ADOPTING A SEMI-IDEOGRAPHIC APPROACH TO CASH FLOW FORECASTING

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Cash flow forecasting is an important part of the management of a construction company. A large proportion of construction company bankruptcy is due to poor financial planning. Many of today's cash flow forecasting models rely on standard S-curves. A standard S-curve is often chosen from a library of curves developed by calculating the average monthly percentage values of a group of completed projects . Therefore a single standard S-curve is often used to represent many projects that belong to a particular group. In this paper, the authors demonstrate that the above approach (i.e. nomothetic models) will not always yield the most accurate results. The paper proposes that an idiographic (a specific curve for a specific project) model should be adopted instead. The paper begins by describing briefly a nomothetic model which was developed using 150 projects. This model was based on groups classified in terms of duration and cost. The models were then modified to be able to incorporate the affects of the actual duration of the project concerned. The paper concludes by testing the accuracy of the proposed idiographic models. The results confirm that better accuracy is achieved when using this approach.

INTRODUCTION

The success of a company depends on the ability of the management to foresee and prepare for the future. A contractor can use cash flow forecasting techniques to improve his understanding of his financial position and reduce the risk of bankruptcy that threatens so many construction companies. Analysis of one of the most popular cash flow management packages reveals that it is based upon research that was published in 1978 (Drake 1978). The general economic situation and the contractors management and organisational practices have changed dramatically since that time and these changes may render the models on which the software has been based invalid. Several cash flow forecasting models have been developed for use by contractors at the tendering stage (Kaka and Price (1991), Khosrowshahi (1991), etc.). The majority of these have been based on standard value which is what the client pays the contractor or cost, which is the contractors expenses, S-curves. The accuracy of these models depends on the accuracy of the standard S-curves used. The opinion that accurate standard S-curves can be developed using past projects is in question. Previous research has used broad based categories to establish a standard S-curve with varying degrees of success.

Several pieces of research have attempted to develop standard value/cost flow curves. Bromilow and Henderson (1974) used four building projects to develop their value S-curve. Hardy (1970) analysed 25 projects and found that there was no strong correlation between the interim values of individual projects investigated, even when separating them into different categories.

Oliver (1984) analysed projects collected from three construction companies. He concluded that, although the number of projects was statistically small, construction projects are individually unique and follow such diverse routes that value curves based

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on historical data are not capable of providing the accuracy required for the control of individual projects. Drake (1978) collected projects from Regional Health Authorities and further classified them into different cost categories. An S-curve was fitted into each of these categories. Unfortunately, figures were not given which indicated the number of projects analysed or of the level of accuracy of the fitted functions.

Singh and Woon (1984) fitted envelopes of S-curves for high rise commercial industrial and residential buildings. The envelopes were drawn so as to include half of the values considered in each category. Although they did not quote the number of projects analysed, the graphs plotted through the scatter points show that the sample was small and the values outside the envelopes were widely scattered.

The failure of the above authors to produce typical value curves indicated the shortcomings of the nomothetic models (models which aggregate groups of projects in order to develop a single standard curve). This pointed the way to the introduction of an idiographic approach. The basic principle of this methodology was that value curves were generally unique and should be modelled separately (i.e. a curve should be fitted for each project).Berny and Howes (1983) modified a nomothetic approach to reflect the specific form of the individual projects. By proposing an equation for the general case of an individual project curve, as distinct from the curve of the general (standard) function, they moved from a nomothetic to an idiographic approach.

Kenley and Wilson (1986) applied the idiographic methodology further and used the logit transformation to fit data. They analysed 72 commercial and industrial building projects in two groups of data. They also developed a value S-curve for each individual project and an average S-curve for each of the two groups. The error obtained from the two average curves was much higher than that of the individual fits. This indicated that the systematic error involved in group regression was high and that the individual curves took a unique shape. They concluded by saying that it was their belief that group models are both functionally as well as conceptually in error. It is important to acknowledge that idiographic model proposed by Kenley and Wilson (1986) was only useful for evaluating the accuracy of the best fit that can be achieved when using the Logit transformation technique.

The need for cash flow forecasting (and cost control) and the failure of previous work to prove the feasibility of standard value curves made it necessary to choose another variable that could be modelled more accurately and thus used to calculate the value curve. Kaka and Price (1993) collected data for 150 projects and selected cost flow curves to model instead of value flow curves. They classified the projects in terms of size (small, medium and large), type of contract (traditional, design and build and management) and type of building (commercial, industrial and public). Using this classification system the projects were split into seven groups. They analysed the accuracy of these curves and demonstrated that there was a limited improvement to that of previous research (namely those using value curves).

As forecasting models developed for use at the tendering stage rely on an average S-curve created from a group of projects, rather than a curve created specifically for the project in question, the accuracy of the forecast could theoretically be improved. It is this hypothesis that is examined and confirmed in this paper.

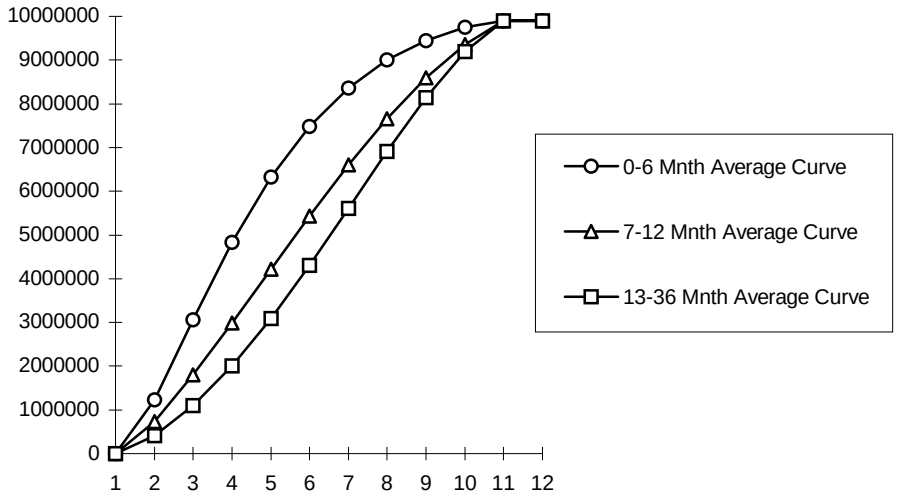
THE SEMI-IDIOGRAPHIC APPROACH

The basic principle of the ideographic approach is that actual S-curves are generally unique and should be modeled individually. The principle of the nomothetic approach is that a standard S-curve is developed out of a group of projects.

The work carried out using the ideographic approach indicated that as each project is unique that a curve should be modeled separately, this is impractical and only suitable for analytical purposes as suggested by Kenley and Wilson (1986). Although it is impractical to produce an individual standard curve for each project, it is possible to produce an individual curve using the average standard curves that closely represent the project (semi ideographic approach).

The research that produced the average curves for the different classifications (i.e. Traditional contract 0-6 months, Design and Build 13-36 months, etc.), found that as the duration of the project increases the shape of the S-curve becomes more concave. Figure 1 illustrates this and indicates that a standard S-curve could be found for an individual project using two average curves with average duration's either side of the project in question.

Figure 1: The Average S-curves



This method is a mixture of both nomothetic and ideographic models as it uses average S-curves developed from a group of projects in order to develop an individual curve for a particular project.

Figure 2: Average Curves and Interpolated

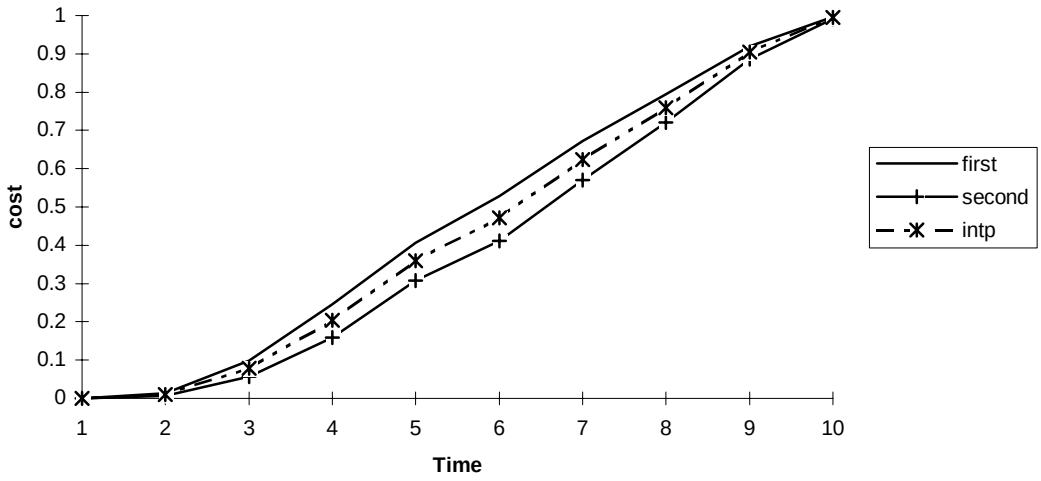
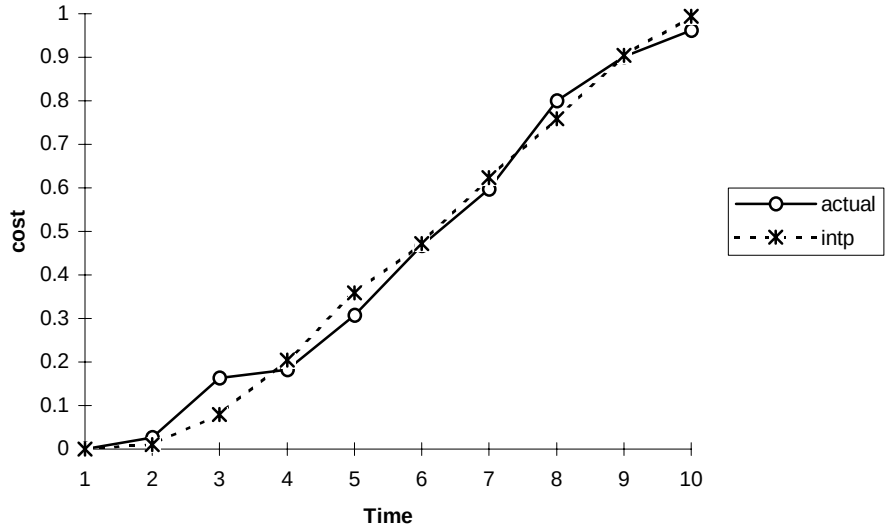


Figure 2 demonstrates how the proposed semi ideographic model works. The duration and procurement route of the project in question is used to decide the groups of standard S-curves to be used. The example indicates a 7 month project, therefore the average S-curves for 7-12 months (second) and 0-6 months (first) are used. The specific curve (intp) is then found by interpolating between the two average curves.

Figure 3: Interpolated and Actual



The duration of the standard S- curves representing a group, is the average of that group, for instance the average curve of the 0-6 months group is 5.4 months and the average duration for the 7-12 month group is 9 months. As in this example the project is 7 months in duration, the model would have used the 7-12 month standard S-curve, as the duration of the project falls within this group. However, it can be seen that the 0-6 month S-curve is in fact closer (7 - 5.4 = 1.6 and 9 - 7 = 2). Therefore by interpolating between the two library curves a individual S-curve, that can be used in the forecast can be found (Figure 3).

The principle was investigated further and it was found to improve the accuracy of the forecast. The next stage was to investigate the semi ideographic approach further by using a larger sample of data and comparing the results against an accurate model.

THE PROJECT DATA

In order to evaluate the accuracy of the proposed modeling technique a reasonable data sample is needed.

Data for thirteen projects (Table 1) was collected from two different sources, the first source being a large construction company based in the UK. Data for five completed projects was supplied in the form of cost value reconciliation sheets. The second source of data was a quantity surveying practice. Both sets of data contained the value and duration of the projects and the monthly payments.

The data contained projects of varying duration and cost which ensured that testing was not limited to a certain size of projects. The duration's varied between 5.5 months to 17 months. The cost of the projects ranged form between three hundred and thirty thousand pounds to just over three million pounds. Although the data was collected from two different sources it was found to have all been completed using a traditional procurement route.

Table 1: The Project Data

Project	Project Cost (£ Million)	Project Duration (Months)
1	2.315	8
2	1.555	7
3	0.983	11
4	2.699	5.5
5	2.206	11
6	1.34	7
7	0.695	12
8	3.236	17
9	0.920	12
10	1.383	15
11	0.786	8
12	0.336	6
13	2.504	15

THE STANDARD METHOD OF MEASUREMENT

Once the S-curves were fitted into the actual data, it was necessary to be able to compare the accuracy obtained using the ideographic approach and that obtained by the nomothetic approach.

The method used involved the calculation of the standard deviation of the difference between the actual and the forecasted project values. It is known as the SDY method, since "project value" is the y-axis variable. This method has been adopted by several authors including Kenley and Wilson (1986), Kaka and Price (1993) and has become the standard method of measurement. The method of calculating the SDY was first put forward by Jepson(1969) who utilized it as a risk index.

$$SDY = \sqrt{\{ \sum (Y - Ye)^2 / N \}}$$

Where Y is the actual value at the accounting period

Ye is the estimated (or fitted) value

N is the number of observations (accounting periods)

The model with the lowest SDY value is judged to be the most accurate. The method is described in greater detail by Kenley and Wilson (1986).

THE ANALYSIS AND RESULTS

The analysis involved using actual past projects as case studies in order to compare the accuracy achieved using the semi ideographic model with that of the forecast using the nomothetic model. The duration and the contract type of each of the past projects was used to find the correct average curves as described earlier. The different average curves were then used to find a individual curve for each project in the data sample. Once all the forecasts were completed it was necessary to measure the accuracy of the fit. The SDY's of the actual curves against the forecast were measured and recorded.

Table 2: The SDY's and % Improvements

Project	Old.	Interpolate.	Improvement	% improvement
1	**16.613**	**12.907**	**yes**	**22.30783122**
2	**8.55**	**5.806**	**yes**	**32.09356725**
3	**9.97**	**14.66**	**no**	**-47.04112337**
4	**26.708**	**26.27**	**yes**	**1.639958065**
5	**17.324**	**11.102**	**yes**	**35.91549296**
6	**18.28**	**24.8**	**no**	**-35.66739606**
7	**12**	**4.01**	**yes**	**66.58333333**
8	**14.881**	**16.626**	**no**	**-11.72636248**
9	**5.288**	**3.919**	**yes**	**25.88880484**
10	**6.21**	**5.984**	**yes**	**3.639291465**
11	**4.608**	**5.169**	**no**	**-12.17447917**
12	**19.348**	**17.348**	**yes**	**10.33698573**
13	**18.61**	**18.243**	**yes**	**1.972058033**

Table 2 contains the SDY values for both methods of forecasting compared against the actual. It can be seen that in 9 of the 13 projects the ideographic approach has improved the accuracy of the forecast, while in 4 of the projects the nomothetic model proved to be the most accurate.

Having determined that the ideographic approach in general, improved the accuracy it was necessary to investigate the degree in which the accuracy of the forecast was improved. It was found that the new approach had improved the 9 projects forecasts by a percentage that varied between 66.5% and 1.6% with an average improvement of 24%. The proposed semi ideographic model however, did not improve the forecast in four of the projects (the decrease in accuracy varied between 47% and 11%).

Although the model improved 9 of the 13 projects it was important to ensure that the semi ideographic approach had improved the overall accuracy of the forecasts. This was done by calculating the overall average SDY for the nomothetic approach and the overall average SDY for the semi ideographic approach (13.72 and 12.83 respectively). This proved that the ideographic approach has overall, improved the forecast, albeit not evenly

CONCLUSION.

A semi ideographic approach has been investigated and has been found in most cases to provide more accurate results than a nomothetic model. A cashflow model previously developed which adopted the nomothetic approach by using average S-curves developed from research carried out using 150 projects was examined.

The model classifies projects in terms of duration and contract type. An average S-curve is used with the same procurement route and duration as the project to be forecast. The average S-curves developed for this nomothetic model were investigated as the graphs of the average S-curves indicated that as the duration increases the S-curve becomes more concave. This indicated that a semi ideographic approach in

theory could improve the accuracy of the forecast over that produced by the nomothetic model.

A larger data sample was collected and the approach was tested using this data. The forecast using the semi ideographic approach was compared against the results obtained by the nomothetic model and the actual project curve to indicate whether any improved was made by the semi ideographic approach. Although the test sample was statistically small by research standards the results indicated that the semi ideographic approach improved the accuracy in 69% of the cases and by an average of 24%

This research has indicated that, the semi ideographic approach has improved the accuracy of projects using only the traditional procurement route. Further research with a larger sample, containing completed projects which have employed different procurement routes, should be carried out to investigate the approach on other procurement routes.

The semi ideographic approach uses two average S-curves created by research for the nomothetic model. A curve is modeled from these two curves, to more accurately represent the actual. As an individual curve is developed to represent the actual project, the semi ideographic approach improves the accuracy of the forecast.

In this paper, due to the individual nature of projects only the duration is considered. It is believed that by incorporating more variables or characteristics into the proposed model, more accurate results would be obtained.

A Factor that makes projects unique is the programming (i.e. how the contractor goes about the planning of the contract). There is no standard way in which a large project should be planned. It might be the policy of the contractor to execute the main body of the work as fast as possible and then reduce the management team over the remaining contract. This therefore, creates variations form project to project and thus makes projects unique.

The way in which the valuations of the work carried out also affects the project by either under measurement or over measurement. Claims, re-measurement of provisional work, variation orders, delay in settlements of such items all make the individual projects unique.

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