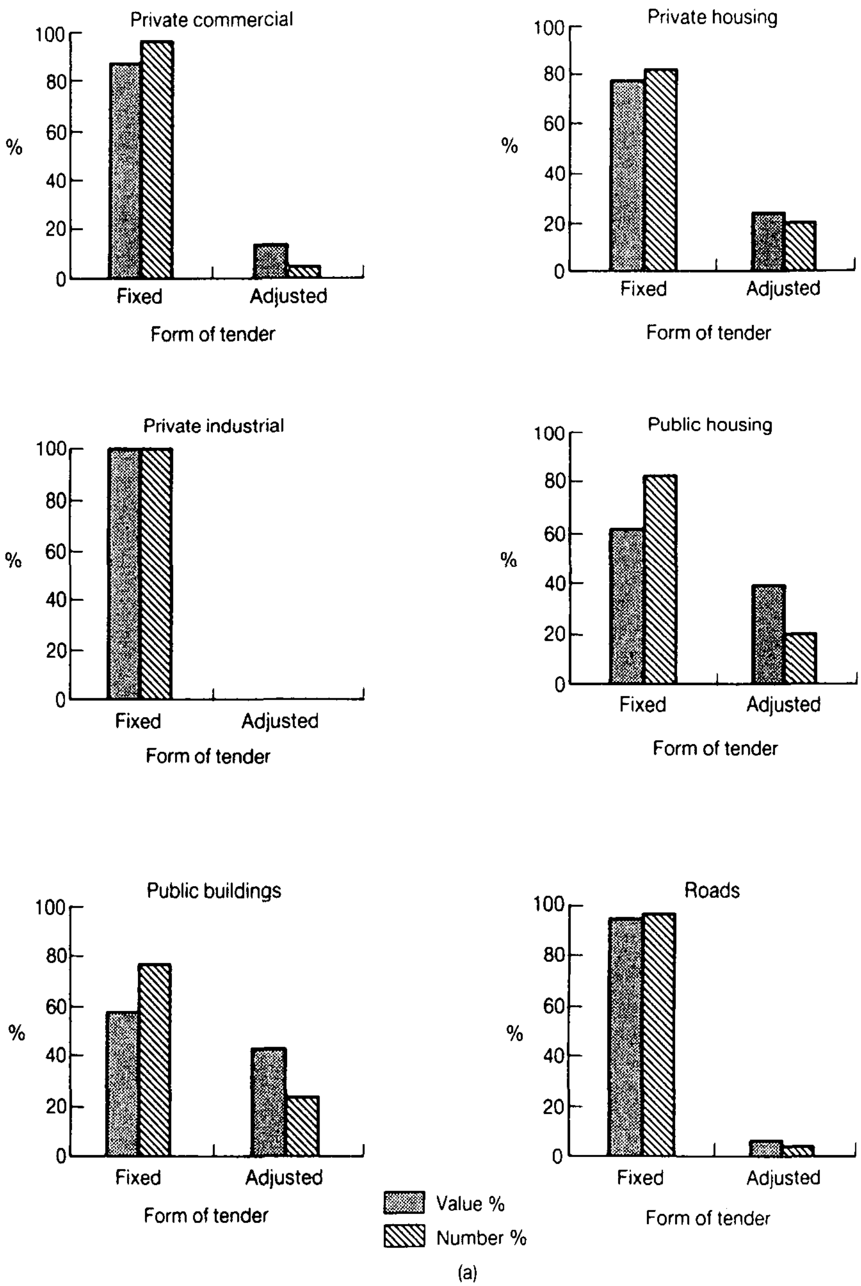
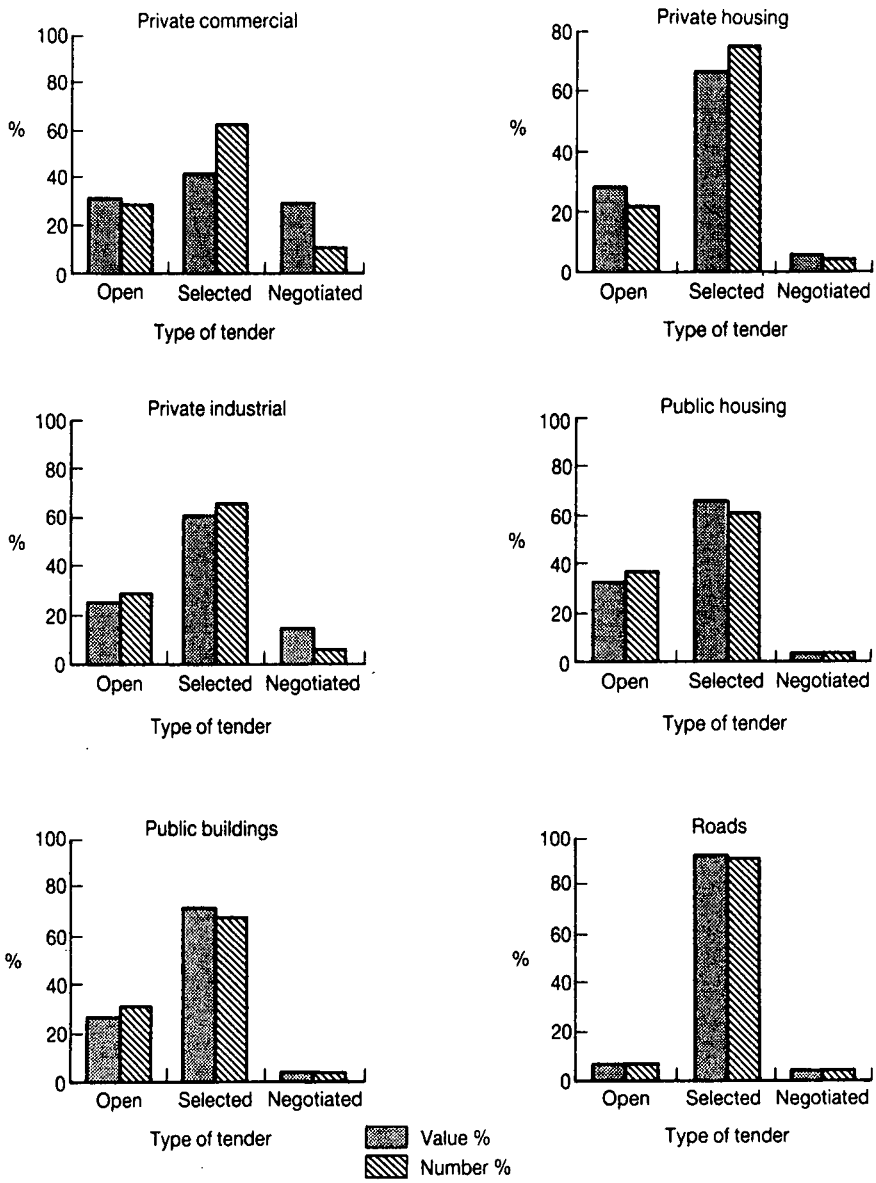


Fig. 1. (a) Proportions of form of tender in samples 1 and 2. (b) Proportions of type of tender in samples 1 and 2.


Private commercial
Private housing
Private industrial
Public housing
Public buildings
Roads
%
Open
Selected
Negotiated
Type of tender
Value %
Number %

(b)

Table 3. Values and numbers of different types of projects (percentages) for different forms of contracts (from NEDO, 1975)

	Value			Number		
Type of project	Open	Select.	Negot.	Open	Select.	Negot.
Education	11	61	28	15	65	20
Public housing	12	47	41	22	55	23
Other building	10	78	12	12	77	11
Roads	3	95	2	19	77	4
Other civil	10	81	9	14	79	7

Table 4. Value of projects investigated compared with total value of projects of the same type ordered (January 1984 to January 1989 only)

Type of project	Total value of projects	Total value of projects surveyed	%
Public buildings	8 235.0	283.3	3.44
Private commercial	28 090.0	134.2	0.48
Private industrial	13 133.0	43.2	0.33
Public housing	4 167.0	92.3	2.22
Private housing	28 312.0	27.8	0.10
Civil roads	4 427.0	120.9	2.73

The first stage of the analysis was to evaluate the difference between the agreed and actual construction durations. The test was conducted on sample 2, which involved calculating the ratio of the actual duration over the agreed one regardless of the value of the contract. The objective of this test was to determine the accuracy of the forecasted duration performance and, to some extent, the reliability of the figures in sample 1.

The second test examined the relationships between duration and actual cost and agreed values. The possibility of a time delay in a contract associated with an increase in cost was evaluated. The second sample was used to determine the consistency of this increase. A limited difference between the two relationships would open the way to a comprehensive analysis for all the building projects available in sample 1.

The third step was to evaluate these relationships within the model application. Previous work showed that neither the type of project nor the location had a significant effect on the relationship; therefore, only the four criteria proposed earlier were considered for the analysis. A test was required to establish whether these criteria had a significant effect on the relationship. A visual test was considered to be the simplest and most desirable, as the number of criteria was small and could be compared easily. In addition, the equations representing the relationships were determined with their correlation coefficient (R). Seven groups were established and plotted in a unified scale. These were.

1. Public buildings fixed prices.
2. Public buildings adjusted prices.

3. Public buildings open competition.
4. Public buildings selected competition.
5. Public buildings negotiated competition.
6. Private buildings fixed prices.
7. Civil roads fixed prices.

These groups were used to identify the effect of each of the four criteria on the relationship between the value and duration of construction projects. The first test was conducted on the first two groups in order to determine whether the form of tender affects the relationship. The process of 'filtering' the data (to eliminate the effect of type of tender from the analysis) was not required in this case, as there was no correlation between the form of tender and the type of tender (see Table 5).

Table 5. Distribution of type of competition in different forms of tender

	Type of competition		
Form of tender	Open	Selected	Negotiated
Public fixed price	110	216	12
Public adjusted	29	72	1

The visual test involved plotting the scatter points of the agreed duration (y axis) against value of contracts (x axis). The most revealing way of plotting construction duration against value is to use logarithmic scales. This avoids a crowding of the relatively large number of 10 000–1 000 000 contracts in the lower left-hand corner of the figure, and shows the mean trend line to have a linear shape. The actual form of the trend line is:

$$T = KC^B \qquad \text{(as presented earlier)}$$

The two constants are determined by the following process:

$$\log T = \log KC^B$$

which is also equal to

$$\log T = \log K + B \log C$$

This is a linear equation from which K and B can be determined through linear regression of the transformed (logarithmic transformation) data. Alternatively, some software performs this process directly, e.g. the 'cricket graph' on the Macintosh. Hence, comparisons can be conducted between the trend lines in order to identify the differences in the levels and sensitivities (slopes) of the relationships. The scatter points and the correlation coefficient (R) were used to determine the variability of points within each group and between groups.

Comparisons were also undertaken between groups 3, 4 and 5. The results showed that no significant difference was found and hence the type of competition was ignored. Groups 1, 6 and 7 were also compared in the same manner. The type of client and type of project were tested together. The following step in the analysis involved grouping the data into several categories according to the effective criteria. Two groups were added to the four groups remaining from the analysis: private adjusted prices contracts and civil adjusted prices contracts. A line was fitted through each of the two groups and plotted with the scatter (see Figs 6 and 7).

Results and discussion

The difference between the actual and the agreed durations are presented in ratio terms. The average ratio of the actual duration to the agreed duration is 1.0351. The estimated ratio varies between a maximum value of 2 and a minimum of $\frac{1}{3}$. If a comparison is made between these values and the duration performance of Australian building contracts in the late 1960s, the average ratio was 1.478 and the range was 0.73–3.93. Because sample 1 included only tendered and agreed values, no comparison was made on the performance of building contracts. However, the results obtained from the road contracts confirm strongly that the trend has changed and delays associated with contracts executed in the past are not present at this point in time.

The results of the second test are shown in Fig. 2. The values of the constants B and K of the fitted lines are listed in Table 6. The two fitted lines can be shown to have almost the same shape. The scatter points for the two groups are similar (see R values) and all of the data came from one group. This is strong support for the hypothesis that even when there is a significant variation in the duration performance of estimated and actual values, the relationship between value and duration remains the same.

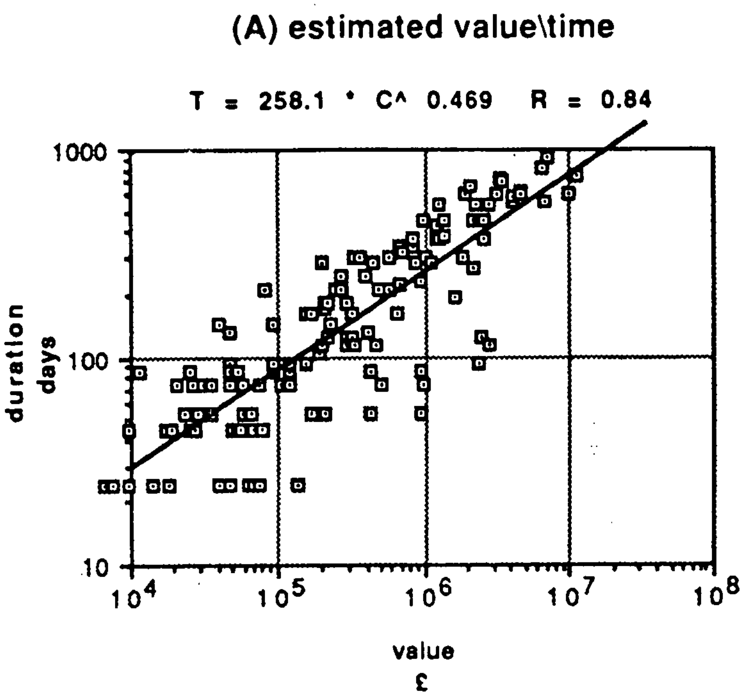
The results of the third test are shown in Figs 3, 4 and 5. The constants of the fitted lines were calculated and are listed in Table 7. The first comparison between fixed price contracts and adjusted price contracts is shown in Fig. 3. The value/duration relationship for the two forms of contract are significantly different. The difference is recognized in both the shape and the level of the lines. Fixed price contracts have a more sensitive relationship and the level of the line is lower. The scatter points of the two forms of tenders are located differently; therefore, the data should be treated separately.

The second comparison is shown in Fig. 4. The trend lines of the three types of competition have close shapes, especially for open and selected competition. Negotiated tenders are less sensitive. However, more detailed observation of the scatter points shows that the three groups are similar and can be related to one group. It was therefore concluded that the type of competition did not affect the considered relationship.

The two remaining criteria (type of client and type of project) were compared, as shown in Fig. 5. Only fixed contracts were included in the test. The results showed that the three graphs are significantly different. Private buildings have the lowest slope, with almost the same starting level as the public buildings. Civil engineering contracts (roads) are shown to have a significantly lower starting level, while maintaining the highest sensitive relationship. Thus, it can be concluded that both the type of client and the type of project influence the value/duration relationship.

The following stage of the analysis was to establish the final groups of the model upon which the relationships are significantly different. Six groups were modelled.

1. Public buildings fixed price.
2. Public buildings adjusted price.
3. Private buildings fixed price.
4. Private buildings adjusted price.



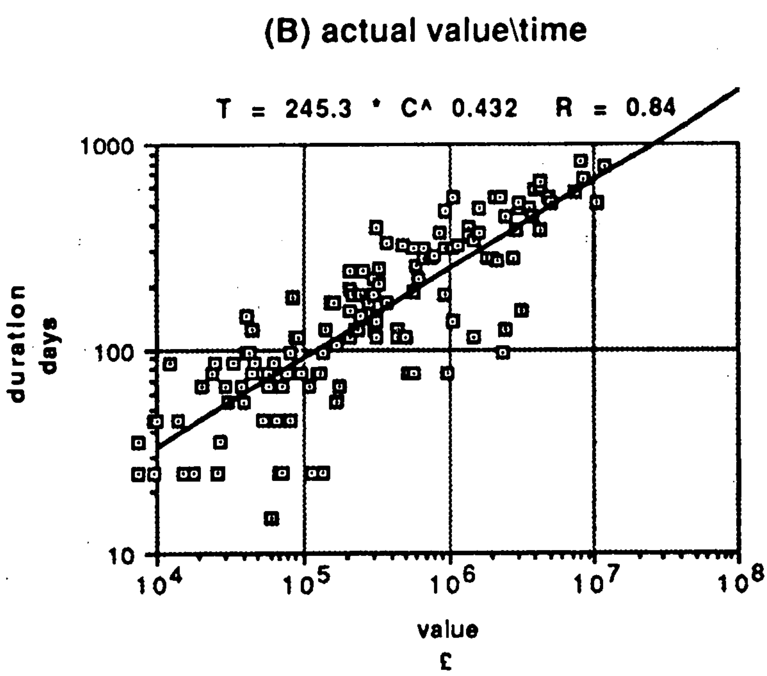


Fig. 2. Standards of duration performance realized in civil engineering projects.

Table 6. *B* and *K* values for tendered and actual road contracts

Civil (roads)	*B*	*K*
Tendered	0.469	258.1
Actual	0.432	245.0

5. Civil engineering fixed price.
6. Civil engineering adjusted price.

The final modelling involved fitting the function through the private buildings and the civil engineering projects, both of which are adjusted price contracts. The two plots and the fitted trends are shown in Figs 6 and 7.

The constants for the fitted functions for all the groups are listed in Table 7. Although the number of projects used is limited, the effect of the form of contract is consistent with the previous tests. The level of the adjusted contracts is higher than that of the fixed contracts. Also, the sensitivity (slope) can be shown to be lower. The differences between the types of clients and types of projects are also consistent with previous comparisons.

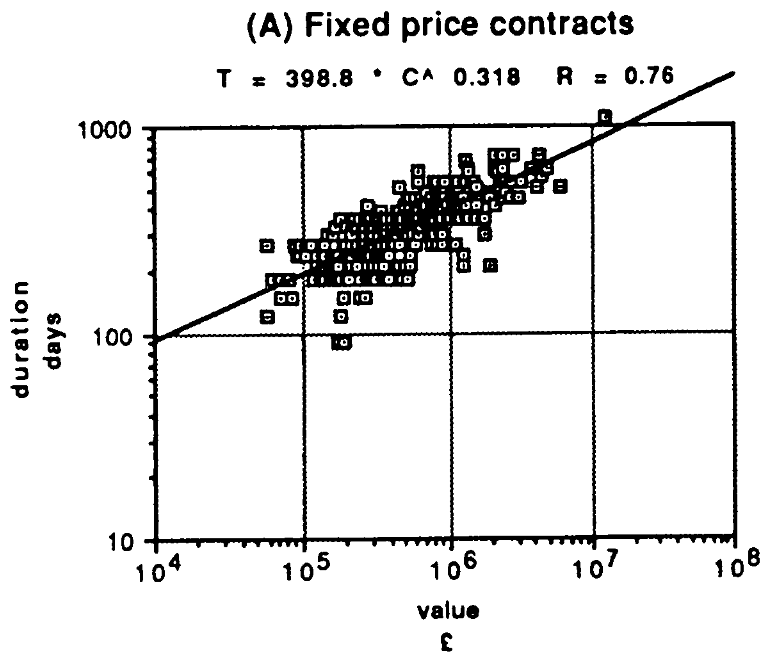
General discussion

The analytical side of the results showed a significant variation within certain groups. The fitted function proved to be a good average of the trend. However, a practical explanation of the results is required to draw conclusions on the reliability of the analysis.

The difference between actual and tender values for civil engineering (road) contracts was limited. The duration performance varied between the ratio of 2 and 0.333 with an average of 1.0351. The significant variation in the duration performance is attributed to the high uncertainty in civil engineering projects. However, the average assessment of these factors was accurate.

Comparisons of these values with a study on building work in the late 1960s revealed that duration expectations in the past were significantly underestimated and variation from the expected duration reached three times. No data were available on the actual duration performance for building work; however, the trend is expected to be more accurate with smaller variations. This is due to the lesser uncertainty involved in building works as opposed to civil engineering.

The form of contract, type of client and the type of project were shown to have an effect on the investigated relationship. Adjusted price contracts tended to be the larger ones. They generally took longer than fixed price contracts, as shown from the previous plots. The durations were less sensitive to the values of the contracts. For a public building fixed price contract, the average duration taken to execute a £1 million fixed price contract was 399 days. The corresponding figure for an adjusted price contract was 487 days. The logic behind this is that adjusted price contracts are used for projects which are expected to take a relatively long time to complete, thus eliminating the risk incorporated in assessing future inflation. In other words, contracts which cost between £50 000 and £1 million and expected to take longer are likely to pursue the adjusted price formula. Note that some of the scatter points within the fixed price plot intersect with that of the adjusted price plot. This shows that



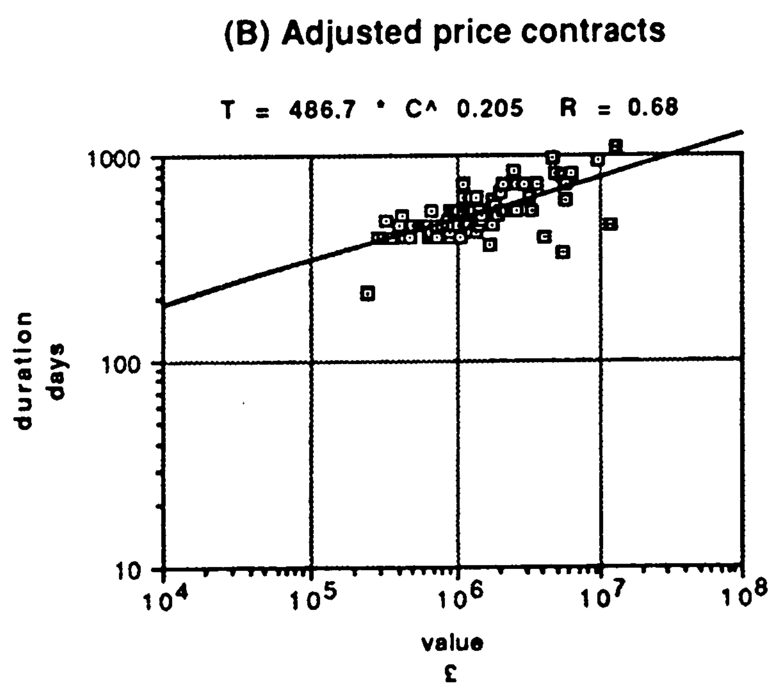


Fig. 3. Standards of duration performance realized in public building projects: 1.

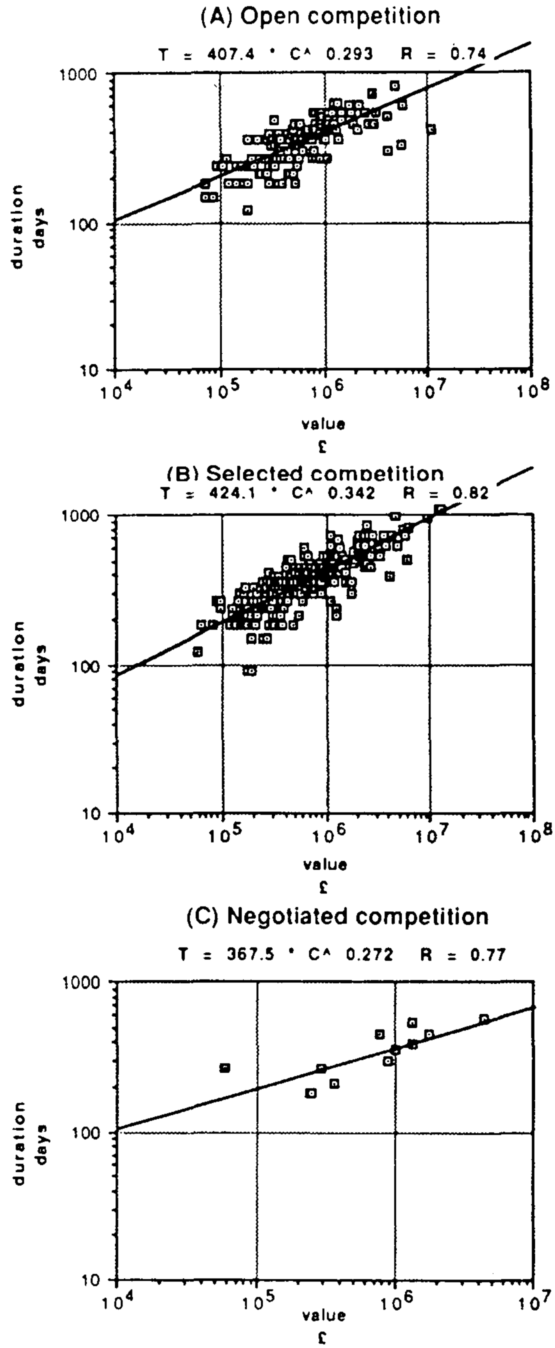


Fig. 4. Standards of duration performance realized in public building projects: 2.

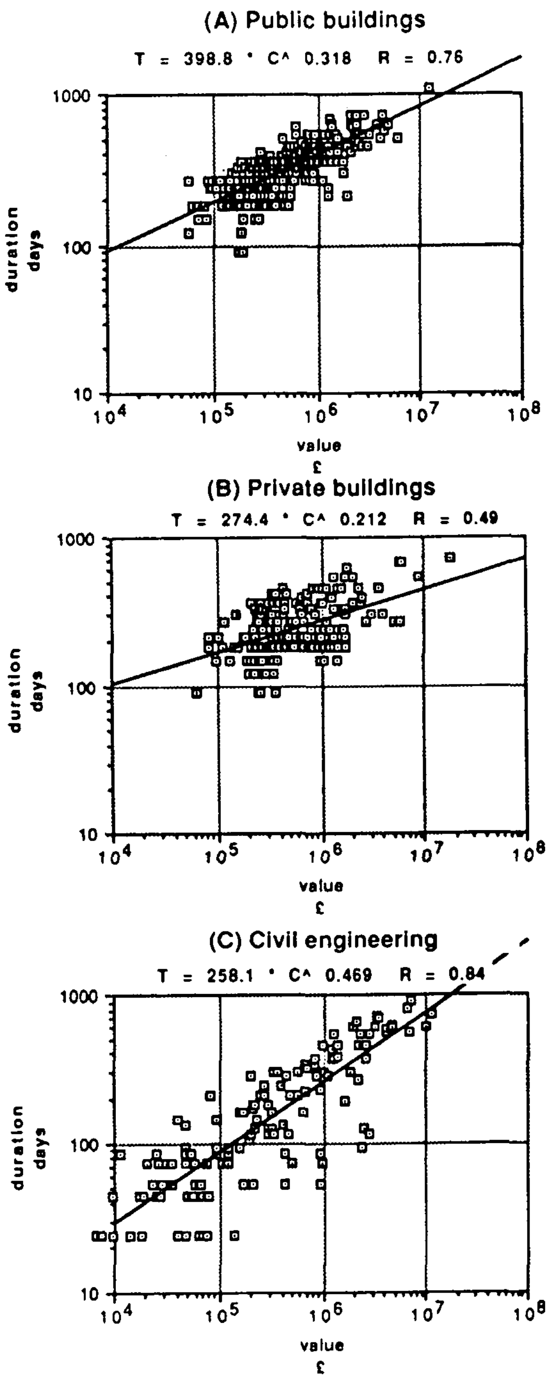


Fig. 5. Standards of duration performance realized in fixed price contracts.

Table 7. *B* and *K* values for the final six groups

Effective groups	*B*	*K*
Public fixed	0.3178	398.80
Public index	0.2050	486.70
Private fixed	0.2120	274.40
Private index	0.0817	491.22
Civil fixed	0.4693	258.10
Civil index	0.4370	436.30

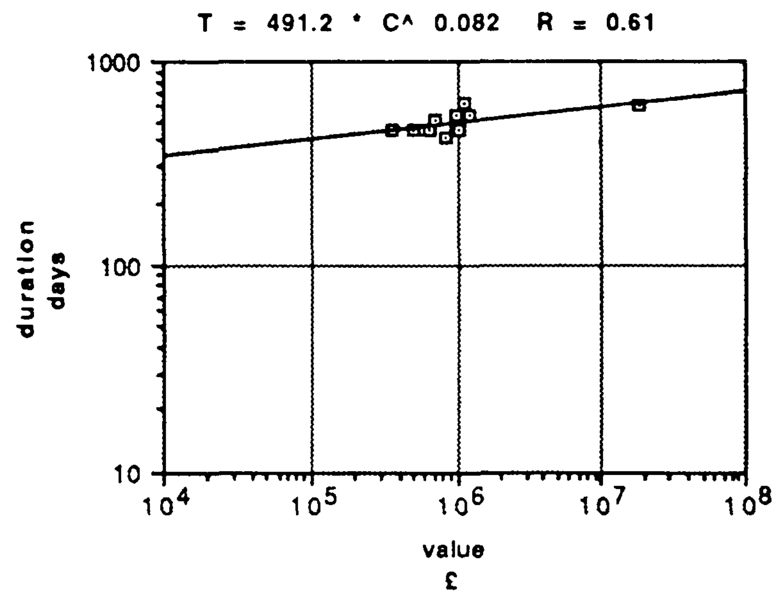


Fig. 6. Standards of duration performance realized in private building projects (adjusted price).

larger and more time-consuming projects are not solely adjusted price contracts. They could well be fixed, especially during periods of low inflation like the one investigated.

The type of client within building works does influence the duration/value relationship. The results showed that public buildings take longer, on average, than private buildings. The construction period for public buildings was generally more sensitive to the contract value than the private ones. Projects with values of less than £100 000 took similar durations for both types. It was the larger ones which differed noticeably. The practical explanation behind this is that private clients are more concerned with time than public organizations. Private clients, like retailers, hotel companies or manufacturing firms, have to complete their projects as soon as possible in order to start operating that part of the business and get returns on their investments. Moreover, private clients tend to leave the duration of the contract open for competition; hence, the contractor with the shortest submitted duration is likely to head the shortlist.

The results also showed that private projects had a wider scatter of points than public

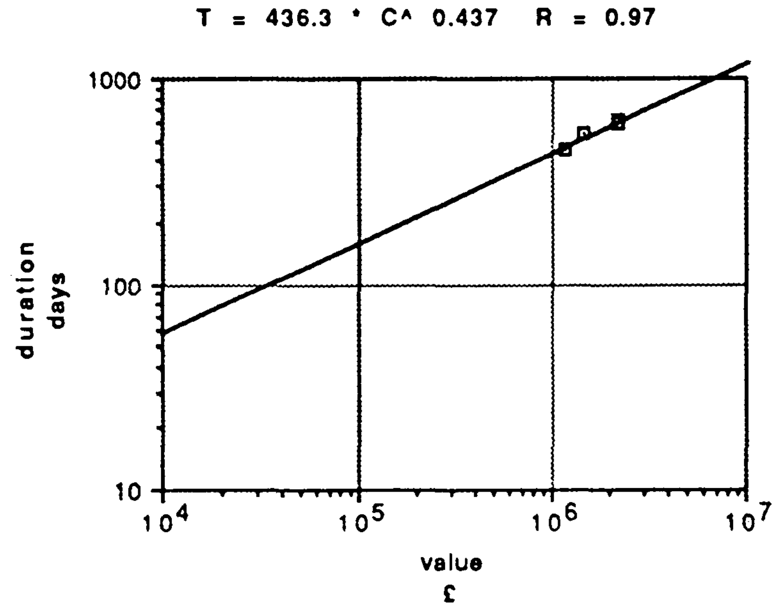


Fig. 7. Standards of duration performance realized in civil engineering projects (adjusted price).

projects. This was due to the fact that private clients include a wider range of types of sophistication. A five-star hotel which contains 150 rooms with all sorts of luxurious furniture and fittings could well cost more than £5 million. At the other extreme, a similar-sized three-star hotel may cost considerably less but the time to complete the two projects should not differ that much.

Public clients are significantly controlled by government spending, and therefore the class of the finishing does not vary considerably. Whatever the type of building, it will include floors, walls, columns and a consistent level of finishing.

The type of project (building or civil engineering) affected the relationship considerably. Civil engineering contracts do not involve the number of walls and floors that building projects do. They involve more earthworks and heavy plant. The sample of data analysed contains all sorts of roads and bridge contracts. The time taken for a civil engineering contract to be executed was generally less than that for a building project of similar value. This difference increases when contracts are below £1 million.

The reason behind this is that most civil engineering contracts involve high transportation costs for heavy plant and equipment. The premium cost of transportation for small works is considerably higher with respect to the actual direct cost. Moreover, once the plant is operating, the actual work can be conducted quickly. For higher values of contracts with longer durations, the cost of transporting plant and operating them is relatively small compared to the value of the contract. Hence the difference between building and civil engineering projects decreases.

In all cases, the fitted function was shown to have an average of the scatter points, although the scatter points are shown to have a wide range especially in private building projects. Public buildings and civil engineering projects produced encouraging values of R (0.76 and 0.84). Public authorities and organizations may use these relationships reliably. Private buildings varied significantly ($R=0.49$) and the model fitted the data poorly. This is to be expected in such a highly volatile and unpredictable industry. Further classification of projects may be required to enhance the accuracy of the relationship; however, this should be associated with an increase in the amount of data utilized. It should also be realized that when classifying projects in more depth, the model becomes more difficult, especially when working at a corporate level. As far as the corporate financial model is concerned, the fitted relationships should produce accurate results. The corporate financial model is recommended for large contractors who simultaneously execute large numbers of contracts. The most important finding was the identification of significantly different relationships within different groups. Therefore, as long as the scatter points are randomly distributed over the fitted functions, the application of such functions are reliable.

References

Bromilow, F.J. (1969). Contract time performance – expectations and reality. *Building Forum*, **1**, 70.

Bromilow, F.J. (1970). The nature and extent of variations to building contracts. *The Building Economist*, **9**, 93.

Bromilow, F.J., Hinds, M.F. and Moody, N.F. (1980). AIQS survey of building contract time performance. *The Building Economist*, September, pp. 79–82.

Division of Building Research (1968). *Annual Report 1967–68*. CSIRO, Melbourne.

Kaka, A. (1990). Corporate financial model for construction contractors. PhD thesis, Loughborough University of Technology.

NEDO (1975). *The Wood Report: The Public Client and the Construction Industries*. HMSO, London.

NEDO (1988). *Faster Building for Commerce*. HMSO, London.

Royal Institute of Chartered Surveyors (1983–90). *Building Cost Information Service Manual: Tender Price Indices*. RICS, London.

Royal Institute of Chartered Surveyors (1984–88). *Building Cost Information Service: Concise Cost Analysis*. RICS, London.