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Changes in profit as market conditions change: an historical study of a building firm.

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Summary

This paper analyses the profits from 221 construction projects undertaken by an Australian building firm in the period 1910-1938 and examines the factors that influence the firm's profit levels. This involves a series of multiple regression analyses with three dependent variables representing profit and 26 independent variables representing economic conditions and project characteristics. From these, 11 models are derived of which two are chosen as having the best explanatory power in explaining approximately 72% of the variability in profit levels movements. The results show that unemployment, interest rates, level of construction activity in the state, change of wage level, inflation rate of building material and project value significantly influenced the firm's profit levels during the period.

Keywords: Intrafirm profit, Australian economy, regression analysis.

INTRODUCTION

The ability to understand and predict changes in profit levels is of fundamental importance for the survival and progress of any company. Business profitability is closely related to the willingness and ability of businessmen to invest and employ. These are the basic forms of business activity, but they require an environment in which adequate business profits are made. Private non-residential building, a component of new business investment, suffers particularly when economic conditions undermine confidence, introduce added uncertainty to investment decisions and diminish business profits (Robinson, 1977:60).

As a result, it is believed that the building industry cycle is closely related to general economic conditions and that the national policies chosen to regulate them have a vital impact on the building industry. Conversely, it is also argued that the building industry has an important influence on the general economic cycle "... there are strong cause and effect relationships" (Rothman, 1979:73).

In order to increase the understanding of the relationship between company profit levels in the building industry and general economic activity, a series of 221 contract data of an Australian building firm in the period 1910-1938 were analysed. By the beginning of the1920s the Australian economy had developed the basis of a manufacturing industry. Fabricating processes were developed and public investment in railways and complementary engineering industries together with the building and construction industry led to the establishment of an industrial core in the economy which expanded during the First World War (Gallagher and Burthardt, 1980). Productivity was increasing at the rate of 2% per annum during 1918-1930. The period 1930-1938 was affected by the great depression and the growth in productivity was only 1.1% per annum (Clark, 1962). In addition, several different phases of business activity were experienced: the depression during the First World War (1914-1918) when real income fell, the recovery phase (1919-1922), the expansion phase (1922-1927), when real income rose, the peak (1928-1929), the contraction phase (1929-1930), the depression phase (1930-1933) with falling real income and the recovery and expansion phase (1933-1938) when real income rose again. Hence, Australia experienced a series of changes in the economy which affected the total level of aggregate demand and this allows the investigation of the corresponding profit level movements. For this reason, the period 1910-1938 was considered suitable for a study of this kind.

While the selection of this time period means that the study has a certain historical interest, covering a very dynamic period of Australia's development, the implications are much wider. It investigates the operations of a competitive market system that in principle has not changed since then. It examines the effects of market forces, supply and demand, that still act in a very similar way on any firm in the building industry, an inherent aspect of our economic system. The precise impact of each variable may be different at different times or indifferent locations, but the principles can be generalized to any market system.

The analysis employs a series of multiple regression analyses involving three dependent variables representing profit and 26 independent variables representing economic conditions and project characteristics. From these variables, 11 models were derived of which two were chosen as having the best explanatory power in explaining approximately 72% of the variability in profits. These models indicate that unemployment, interest rates, level of construction, changes in wage level, inflation rate of building material and project value significantly influence the profit levels. Finally, the various implications of these results on tendering strategies and theoretical tendering models are discussed.

Review of previous studies

Macroeconomic effects have not always been considered fully in previous treatments of profitability issues. Most work on tendering strategies, for instance, has been restricted to considering the profitably of winning contracts with various mark-ups and the accuracy of cost estimates (Fine, 1975) or to the mark-up as a function of previous success or failure in winning contracts (e.g. Friedman, 1956; Gates, 1967) irrespective of general economic conditions.

However, studies by Andrews and Brunner (1975), de Neufville et al. (1977), Gaver and Zimmerman (1977),Carr and Sandahl (1978), McCaffer (1979b), McCaffer et al.

(1983), Runeson and Bennett (1983), Taylor and Bowen (1987) and Runeson (1988, 1990) have found a strong relationship between the price level in the building industry and the level of competitiveness in the industry. It is clear that the level of activity in the economy determines the demand and supply, i.e. the competitiveness for all goods and services, including building and construction. Hence, the level of general economic activity is correlated to the price level in the industry.

The implication is that changes in the mark-up pattern of building firms correspond with changes in general economic activity. The studies by Runeson (1988, 1990) confirmed the existence of a systematic relationship between market conditions as measured by the level of economic activity and price level and found that demand and supply variables explained some 85% of price changes while McCaffer et al. (1983) found that contract price level movements were partly explained by the level of economic activity, but also by contract value, contract duration, construction type and location.

From the studies described above, it is clear that the price level responds to contract characteristics as well as to the level of activity in the building industry. The implication is that the mark-ups of building firms, which account for a major component of building prices, are likely to change in response to changes in market conditions and to be different for different project sizes, construction types and contract duration.

There have been no previously published studies on how differences in price levels affect the achieved profitability. Obviously, the level of mark-up is an important determinant of profit but, as Runeson and Bennett (1983) observed, it is also possible that part of the variability in the price level is due to changes in cost, as `during levels of high activity in the industry a shortage of material and skilled labour has developed which has added to the contractor's costs' (p.34). If such changes are not accurately forecast, the realized profit may be quite different from the planned profit. It is, however, reasonable to assume that the same economic and project variables that affect the price level will also determine costs and therefore the level of profits.

The data

The contract data available comprised the full set of accounts for contracts acquired and completed by an Australian building company during the period 1910-1938. Most of the contracts were for the construction of private non-residential buildings in New South Wales. The contract values range from $50 to $400000 in 1920 currency, which is approximately equivalent to $2000-$15000000 in current (1994) values, indicating a wide range of large and small contracts. All contracts of less than $20000 in current (1994) values were excluded as these were probably for minor maintenance work and of little relevance to the demand for new building work. From the remaining 221 contracts, the starting and finishing date of each contract (first and final transaction), the contract duration, the contract price (tender price adjusted for any variations), the contract cost (including any variations but excluding general overheads) and the profit were extracted. The variable investigated, the dependent variable, is the profit of each contract expressed as a percentage of the contract sum or as a percentage of the contract cost.

Since each contract was executed over a period of time, the realized profit has to be adjusted for inflation so as to standardize the data. Strictly speaking, the cumulative project building cost over time should resemble an S-curve as it is the nature of construction work that costs are incurred slowly at the beginning and end of the contract but rapidly during the middle portion (e.g. McCaffer, 1979a, p.22). However, the main objective of the adjustment is to remove any bias caused by inflation, so that the profit levels at different purchasing powers can be compared and as any over and under adjustment errors are not serious and tend to cancel each other, the S-curve was approximated by a straight line cost curve for inflation adjustment.

After extracting the contract price and contract cost from the firm's accounts books, they were adjusted for inflation (converted into constant prices) by the use of an input cost index. Each quarter, the contract cost was adjusted for inflation by the use of this index, i.e. if the contract ran through 1 year, three adjustments would be made. Each adjustment was made by using the mean percentage changes of the weighted labour and building material indices over the quarter. The contract price adjusted for inflation is termed the adjusted contract price and the contract cost adjusted for in̄ inflation is termed the adjusted contract cost. Three formats of profit levels are possible and they are shown in the Appendix. These were analysed separately by using the same set of independent variables identified in the next section.

Independent variables

Independent variables belong to one or more of the following categories: general economic variables, variables allowing the investigation of how the inflation impacted on profit and variables describing the project.

Economic variables

There are a number of variables that measure influence or are indicative of general economic activity including gross domestic product (GDP), consumer expenditure, new capital expenditure by private business, registration of new motor vehicles, building approvals, retail price index, employment and interest rate. Together they give an insight into the state of the economy.

A major problem in this study however was that most of these statistics were unavailable for the period under study. As a result, it was necessary to develop a set of continuous series of economic statistics for the period1910-1938. A retail price index was compiled by joining four different cost of living indices. Similar manipulations were required for the other statistical series, e.g. for the first 4 years of the period, quarterly data for the wage index were calculated from the minimum wage rates for 125 jobs for which statistics were available, one-third of the building material index was estimated by correlating the retail price index to the building material index, quarterly data of GDP were constructed from yearly data based on an assumption of linear change and so on. Some variables that would have been desirable could not be estimated. The details of how the statistics were compiled and the estimated values are available from the authors.

Although the methods of compiling the economic statistics mean that in all probability some accuracy was lost, it was considered that they were satisfactory and that the trend of the performance of the economy is well reflected by the calculated values.

Variables allowing the investigation of how inflation affected the profit

Most building contracts let during the period under study were lump sum contracts and it was assumed therefore that allowances for any inflation would have been incorporated into the tender. The estimated inflation rate and contract duration are essential for this and the most relevant information on inflation is the past trend. However, there was no general inflation rate published 85 years ago and wage and building material indices with a limited coverage only were available. Several variables were identified in the light of this and these are summarized in the Appendix. Each of these variables consists of two parts: contract duration and the time-lagged percentage change of wage or building material cost.

Project variables

Research by McCaffer et al. (1983) indicated that the variability of tender price movements after adjustment for changes in building costs can be explained in part by contract variables such as contract sum, construction type and location. It is therefore possible that some of the characteristics of the contract will influence the profit level. The variables that could be tested included the contract price in constant, current and inflation-adjusted terms, the direct actual contract cost in current and inflation adjusted terms and the contract duration in quarters.

Empirical results and the regression models

Three groups of regression models were developed, using the data for the 221 contracts available. The different groups were based on three different methods of expressing profit. The best model within each group was then identified. In developing the preferred models, the criteria for the inclusion and deletion of independent variables were set so that all estimated coefficients and the regression equation itself should be statistically significant at the 95% level of significance and so that there should be no discernible patterns in the residuals.

Group 1 models

In group I, the profit was expressed as (adjusted contract price-adjusted contract cost)/adjusted contract cost. The results of the group 1 regressions are given in Table 1. Full regression model Ia using all the independent variables has a multiple coefficient of determination (r^2) of 0.2675 and an *F* ratio of 2.724 (f_2=194, f_1=26) which satisfies the 95% level of significance. The low values of r^2 indicate that the explanatory power of the model is weak.

As the first step in developing a better model, the variables with a *t*-value of less than 1.6 were excluded from model Ia. The reason for including variables at only 90% significance level is that some of those variables may improve their significance to the predetermined 95% level when some of the other variables are eliminated. This resulted in model Ib, comprising four variables of which only the variable BMAT. T_{12} satisfied the 95% level of significance. The adjusted r^2 dropped from 0.1693 to 0.0531, but the *F* ratio improved from 2.724 to 4.082.

In order to satisfy the 95% significance level, the variables BMAT. T_9 and I.BMAT$_{12}$ were eliminated from model Ib. The variable N.IMM.T marginally failed the 95% level, so it was not eliminated at this stage in the hope that its significance would improve. Hence, model Ic was developed comprising variables BMAT.T_9 and N.IMM.T. In model Ic, the *t*-value of N.IMM.T dropped to 1.684 and failed the 95% level of significance, the *t* value of BMAT.T_9 improved to 2.925, the r^2 dropped from 0.0531 to 0.0368 and the F ratio improved to 5.197. Since the variable N.IMM.T still failed the 95% level of significance, it was eliminated, leaving model Id containing only one variable, BMAT.T_9. Although model Id satisfied the statistical criteria, due to the low explanatory power and the fact that only one explanatory variable was included in the model, it did not contribute anything to the study and the model I group was therefore rejected.

Group II models

In group II profit was defined as (contract price-adjusted contract cost) adjusted contract price. Models IIa-c results are given in Table 2. The full regression model IIa has an r^2 of 0.7449, indicating that 74.49% of the variation in the profit level is explained by the variations in the independent variables. The *F* ratio is 21.784 which is well above the 95% significance level.

To develop a better model, the procedures from the previous round were repeated and all variables with a *t*-value less than 1.6 were excluded from model IIa. This resulted in model IIb, in which all the independent variables improved their *t*-values to the 95% significance level except $BMAT.T_9$, N.IMM.T and L.CONT.T. The *t*-values of these variables were 0.62, 0.63 and 1.702, respectively. The adjusted r^2 dropped marginally from 0.7107 to 0.7001, but the F ratio increased from 21.784 to 47.697. The improved *F* ratio indicated that the significance of model IIb is higher than that of model IIa.

In order to improve on model IIb, variables $BMAT.T_9$ and N.IMM.T were removed but L.CONT.T was retained in the hope that its significance would improve. This resulted in model IIc, where the *t*-value of L.CONT.T improved to 2.337, meaning that all variables were now statistically significant. The adjusted r^2 increased marginally from 0.7001 to 0.7017 and the *F* ratio improved to 58.506, indicating that model II c should be the final model II.

Group III models

In group III, profit was expressed as (contract price-adjusted contract cost)/adjusted contract cost. The full regression model IIIa is given in Table 3. The r^2 of 0.7479 and the *F* ratio of 22.130 are both above the 95% significance level and better than those of model II, indicating that more of the variation in profit is explained in this model.

To improve the model, the variables with a *t*-value less than 1.6 were again excluded except N.IMM.T and L.CONT.T as these were considered *a priori* important variables and it was hoped that their *t*-values might improve in a smaller set of variables. The result is model IIIb in which all the independent variables improved their *t*-values to 95% significance level except N.IMM.T and L.CONT.T. The r^2 and adjusted r^2 decreased but the F ratio increased considerably from 22.130 to 50.739.

To further improve on model IIIb and to test individually the significance of the variables N.IMM.T and L.CONT.T, each of those two variables were removed to establish whether this improved the *t*-value of the other. L.CONT.T was first removed to give model IIIc in which the *t*-value of N.IMM.T improved to 2.007 and all variables now satisfied the 95% level of significance; despite a marginal drop of r^2 the *F* ratio improved from 50.739 to 55.301.

The next step was to remove variable N.IMM.T from model IIIb to see if the *t*-value of the restored L.CONT.T improved. This is model IIId, in which the *t* -value of L.CONT.T improved to 2.305 and again, all variables satisfied the 95% level of significance. There was a marginal increase of adjusted r^2, from 0.7132 to 0.7134 and in the F ratio from 50.739 to 55.758.

It is clear that models IIIc and IIId may both represent the final model III. However, model IIId, with L.CONT.T in the model, statistically performs marginally better than model IIIc, with a better r^2 and *F* ratio. Furthermore, on theoretical grounds, the variable L.CONT.T was considered to be a more suitable economic variable to be included in the equation than the variable N.IMM.T as `level of construction represents the demand of new buildings and is more important as a measure of economic activity than is immigration. Hence, model IIId was chosen to be the final model of the model III group.

Comments

Model II

Model II seems to be satisfactory as it includes economic variables (% UNEM.T, INT.R.T and L.CONT.T), inflation allowance variables ($BMAT.T_{12}$, $IWAGE.T_6$ and $I.BMAT_6$) and project variables (PROJ.SIZ, C.PRICE and A.C.COST).

The inclusion of variables in all three areas is encouraging as it indicates that the model is justified on *a priori* grounds. The inclusion of the economic variables for unemployment, interest rates and current level of construction is consistent with the hypothesis that the general level of economic activity has a direct impact on profit level in the building industry. All three variables are measures of the performance of the economy with % UNEM.T representing the supply in the form of available capacity, INT.R.T indicating the demand and supply of funds in the economy and L.CONT.T representing the demand for new buildings.

The variables $IWAGE.T_6$ and $I.BMAT_6$ indicate that the profit was influenced by contract duration, percentage change of wage levels and percentage change of building costs two quarters prior to the commencement of building. The fact that the coefficients of IWAGE.T and $I.BMAT_6$ are very close to each other at 0.00069 and 0.00068, respectively indicated that wage changes and material cost changes have an equal impact on the profit rate.

The positive coefficient for the variable % UNEM.T is contrary to the role unemployment plays in models estimating the price level. In price equations unemployment represents deficient demand in general and increases in unemployment lead to a decrease in the price level as it represents a fall in the level of activity. This difference in impact can however be explained in three ways. Firstly, with a major proportion of the work subcontracted, the cost to the builder is affected in the same way as the builder's (head contractor's) price. Secondly, since unemployment is caused by an oversupply of labour relative to demand, an increase in unemployment means that the employer has a wider choice of the labour to employ. As labourers with higher productivity will be employed in preference to labourers with low productivity the productivity of the workforce is improved and costs reduced. Thirdly, with high unemployment, there is less need to offer over-award payments and the cost is lowered. Hence, the profit level may increase with an increase in the labour supply as measured by unemployment and vice versa, despite the relationship between unemployment and the price level.

The variable INT.R.T also has a positive coefficient which seems to contradict theoretical expectations since a higher interest rate means a higher cost of finance and therefore a lower profit level. However, the contradiction disappears if the cost of finance is included in the tender price. If interest rates are high, the amount allowed for interest charges should be greater and, hence, the gross profit should increase.

The variable for the level of construction L.CONT.T, which represents the demand for new buildings, has a positive coefficient. This is consistent with the theoretical models for increases in the price level but seemingly contradictory to the explanation offered for the positive sign for unemployment according to which increased demand will increase cost. Hence, what is required he e is that the impact on the price level is greater than the impact on the cost level. If this is the case, then an increase in demand will lead to an increase in the profit level.

The positive coefficient of the nominal contract price (C.PRICE) variable indicates that the higher the contract price the higher the profit level is. The variable for the contract price in constant terms (PROJ.SIZ), on the other hand, has a negative coefficient. The fact that different methods of measuring the same variable result in coefficients with different signs, is interesting from both an empirical and theoretical point of view. The possible explanation is that with all inflation variables expressed as change from one period to the next, there are only two of the 26 independent variables that show a trend over the study period: construction costs in nominal dollars (due to inflation) and GDP due to economic growth. Hence, if there is a trend in profit, it would be shown through one or both of these variables. The GDP was available only on an annual basis and converted by a very crude method into quarterly data. It is likely that there has been a trend towards higher profits and that this is shown by C.PRICE as being a more consistent variable than GDP.T.

The negative sign for the variable PROJ.SIZ which is the project price in 1911 dollars, seems to indicate that the builder is more concerned with absolute rather than percentage profit. The larger the contract, the lower therefore is the profit as a percentage. While this may not be the most rational strategy, it is a very plausible strategy, supported by anecdotal evidence and also supporting the findings of McCaffer et al. (1983) that project variables influence the mark-up.

The negative coefficient for actual contract cost (A.C.COST) is consistent with expectations, although the level of significance may be stronger than expected and the explanation requires an examination of the data. While the total range of project prices was quite wide, the majority of projects fell within a fairly narrow range. However, the variability of actual contract costs was quite extreme, ranging from 2 50% to 1 60% of the contract price (28% of the contracts had a negative profit and `yes' - the firm still operating very successfully). Since profit is the difference between price and costs, it is not inconsistent that the contract cost (given the variability) should form part of the final equation, even when profit is expressed as a ratio.

The inclusion of the variable $BMAT.T_{12}$ implies that the change of building material cost lagged four quarters has an impact on the profit levels. The positive coefficient suggests that the higher the rate of increase in material cost, the higher the profit. This will be discussed further below.

The regression model began with 26 independent variables, 17 of which failed the 95% level of significance criterion and thus were excluded from the final regression equation. Their exclusion may be due to the variables' limited influence on the profit level or that while they do indicate the level of economic activity, they do so less directly than other variables for this particular purpose. The change of retail prices during the previous 12 months ($RPI.T_{12}$) was excluded from the final model II even though the general price level is believed to have some influence on the profit level. The exclusion may be due to the narrow and possible unrepresentative regimen of the original price index or it may be that price changes more directly related to building activity such as $I.BMAT._{6}$ have a more direct influence. The two variables are correlated with a correlation coefficient of 0.4574.

The variable net immigration (N.IMM.T) was also excluded. However, it is strongly believed that the effects of immigration are transmitted through L.CONT.T as it is known to stimulate demand in the building and construction industry (Brain et al., 1979, p. 278), but with an unspecified lag. N.IMM.T and L.CONT.T and N.IMM.T and % UNEM.T have correlation coefficients of 0.3849 and 0.4474, respectively and, hence, it is believed that the effects of N.IMM.T are represented in the equation by L.CONT.T and % UNEM.T. It is also probable that the destination of migrants and therefore their impact on local demand changed during the period.

The variable gross domestic product (GDP.T) was excluded indicating that it has no significant effect on the profit levels. However, the quarterly data were not available for the period but approximated from yearly data so we cannot exclude the possibility that this variable may have been significant if actual data had been available. It is also highly probable that the rate of change rather than the absolute level of GDP is the most relevant determinant, but the unavailability of economic statistics did not allow us to test this in a meaningful way.

The variable contract duration (CONT.DUR) was also excluded. With a study period of 28 years, it is to be expected that there will be changes in the duration of the building process due to new technologies and materials and it was demonstrated that cost and price were more consistent indicators of project size. The variables PROJ.SIZ, C.PRICE and A.C.COST have correlation coefficients of 0.6651, 0.6649 and 0.663 with CONT.DUR.

The exclusion of the variables $IWAGE.T_{3}$,-$IWAGE.T_{9}$, $IWAGE.T_{12}$, $I.BMAT_{3}$, $I.BMAT._{9}$ and $I.BMAT._{12}$ implies that price changes with time lags of one, three and four quarters were not significant determinants of profit. However, the similarity between the price movements for material and wages and the stability in the rate of change from one quarter to another, means that not too much emphasis should be placed on exactly which variables best explain inflation. Inflation has an impact, however it is measured. The same applies to the variables WAGE.T3, WAGE.T_6, WAGE.T_9 and WAGE.T_{12}, which are highly correlated to the included variable I.WAGE.T_6. The correlation matrix shows that, except for WAGE.T_{12}, the variables have correlation coefficients ranging from 0.4 to 0.85 with I.WAGE.T_6. The same applies to the variables B.MAT.T_3 and B.MAT.T_9.

Model III

Model III has an r^2 of 0.7264 and an F value of 55.758, indicating a highly significant regression equation. All the ten independent variables have higher than critical t-values (at the 95% confidence level) indicating that their regression coefficients are unlikely to be zero.

A comparison of models II and III shows that the only variables not included in model II are BMAT.T_9 and I.BMAT.$_9$, and the only variable excluded from mode l III is BMAT.T_6. All the other variables in model III were included in model II with the same signs of the regression coefficients. In addition, the magnitudes of the coefficients of the same variables in models II and III are very similar. This suggests that these variables behave similarly in both models. Hence, the comments on the variables included in model II also apply to model III.

However, the combination of IWAGE.T_6 and I.BMAT.$_9$ suggests a pattern of impact of price changes which is different from that of model II. The variable I.BMAT.$_9$ seems to suggest that, when allowing for inflation in tenders, the building firm used changes in building material costs with a time lag of three quarters, while IWAGE.T_6 implies that changes in wage rates are used with a lag of two quarters only. Furthermore, the coefficients for IWAGE.T_6 (0.00061) and I.BMAT.$_9$ (0.0016) suggest that an unequal weighting has been implied when allowing for wage changes and material cost changes in the tender, so that the relative weights given to wages and materials are in the proportion 2.7:1. These perceptions are different from those of model II which indicated a time lag of two quarters for both wage and material cost changes and that they had approximately equal impact. This will be discussed later.

The regression began with 26 independent variables, 16 of which failed the 95% level of significance and thus were excluded from the final regression equation. The variables WAGE.T_3, WAGE.T_6, WAGE.T_9, WAGE.T_{12}, BMAT.T_3, BMAT.T_6, N.IMM.T, RPI.T_{12}, GDP.T, CONT.DUR, IWAGE.T_3, IWAGE.T_9, IWAGE.T_{12}, I.BMAT.$_3$ and I.BMAT.$_{12}$ excluded from model III were also excluded from model II and the comments on these variables made for mode l II also apply to model III. The exclusion of the variable I.BMAT.$_6$ however suggests, contrary to the finding in model II, that the firm would not use the building material cost change by a time lag of two quarters when allowing for inflation in the tender.

Comparison of models

When comparing the models, it must be kept in mind that there is no firm rationale when comparing alternative models on the basis of r^2, r^2_{adj} and F test for, as Aigner (1971, p. 91) observed,

> any statistical basis for comparing models by R^2 must rest on an ability to infer something about R^2_{pop}. Much is known about the distribution of R^2 (and thus $R2_{adj}$) when R^2_{pop}=0. Indeed, this is the basis of the usual F test of overall significance of regression relationship, determined under the assumption R^2_{pop}=0. But when R^2_{pop}=0, the distribution of either R^2 or R^2_{pop} is intractable. Thus, any comparison of models on the basis of R^2 does not rest on a firm statistical theory.

However, Aigner (1971, p. 91) also suggested that

> When the competition among models focuses on subsets of independent variables with the same dependent variable, there is an *ad hoc* rationale for choosing the mode l with the highest R^2_{adj}. Assuming that some specification is the correct one, on the average, it will possess a larger sample R^2_{adj} than any incorrect specification.

In this case, the rationale is even stronger. The model is very clear: profit is a function of the level of economic activity. However, there is no unique measure of economic activity and all the economic variables tested represent some aspect of activity and are highly but not perfectly correlated. The regression equations therefore are not used to suggest some form of theoretical relationships but to establish empirically the combination of variables which together best represent the level of economic activity. Therefore, the models are still comparable on the basis of r^2, r^2_{adj} and the F ratio. However, the final model should be chosen on theoretical considerations as well as if some of the implications of the models are different. Since model I has already been rejected, only II and III are included in the following comparison.

Statistical comparison

The r^2 and r^2_{adj} values indicate that model III is able to explain marginally more variation in the profit level than does model II. However, model II has an F ratio that is marginally higher than the F ratio of model III, which means that model II is marginally more significant than model III. In view of statistical significance alone therefore it could only be concluded that models II and III are both suitable for explaining the variation of profit levels of building contracts.

Theoretical considerations

It is clear that most of the variables in models II and III are the same. In fact, eight of the nine variables included in model II are also included in model III. The closeness in magnitude of the coefficients of the variables included in both models indicates that those variables exert similar influences on the dependent variables. A closer look at the variables included in both models indicates that most of them belong to one of the two categories: general level of economic activity and contract values. Hence, both models suggest the same conclusion: the rate of profit is influenced by economic conditions and contract values.

However, the models are different in that they imply different patterns of the impact of inflation with the inclusion of $I.BMAT._6$ and $IWAGE.T_6$ in model II suggesting that the profit level is determined by the price changes of two quarters prior to the tender, whereas $I.BMAT._9$ in model III suggests that material costs changes lagged three quarters and wage cost changes lagged two quarters are the main determinants. In addition, the coefficients of `inflation allowance variables' in model II, IWAGE.T6 and $I.BMAT._6$, are nearly equal, implying an equal impact of wages and material cost changes when allowing for inflation. This contrasts with the coefficients of $IWAGE.T_6$ and $I.BMAT._9$ in model III which imply a weighting of 2.7:1 of wages and material costs changes. This means that model II conforms better with the national cost adjustment provision, NCAP-1, which was a uniform method for rise and fall calculations accepted by the building industry and which gives 55% weighting to material cost and 45 % weighting to wages (Bentley, 1982).

There are two possible interpretations of the reasons for the difference between the models. For model III, where the impact of inflation is assumed based on the actual costs, to be accurate, it is required that the builder establishes a mark-up and adds to this to compensate for inflation. The positive sign of the variables would require that the builder consistently overcompensates for changes in inflation. Hence, the cost estimate and the mark-up are predetermined and the contract price is a residual.

Neither the use of different time periods for the impact of inflation nor the unequal impact of labour and material appears theoretically acceptable and it is difficult to believe that the builder will always overcompensate for changes in inflation. However, there is also a further problem with model III: at the time the mark-up is determined, the actual cost is not known. If, as appears to be the case here, the correlation between estimated and actual costs is low, the equation, while highly significant, would tell us very little about how the allowance for inflation was made.

For model II to be theoretically valid, there are two requirements. Firstly, the final price is essentially set by competition in the market and the profit is not predetermined but a residual. Secondly, it is required that the inflation variables are included in the equation not because inflation has an impact on the value of the real profit but because inflation is another proxy variable for economic activity. When economic activity picks up so does inflation and when economic activity slows down, so too does inflation. High inflation is high profit because it is a sign of low competition and therefore high contract prices.

To choose between theoretical models with similar explanatory powers, it is customary to compare them on three criteria: how consistent they are with the general theoretical framework, how general the assumptions are and how complex the theory is. On these criteria, model II appears superior on all accounts: it is compatible with microeconomic theory, it has general applicability and the theory is comparative simple.

Model III, on the other hand, is inconsistent with current economic theory, the assumptions are restrictive and any model incorporating it must be complex.

Final model

After the above comparisons of the models, it is clear that in terms of accuracy, model III performs marginally better than model II. The analysis showed that model III can explain 72.64% of the variability of profit while model II can explain only 71.39%. However, on theoretical grounds, model II is the preferred model as it is consistent with general economic theory and is simpler but more applicable.

Model II explains the profit level in the building industry through nine independent variables: three that account for supply and demand in the economy, three that relate to price increases and three that relate to the size or price of the project. The supply and demand variables are the level of unemployment which indicates the available free capacity, the interest rate which gives the demand for funds and the level of construction which shows the current demand for building. The variables relating to price increases are the rate of change in the prices of building material lagged four quarters and the rate of change of cost of labour and material for a period equal to the duration of the construction period but lagged two quarters. It is suggested that these variables also reflect the level of activity in the industry with increasing activity resulting in higher inflation and vice versa. The three project-related variables show different marketing strategies for projects of different size groups, indicating lower profit margins for larger buildings.

In terms of significance, the project-related variables are the most significant followed by the supply and demand variables with the variables measuring price increases being least significant.

Conclusion

The work described in this paper examines the relationship between the general level of activity in the economy and the profit levels in the building industry by means of an empirical study of one building contractor' s records over the years 1910-1938.

Two statistically satisfactory models were developed to explain profit level movements. The accuracy of the models is sufficient to indicate that profit levels are influenced by the condition of the economy and in particular price movements and the level of general economic activity. Contract price and cost were also found to be major influencing variables. The preferred model is able to explain approximately 71% of the variation in the profit levels of the contracts.

One of the problems with the study has been the construction of consistent series of economic statistics for the period of the study. The 29% unexplained variation in the profit level requires more precise study on the subject. It may be due to inaccuracies in the economic statistics, failure to test relevant variables or that variables excluded on the basis of non-significant *t*-values should have been retained. It may also be based on inaccuracies in estimating or unsystematic changes in the actual construction costs.

This study has, however, demonstrated the close links between the performance of the building industry and the level of activity in the rest of the economy. It is also hoped that it has brought into question the crucial assumption of many previous studies of tendering strategies (e.g. Gates or Park), the assumption that tenderers' mark-up patterns change only in response to the number or identity of the competitors but not in response to economic conditions.

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Appendix: List of Variables

Variables	Description
Dependent	
%profit	- (Adjusted contract price 2 adjusted contract cost) X 100/adjusted contract price
%profit.1	- (Contract price adjusted contract cost) X 100/adjusted contract price
%profit2	- (Contract price adjusted contract cost) X 100/adjusted contract cost
Independent	
GDP.T.	- Gross domestic product, current quarter, current prices
N.IMM.T	- Net immigration, NSW, current quarter
%UNEM.T	- %male unemployment, current quarter
INT.R.T	- Interest rates, bank deposits, current quarter
$RPI._{12}$	- (Retail price index [T] 2 retail price index [T 12] X 100 retail price index [T 12]
L.CONT.T	- Residential building applications, City of Sydney LGA
$WAGE.T_3$	- (Wage index [T] wage index [T 3]) X 100/wage index [T 3]
$WAGE.T_6$	- (Wage index [T 3] wage index [T 6] X 100/wage index [T 6]
$WAGE.T_9$	- (Wage index [T 6] wage index [T 9]) 3 100/wage index [T 9]
$WAGE.T_{12}$	- (Wage index [T -9] 2 wage index [T -12]) 3 100/wage index [T -12] $B.MATT.T_3$ - (Building material index [T] building material index [T 3]) X 100/building material index [T 3]
$B.MAT.T_6$	- (Building material index [T 3] building material index [T 6] X 100/building material index [T 6]
$B.MAT.T_9$	- (Building material index [T 6] building material index [T 9] X 100/building material index [T 9]
$B.MAT.T_{12}$	- (Building material index [T 9] building material index [T 12] X 100/building material index [T 12]
$IWAGET_3$	- Contract duration X (wage index [T] wage index [T 3]) X 100/wage index [T 3]
$IWAGET_6$	- Contract duration X (wage index [T 3] wage index [T 6]) X 100/wage index [T 6]
$IWAGET_9$	- Contract duration X (wage index [T 6] wage index [T 9]) X 100/wage index [T 9] I
$WAGET_{12}$	- Contract duration X (wage index [T 9] wage index [T 12]) X 100/wage index [T 12]
$I.BMAT_3$	- Contract duration X (building material index [T] building material index [T 3]) X 100/building material index (T 3]
$I.BMAT_6$	- Contract duration X (building material index [T 3] building material index T-6]) X 100/building material index [T 6]
$I.BMAT_9$	- Contract duration X (building material index [T 6] building material index [T 9]) X 100/building material index [T 9]
$I.BMAT_{12}$	- Contract duration X (building material index [T 9] building material index [T 12]) X 100/building material index [T 12]

C.PRICE	- Contract price without adjustment for inflation
PROJ.SIZ	- Contract price at constant 1911 prices.
A.C.COST	- Actual contract cost at constant prices (start of project)
CONT.DUR	- Contract duration (quarters)

Table 1: Regression coefficients for models Ia to Id

Variable	Model Ia ($x10^{-2}$)	t-value	Model Ib ($x10^{-2}$)	t-value	Model Ic ($x10^{-2}$)	t-value	Model Id ($x10^{-2}$)	t-value
$WAGE.T_3$	-9.28	-0.095						
$WAGE.T_6$	-79.85	-0.836						
$WAGE.T_9$	-50.73	-0.645						
$WAGE.T_{12}$	8.67	0.107						
$BMAT.T_3$	-60.45	-0.875						
$BMAT.T_6$	107.11	1.897						
$BMAT.T_9$	-98.26	-1.663	-40.37	-1.528	63.91	2.925	59.67	2.738
$BMAT.T_{12}$	141.04	2.959	123.24	3.463				
$RPI.T_{12}$	2.22	0.163						
N.IMM.T	0.027	1.644	0.024	1.920	0.021	1.684		
%UNEM.T	27.39	0.856						
INT.R.T	233.32	1.412						
GDP.T	-0.0039	-0.628						
PROJ.SIZ	0.23	0.348						
L.CONT.T	3.91	0.592						
CONT.DUR	-7.37	-0.574						
C.PRICE	0.32	0.492						
$IWAGE.T_3$	1.29	0.249						
$IWAGE.T_6$	3.86	0.733						
$IWAGE.T_9$	5.37	0.923						
$IWAGE.T_{12}$	-0.6	-0.089						
$I.BMAT._3$	3.82	0.824						
$I.BMAT._6$	-5.56	-1.345						
$I.BMAT._9$	4.09	0.933						
$I.BMAT._{12}$	-6.17	-1.550	-4.4	-1.711				
A.C.COST	0.57	-5.923						
Constant	759.67		381.25		399.33		421.74	
R^2	0.2675		0.0703		0.0455		0.0331	
adj R^2	0.1693		0.0531		0.0368		0.1819	
no cases	221		221		221		221	
f_1	26		4		2		1	
f_2	194		216		218		219	
F ratio	2.72		4.08		5.20		7.49	

Table 2: Regression coefficients for models IIa to IIc

Variable	Model IIa ($x10^{-2}$)	t-value	Model IIb ($x10^{-2}$)	t-value	Model IIc ($x10^{-2}$)	t-value
WAGE.T_3	-0.22	-0.168				
WAGE.T_6	-1.56	-1.214				
WAGE.T_9	0.26	0.242				
WAGE.T_{12}	0.22	-0.201				
BMAT.T_3	-0.32	-0.343				
BMAT.T_6	0.68	0.893				
BMAT.T_9	-1.51	-1.898	0.23	0.62		
BMAT.T_{12}	1.02	1.584	1.01	3.236	1.03	3.536
RPI.T_{12}	-0.022	-0.118				
N.IMM.T	0.0002	0.999	0.00012	0.63		
%UNEM.T	1.13	0.0043	1.32	3.723	1.34	3.950
INT.R.T	6.56	2.94	7.18	3.732	7.17	3.749
GDP.T	-0.000004	-0.044				
PROJ.SIZ	-0.19	-20.915	-0.18	-20.505	-0.18	-20.649
L.CONT.T	0.14	1.603	0.13	1.702	0.15	2.337
CONT.DUR	0.017	0.098				
C.PRICE	0.19	22.101	0.19	21.645	0.19	21.776
IWAGE.T_3	0.014	0.2				
IWAGE.T_6	0.12	1.623	0.067	2.458	0.069	2.590
IWAGE.T_9	-0.006	-0.075				
IWAGE.T_{12}	0.022	0.214				
I.BMAT.$_3$	-0.008	-0.125				
I.BMAT.$_6$	0.022	0.39	0.0064	2.544	0.068	2.857
I.BMAT.$_9$	0.14	2.436				
I.BMAT.$_{12}$	0.015	0.288				
A.C.COST	0.008	-6.325	-0.0078	-6.113	-0.0078	-6.098
Constant	-36.79		-40.89		-41.63	
R^2	0.7449		0.7151		0.7139	
adj R^2	0.7107		0.7001		0.7071	
no cases	221		221		221	
f_1	26		11		9	
f_2	194		209		211	
F ratio	21.78		47.70		58.506	

Table 3: Regression coefficients for models IIIa to IIId

Variable	Model IIIa ($x10^{-2}$)	t-value	Model IIIb ($x10^{-2}$)	t-value	Model IIIc ($x10^{-2}$)	t-value	Model IIId ($x10^{-2}$)	t-value
$WAGE.T_3$	-0.75	-0.585						
$WAGE.T_6$	-0.88	-0.704						
$WAGE.T_9$	-0.044	-0.043						
$WAGE.T_{12}$	-0.25	-0.238						
$BMAT.T_3$	-0.34	-0.374						
$BMAT.T_6$	0.45	0.610						
$BMAT.T_9$	-1.44	-1.875	-1.63	-2.713	-1.7	-2.829	0.157	-2.634
$BMAT.T_{12}$	1.38	2.230	1.05	3.569	1.13	3.829	1.0	3.451
$RPI.T_{12}$	-0.11	-0.637						
N.IMM.T	0.00026	1.214	0.00017	0.935	0.00031	2.007		
%UNEM.T	8.9	2.143	0.89	2.675	0.64	2.238	0.97	3.012
INT.R.T	5.79	2.690	5.54	3.102	4.98	2.846	5.65	3.172
GDP.T	-0.0000056	-0.070						
PROJ.SIZ	-0.18	-21.183	-0.18	-21.264	-0.18	-21.217	-0.18	-21.396
L.CONT.T	0.11	1.238	0.11	1.461			0.14	2.305
CONT.DUR	-0.076	-0.452						
C.PRICE	0.19	22.324	0.19	22.372	0.19	22.309	0.19	22.483
$IWAGE.T_3$	0.04	0.592						
$IWAGE.T_6$	0.088	1.283	0.056	2.256	0.051	2.047	0.061	2.457
$IWAGE.T_9$	0.0066	0.087						
$IWAGE.T_{12}$	0.023	0.258						
$I.BMAT._3$	-0.009	-0.144						
$I.BMAT._6$	0.034	0.639						
$I.BMAT._9$	0.12	2.170	0.16	3.73	0.16	3.681	0.16	3.689
$I.BMAT._{12}$	-0.0077	-0.149						
A.C.COST	-0.0075	-5.971	-0.0072	-5.911	-0.0074	-6.118	-0.0071	-5.859
Constant	-27.24		-27.78		-19.78		-30.02	
R^2	0.7479		0.7276		0.7248		0.7264	
adj R^2	0.7141		0.7132		0.7117		0.7134	
no cases	221		221		221		221	
f_1	26		11		10		10	
f_2	194		209		210		210	
F ratio	22.13		50.739		55.301		55.758	