CHAPTER - 6

Multi-Factor Model, Factors and Factors Weights

Multi-Factor Model, Factors and Factors Weights

6.1: Introduction

Any method of investment appraisal based on a single criterion, however scientific it may be, is susceptible to suffer from certain limitations, because at the time of evaluation implications of many other variables are overlooked. To overcome such limitations, Multi-Factor models can be safely used, as evaluations are based on multiple factors instead of a single variable. This chapter is dedicated to introduce factor models and show how factors can be identified using empirical methodology.

Financial evaluation of an investment proposal is essentially an important step in the process of capital budgeting, which is undertaken for ascertaining economic merit of the investment so that the investment may be approved and resources can be allocated to the investment proposal for launching and implementation. However, this is not the only yardstick for accepting or rejecting a project. Meredith and Mantel (2000) provide a list, which includes both financial as well as non-financial factors leading to the success of an investment [See Appendix of Chapter 5].

A limited number of researchers [such as Moutinho Nuno (2010), Lopes and Flavell (1998), Mohamed and McCowan (2001)], who have attempted to study the role of non-financial factors, have noticeably concentrated on analyzing risks associated with non-financial factors and inter-relationship between the factors. They left financial factors outside the purview of their analysis. In fact, success of a project does not depend on non-financial factors alone; rather, it depends on both factors, financial and non-financial. In making capital budgeting analysis appropriate, objective and rational, this study appreciates the need for analyzing both the financial and non-financial factors.

An important question, which has not been properly researched is - how an evaluator should assign weights to financial and non-financial and strategic factors. The studies noted in literature survey left this question unanswered. This chapter proposes to fill this gap by studying financial and non-financial factors together and assessing the relative merits of the each set of the factors. The result of the study is likely to help the

management and CFOs to understand the weights they should assign to each set of factors to arrive at an objective and rational capital budgeting decision.

6.2: Objectives of this Chapter

i) To examine methods for incorporating several factors into analysis

ii) To understand and estimate relative importance of financial and non-financial factors

ii) To find an objective method of determining weights for the factors to be evaluated

To meet the objectives enumerated above, the chapter is designed to present a discussion of factor models and show how factors and factor weights can be determined.

6. 3: Factor Model in Capital Budgeting

Traditional financial models such as IRR or NPV confine the focus of investment appraisal on a single decision criterion, - profitability, which inherently suffers from short-run bias. In real world, when the selection of a long-term investment proposal is done, multiple criteria and myriads of constraints are taken into account. The nominal financial appraisal based on DCF models cannot capture the complexity of the decision-process and points of trade-offs involved in the real life task of project selection. In an attempt to overcome the limitations of DCF models, some comprehensive models encompassing multiple variables and criteria have been developed. Some of those models include

a) 0-1 Factor Model
b) Un-weighted Factor Scoring Model
c) Weighted Factor Scoring Model
d) Constrained Weighted Factor Scoring Model

In some selected books of project management such as Meredith and Mantel (2000), brief discussions about different factor models are available. In the following paragraphs these factor models have been briefly discussed.

6.3.1: 0-1 Factor Model

While applying this method, management selects a set of relevant factors and lists them in a printed pro-forma. The copies of the printed pro-forma are then forwarded to senior managers and personnel having profound knowledge and experience in project appraisal and selection. These senior managers and experts, who have clear understanding of the corporate mission, goals and investment portfolio, are given the copies of the pro-forma for giving credits to the enlisted factors. The expert respondents indicate if the concerned project qualifies a collection of essential factors or not. If the project qualifies a specific factor, the rating manager assigns 1; on the other hand, if the rater finds that the project does not qualify the specific factor, he assigns zero to it.

Sample of Evaluation as per 0-1 Factor Model

Project:

Rater: Date:

No.	Factors	Qualifies	Not Qualifies
1	No increase in energy consumption	1	
2	No additional facility is required	1	
3	No new technical hand is required	1	
4	Project does not impair factory safety		0
5	Project increases market share		0
6.	Project does not cause environment pollution	1	
7.	Project can offer return more than 10%		0
8.	Project can increase market share	1	
9.	Project can reduce per unit cost	1	
10.	Product quality will improve		0

The third and fourth columns of the sheet are summed. These totals show the number of factors a project qualifies and number of cases the project fails. The project that qualifies sufficient number of factors is selected. In case of mutually exclusive projects, the project that qualifies the highest number of factors is recommended for selection. The fundamental merit of this method is that the evaluation is done on the basis of several

criteria, instead of a single criterion. The limitation of this model is that it does not categorize the factors in terms of their relative importance in the light of the firm's survival and attainment of the envisioned goals. This method gives equal weights to all factors. It leaves a possibility that a project of lesser merit may get selected only because of qualifying a large number of less important factors.

6.3.2: Un-weighted Factor Scoring Model

Major limitation of 0-1 Factor Model is that it merely indicates if a project qualifies a factor or not. The strength with which it qualifies a factor is not measured. This limitation can be overcome by using Factor Scoring Model. Here instead of assigning √ sign or 1 to denote that the project qualifies a factor, a linear measure of the degree to which the project meets / satisfies a factor is introduced. Scores can be recorded using 5-point, 7-point or 10 point scale depending on the problem involved.

Scores for each factor are initially defined on the basis of objective criteria such as level of achievement of the firm's objective. The box given below indicates the mechanism of deciding scores corresponding to factor attainment level.

Box- 1: Defining Scores for Defined Level of Performance

Levels of achievement	Assigned Scores
Sales $\geq$ 1000 million	5
Rs 800 million $\leq$ Sales $\leq$ Rs 1000 million	4
Rs 700 million $\leq$ Sales $\leq$ Rs 800 million	3
Rs 600 million $\leq$ Sales $\leq$ Rs 700 million	2
Rs 500 million $\leq$ Sales $\leq$ Rs 600 million	1

While factor scores for level of performance are determined, expert raters indicate scores for each factor enumerated in the printed pro-forma. Following table shows an example of un-weighted factor scoring model using 5 point scale.

Sample of Evaluation as per 0-1 Un-weighted Factor Scoring Model

Project:

Rater: Date:

No.	Factor	Factor Scores
1	No increase in energy consumption	4
2	No additional facility is required	2
3	No new technical hand is required	3
4	Project does not impair factory safety	5
5	Project increases market share	3
6.	Project does not cause environment pollution	3
7.	Project can offer return more than 10%	2
8.	Project can increase market share	5
9.	Project can reduce per unit cost	3
10.	Product quality will improve	4
	Total factor Score	28

Management may define a minimum required cut-off factor scores for choosing a project. In case of mutually exclusive projects, the project that earns the highest factor score [or sufficient score] is selected.

This model is also suffering from same limitation as '0-1 Factor Model', which treats all factors with equal weights. In practice some factors have greater weights in terms of their contribution to firm's objectives and survival, while other factors (which are desirable only) have less weight. If all the factors are treated at par, the evaluation cannot be taken to be rational. In fact there is a necessity to determine the relative weights of each factor.

6.3.3: Weighted Factor Scoring Model

In Weighted Factor Scoring Model, weights are assigned to different factors, based on their relative importance. Symbolically the method can be expressed as below:

$$S_i = \sum_{j=1}^{n} s_{ij} w_j$$

S_i = Total Score of ith project

s_i = Score of ith project on jth criteria

w_j = Weight of jth criteria

The weight w_j may be generated using Delphi Method. However, this method is grossly subjective; because, the weights are initially decided by experts based on their wisdom. Subsequently these weights are matched. Marginally relevant criteria may be incorporated into the model and based on their scores a project of lesser merit may be selected.

6.3.4: Constrained Weighted Factor Scoring Model

The temptation to include numerous criteria into the model can be avoided by treating the marginal criteria as constraints. Say, in an appraisal process there are 20 such factors to be evaluated. If it happens that ten factors account for 95% of the total weights and remaining ten factors attach very low weights, then the latter factors (from 11 to 20) can be treated as constraints instead of treating them as factors. The model can be described as below:

$$S_i = \sum_{j=1}^{n} s_{ij} w_j \prod_{k=1}^{m} c_{jk}$$

$S_i = Total\ \ Score\ \ of\ \ ith\ \ project$

$s_i = Score\ \ of\ \ ith\ \ project\ \ on\ \ jth\ \ criteria$

$w_j = \text{Weight}\ \ of\ \ jth\ \ criteria$

$c_{jk} = 1, When\ \ jth\ \text{Project satisfies K}^{th}\ constraint$

6.4: Comparing Relative Importance of Non-Financial Factors: An Analysis

In the light of discussions presented above, this chapter proposes to present the findings of the study undertaken in this research study to assess the role financial and non-financial factors in capital budgeting decision-making of Indian corporate houses. To obtain a working idea regarding relative worth of different financial and non-financial variables, a set of 11 variables has been selected. The CFOs and Directors of responding companies were asked to assign value according to their assessment of importance of the variables on a five point scale. [1 meaning least important, 5 meaning highest important]

Compiled responses in respect of multiple variables on a five point scale have been compiled in the table below:

The variables assessed have been enlisted below:

1. Corporate Strategy
2. Environmental Considerations
3. Organizational Structure and Human influence
4. Profitability and Revenue
5. Input and capital costs
6. Liquidity Considerations
7. Production Technology
8. Operational convenience,
9. Product Market Position
10. Future Orientation
11. Competitors modernization

Values assigned by the responding firms have been compiled below:

The data presented below indicates that the allegation that corporate houses emphasize too much on financial factors, is not true. The fact is that they care for the non-financial factors and financial factor almost with equal weights. The most important point is that there is no formal methodology for incorporating non-financial factors into the analysis. Secondly, exact measure of the relative weight that a firm should assign to non-financial factors has not been duly devised. Though firms in developed countries have devised their own methods for handling non-financial risk, yet it India the exact picture is not clear.

Table 6.4: Weights that CFOs Assigned to Financial and Non-Financial Variables

Serial No of Firm	Strategy	Environment	Operating Employee	Profit	Cost of Capital	Liquidity PBP	Technology	Operating Convenience	Product Market	Future Orientation	Competitors Modernization
1	4	3	2	5	5	4	5	3	4	5	5
2	4	1	3	5	4	5	2	2	4	5	3
3	5	3	3	5	5	4	4	3	4	5	5
4	5	5	4	5	5	4	4	4	4	5	5
5	4	5	4	5	3	3	5	4	4	2	2
6	5	4	3	5	4	3	5	4	4	4	5
7	4	5	3	5	5	3	2	2	3	4	2
8	5	4	3	5	4	4	4	4	4	4	4
9	4	5	3	4	4	4	5	5	4	4	5
10	4	5	3	5	4	3	4	4	2	3	1
11	5	5	4	5	5	4	4	4	4	5	4
12	2	3	3	5	5	4	3	3	4	3	2
13	4	5	3	5	5	3	4	5	3	2	3
14	4	5	2	3	3	3	5	5	1	1	3
15	3	4	2	5	5	3	4	3	3	2	3
16	4	4	1	5	5	3	2	2	1	3	2
17	4	4	5	5	4	3	4	4	5	5	5
18	5	4	4	5	5	4	4	4	4	5	5
19	5	4	4	5	5	5	4	4	5	4	5
20	4	3	4	3	1	3	3	4	3	2	2
21	5	3	4	5	5	4	4	4	4	5	4
22	5	4	4	5	5	5	4	4	5	5	4
23	2	2	2	5	5	5	4	3	4	2	3
24	3	4	4	3	1	2	3	4	4	3	2
25	5	4	3	4	4	3	3	3	5	5	2
26	5	3	4	4	3	3	2	1	5	5	2
27	3	5	3	5	4	4	3	4	4	4	5
28	5	5	3	4	3	4	5	5	4	4	5
29	5	4	4	5	5	3	5	4	3	4	3
30	5	5	4	5	5	3	4	4	3	5	3
31	**3**	5	1	5	5	2	2	0	4	4	3
	4.19	**4.03**	**3.19**	**4.67**	**4.22**	**3.55**	**3.74**	**3.51**	**3.71**	**3.83**	**3.45**

Source: Survey responses of the CFOs

This study gives much freedom to the respondents in assigning values to eleven variables. The average score of each variable is shown in bold face at the bottom of the table. The results show that consciously the responding CFOs give more importance on financial factors like profits and costs. Average scores for profits and costs were 4.67 and 4.22 respectively. Immediately after these two, strategic and environmental factors

assume third and fourth positions. Average scores of these two variables are 4.19 and 4.03 respectively. Remaining all variables have scores between 3.45 and 4. It means that the responding CFOs don't treat any of the non-financial variables as less important. This trial offers the second opportunity of comparing so called bias towards financial factors in terms of a set of eleven proxy variables. Results of t-test shows that difference between two averages scored for strategic priority and profit priority is insignificant. The result of t-test for comparing (two means) average scores for strategic priority and profit priority is given below:

Table 6.4A: Independent Samples t-Test

Variables	N	Mean	Std. Deviation	Std. Error Mean	t-test for Equality of Means		
					T	df	Sig. (2-tailed)
Profits	31	4.6774	.65254	.11720	2.406	60	.020
Strategy	31	4.1935	.90992	.16343			

Average scores of two variables are same is taken as the Null Hypothesis for the test. Computed t is 2.40. At 5% level of significance critical value of t is equal to 1.96. Since the computed value is greater than the critical value, the Null Hypothesis is rejected. At this point it is transparent that CFOs have significant inclination towards financial and profitability criterion. Different result at this point is due to use of better methodology.

6.5.Factor Analysis, Factor Extraction and Factor Weights

As noticed in the factor scoring models, there is no objective method for determining the weights to be assigned to individual factors. The objective of following part of this chapter is to apply empirical methodology to find the factors and factor weights. The emphasis is on devising an empirical approach, which can be reliably used for getting the correct value of factor weights so that any firm can evaluate investments objectively depending on the effect of the variables on capital budgeting.

To meet this goal while field survey was executed, responding CFOs were asked to assign value to each of the variables enlisted below on the basis of their relative assessment. The respondents were asked to mark score for each variable depending on

the importance they assign to each of the financial and non-financial measures on a scale of 1 to 5 (1 meaning "unimportant", 5 meaning "very important"). The data so gathered have been shown in Table 6.1. The same was analyzed to explore the important dimensions of capital budgeting decisions. SPSS output of Factor Analysis has been given below:

Table 6.5: Factors and Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.271	29.738	29.738	3.271	29.738	29.738
2	2.470	22.453	52.191	2.470	22.453	52.191
3	1.750	15.913	68.104	1.750	15.913	68.104
4	1.277	11.610	79.714	1.277	11.610	79.714
5	.665	6.049	85.763			
6	.645	5.863	91.626			
7	.361	3.282	94.907			
8	.236	2.145	97.052			
9	.150	1.366	98.418			
10	.104	.944	99.362			
11	.070	.638	100.000			

Extraction Method: Principal Component Analysis.

The output given above indicates presence of the influence of four different factors in the process of capital budgeting. Following component matrix is explaining contribution of variables in the construction of the factors extracted from the data.

Table 6.5A: Component Matrix[a]

	Component			
	1	2	3	4
Strategy	.591	.305	-.169	.467
Environment	-.075	.501	.394	.618
Organization Employee	.490	.424	-.530	.116
Profits	.502	-.538	.491	.154
Cost of capital	.474	-.528	.621	.163
Liquidity	.646	-.199	.092	-.596
Technology	.386	.677	.424	-.212
Work Convenience	.267	.860	.220	-.227
Market Share	.625	-.162	-.528	-.114
Future Orientation	.751	-.294	-.330	.359
Rivals' Modernization	.779	.166	.186	-.144

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Four important variables that constitute first factor are strategy, competitors' modernization, future orientation and market competition. These are different measures of a dimension called strategic perspective. Therefore, the first factor may be called **strategic factor**. Technology and work convenience strongly contribute to second factor; hence, second factor may be called **technological factor**. The third factor is constituted by profits and costs; hence this factor may be termed as **economic factor**. In the fourth factor the major contributing variable is environment; hence, the fourth factor may be termed as **environmental factor**.

The result of the study reflects that consciously the Indian corporate houses assign the highest weights to strategic factors; Weights that they assign to different factors are as follows

Table 6.5B: Factor and Factor Weights

Factors	Eigen Values	Weights
Strategic Factors	3.271	37%
Technological Factors	2.470	28%
Economic Factors	1.750	20%
Environmental Factors	1.277	14%

Therefore, while in industrial practice management is confronting the problem of identifying relevant factors and deciding the importance they should assign to each of the factors, findings of this research study unfolds a way to find solution to this problem. As any model based on measurement of a single criterion has inherent limitation, factor model can be used for comprehensive evaluation of different dimensions of a long-term investment and eliminate biases. Consultancy houses can conduct similar study and explore relevant factors and their corresponding Eigen Values. They can use Eigen values for computing factor weights in the way illustrated in the table above. After all, it is not appropriate to tell that all projects having high NPV should be selected.

Reliability Statistics	
Cronbach's Alpha	N of Items
.728	11

As the value of Cronbach's Alpha is more than 0.70, survey and the result of the study can be accepted as reliable.

6.6: Conclusion

Using DCF methods and choosing projects with attractive indices of value addition is no guarantee that all firms using DCF methods will finally have a track record of successful value addition. A glimpse from corporate world reveals that firms making investments in strategic lines are successful performers. Therefore, instead of relying simply on DCF methods, systematic analysis of fundamental and strategic factors should be made before finalizing a project proposal. Every investment should be fit in terms of parameters like fighting competition, enhancing market share and accelerating growth.

As an appraisal method, based on measures of a single parameter, has inherent limitations and biases, it is recommended that multi-factor model such as Weighted Factor Scoring Model may be used for comprehensive appraisal of project proposals. Consultancy houses can conduct survey, use empirical analysis to extract relevant factors and use Eigen values for computing factor weights.

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