

# Determinants of Investment in Fixed Assets in Electric Power Industry - An Econometric Analysis

S. L. Tulasi Devi and R. N. Rao

**Abstract**—This paper focuses attention on specific aspects of entrepreneurial decisions relating to investment, both in the total fixed investments and plant & machinery (separately). Demand and financial factors, internal and external, are considered in the investment analysis. Finally the influence of determinants of fixed investment and investment plans are examined in Electric Power industry in India.

**Keywords**—Determinants, Electric Power Industry, Fixed Assets, Econometric Analysis.

## I. INTRODUCTION

THE fixed investment decision is an important decision in the valuation of the firm, attempts were made previously to understand the factors that influence the fixed investment decision of the firm. Such studies have identified different factors which play an important role in the determination of the fixed investment of the companies and the studies made by some of the researchers [1]-[8]. Some of the studies have added significant contributions to this important area of Business Finance [9]-[15].

Though some attempts were made earlier to find out the validity of such contributions in the Indian context, there are very few studies, which tested their applicability at the micro level units on a more comprehensive basis. Hence an attempt is made in this study to understand the different economic variables which influenced the fixed investment of some sample companies in Electric Power industry in India.

## II. OBJECTIVES, METHODOLOGY AND LIMITATIONS

Being exploratory in character, the present study aims at understanding the fixed investment behavior of some sample companies in Electric Power Industry. This study is undertaken:

- To analyze the investment pattern in Gross Fixed Assets of some selected companies in the Electric Power Industry in India.

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- To analyze the investment pattern in Plant & Machinery separately in the above companies of Electric Power Industry.
- To analyze the determinants of investment in Gross Fixed assets i.e., Gross Block and Plant & Machinery in Electric Power Industry.
- To analyze the best models, which determine the investment behavior in fixed assets through Stepwise Multiple Regression Analysis and Econometric Analysis.

### A. Source of Data

The data relating to the different economic variables of companies have been collected from various issues of the Bombay Stock Exchange Official Directory.

The source of data for the fixed investment policy of Electric Power Industry is the data relating to the individual sample companies in Electric Power Industry. The industry, for the purpose of the study, means the aggregate of sample units in the industry. Thus the cross section data of micro level economic variables is added to make up the industry data.

### B. Period of Study

The present study covers a period of 10 years from 2000 to 2009. Since the fixed investment policy is a long-term policy, a period of 10 years is considered to be long enough to study the Fixed Investment policy of companies/Industries.

### C. The Sample Selection

The selection criteria of the companies for inclusion in the sample of the study have been that

- a) Companies must have been incorporated on or before 1975, i.e., 25 years before the period for which analysis has been started here so that a minimum period of at least 25 years must have been elapsed for them to establish themselves and invest in fixed assets;
- b) Companies must have had a paid-up capital of more than Rs 10 lakhs in 1975 so that only medium and large companies as per the classification of the Reserve Bank of India are included in the sample; and
- c) Companies must be continuously profit making companies in all 10 years (which is the study period here) so as to ensure that only which made profits on consistent basis are included.

Based upon the above selection criteria a total of the following five firms constitute the size of the sample for the purpose of this study.

1. Andhra Valley Power Supply Co. Ltd.
2. BSES Ltd.
3. Surat Electricity Co. Ltd.
4. Tata Hydro Elec. Power Supply Co. Ltd.
5. Tata Power Co. Ltd.

#### 1. Variables

A list of the variables – both dependent and independent – that are used in this study is presented.

#### 2. Dependent Variables

1.  $GB_{t-(t-1)}$  = Change in Gross Block
2.  $Pm_{t-(t-1)}$  = Change in Plant & Machinery

#### 3. Independent Variables

1.  $S_{t-(t-1)}$  = Change in sales
2.  $GIF_t$  = Gross Internal Funds
3.  $NL_t$  = Stock of Net Liquidity
4.  $D_t$  = Dividends
5.  $EC_{t-(t-1)}$  = Growth of equity capital
6.  $DETOUT_t$  = Debt outstanding
7.  $T_t$  = Provision for taxes
8.  $I_t$  = Interest on borrowed funds

#### D. Stepwise Regression

The present study is mainly based on stepwise multiple regression analysis. This technique begins with the simple correlation matrix and enters into regression of the independent variables most highly correlated with the dependent variable. Using the partial coefficients generated with respect to the other variables, the computer program then selects the next variable to enter the model.

Stepwise regression permits the analyst to start with a large number of variables that might have predictive values and then use the model to select the particular variables that appear to provide the prediction.

#### E. Statistical Analysis

The data used in this study was processed by using computer packages, they are Statistica and Limdep. The multiple linear stepwise regression was run in order of importance in terms of explanatory powers of different variables influencing the dependent variable in the study. In other words, which independent variable has the greatest effect in determination of the dependent variable? How sensitive is dependent variable to fluctuations in independent variables? This technique is adopted in order to obtain a realistic picture of the importance of the various independent variables, which influence financing investment in the Electric Power Industry in India.

#### F. Models Built

This study is conducted on the basis of three models. These three models have been tested in the case of each company. They are;

- A. Adding Model
- B. Constant Model
- C. Elimination Model.

The above three models have been tested in each case with the intercept term. Thus altogether 15+ equations are estimated in each case.

#### A. Adding Model

It may be noted that in this model, an independent variable has been entered into the model at an earlier step, and then another independent variable is added to the first one and then another variable etc. So ultimately all the independent variables are added and tested under this model.

The following are the equations, which are estimated under this model.

1.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)}$
2.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t$
3.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t$
4.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t + b_4D_t$
5.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t + b_4D_t + b_5EC_{t-(t-1)}$
6.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t + b_4D_t + b_5EC_{t-(t-1)} + b_6DBTOUT_t$
7.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t + b_4D_t + b_5EC_{t-(t-1)} + b_6DBTOUT_t + b_7T_t$
8.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t + b_4D_t + b_5EC_{t-(t-1)} + b_6DBTOUT_t + b_7T_t + b_8I_t$

#### B. Constant Model

In this model the first two independent variables (change in sales and gross internal funds) are kept as constant variables because these two are very closely related to the dependent variables, and the third variable is changed in each model.

The following are the equations, which are estimated under this model.

1.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3NL_t$
2.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3D_t$
3.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3EC_{t-(t-1)}$
4.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3DBTOUT_t$
5.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3T_t$
6.  $GB_{t-(t-1)}$  or  $PM_{t-(t-1)} = b_0 + b_1S_{t-(t-1)} + b_2GIF_t + b_3I_t$

#### C. Elimination Model

In elimination model, the estimated equations are not constant but the number of equations depends on the significance of the variables which proved to be significant.

The following procedure is adopted while estimating the equations. Initially, all the independent variables are included in the model. Based upon the significance of 't' values, the variable with the least 't' value is dropped and then again the equation is estimated with the remaining independent variables. Again the variable with the least 't' value is dropped and the equation is again estimated. This process is continued till all the independent variables in the equation have proved to be significant either at 5% or at 10% level.

So the number of equations varies depending upon the significance of variables in each case of companies.

The above 15+ equations are estimated for all the 6 companies and industry aggregate. The total numbers of estimated equations are as follows:

For 5 companies and industry aggregate in two cases (both gross block and plant and machinery):

In Adding Model	.....6×8×2 =	96
In Constant Model	..... 6×6×2 =	72
In Elimination Model	..... =	46
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<b>Total</b>		<b>214</b>
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Thus altogether 214 equations have been estimated with all the necessary tests, using the data for 10 years in each case.

To find out the effect of different independent economic variables on the fixed investment of the companies during the period of this study, the Multiple Linear Regression Analysis is used with all its limitations.

#### 1. Selection of the Best Model

The following procedure is adopted to select the best model in each case from out of the 15+ estimated equations.

#### Step - I

Out of the 15+ estimated equations in each case, all those equations, whose Multiple Correlation Coefficients are found to be significant at 5% level based on their calculated 'F' values are picked up for further analysis.

#### Step – II

The equations thus picked up according to step-I above are further screened in the following way:

- The values of intercept term ( $b_0$ ) and other regression coefficients ( $b_1, b_2, b_3$ ) are tested at 5% level of significance based on their calculated 't' values. If only one equation is found in which all the explanatory variables are significant at 5% level, then that equation is taken as the best model to explain the fixed investment behavior of the company. If, on the other hand, there are two or more equations in which all the explanatory variables are found significant at 5% level, the procedure explained in step III is followed.
- But if, in a company, there is not even a single equation in which all the independent variables show significant effect at 5% level, the significance level is relaxed and the impact of the variable is tested at 10% level wherever necessary. That is, the variables, which are not significant at 5% level, are tested at 10% level of significance. However, this has happened in a very few cases in this study. If only one equation is found in which the explanatory variables are significant at 5% level or 10% level, then that model is selected as the best model to describe the fixed investment behavior of the company. On the other hand, if there are two or more than two equations in which the independent variables are significant at 5% or 10% level, the procedure explained that in step III is followed to decide the best model.

#### Step – III

As stated in step II, if there are two or more equations in which all the explanatory variables are significant that particular equation whose  $R^2$  is the highest is chosen as the best equation to explain the fixed investment behavior of the company.

#### 2. Limitations of the Study

This study has the following limitations.

- The accounting years of the sample companies are not common and the closing of the accounting years is spread over all the 12 months of the year. So for the industry aggregate data the accounting year is not uniform.
- The Industry data, for the purpose of the study, comprise the aggregate of the data of the micro level sample units that are selected for this study. As there is difference in the classification of industries between Reserve Bank of India and the Bombay Stock Exchange, the RBI data could not be relied upon for the industry aggregate data and the Bombay Stock Exchange Directory does not provide the Industry aggregate data. Since it is highly difficult to collect the data of all the firms which appear on the Bombay Stock Exchange Directory the aggregate data of the sample micro level units is taken to represent the industry data for this study.
- The data for the study are taken in absolute values as given in the Bombay Stock Exchange Directory and no price deflator is used to adjust for the inflationary trends.
- This study is only exploratory in its objectives and does not aim at recommending any policy measures either for the companies or for the government.

#### III. ANALYSIS OF THE REGRESSION RESULTS OF FIRMS IN ELECTRIC POWER INDUSTRY

This section deals with the study of investment behavior of sample firms taking into consideration two dependent variables namely Gross Block ( $Y_1$ ) and Plant and Machinery ( $Y_2$ ) in Electric Power Industry of India.

This study deals with eight explanatory variables, which influence the investment behavior in fixed assets ( $Y_1$  and  $Y_2$ ). This study is conducted on the basis of three models. They are Adding model, Constant model and Elimination model. In Adding model there are eight estimated equations. In Constant model there are six estimated equations and in Elimination model the estimated equations are not Constant but the number of equations depend on the significance of independent variables.

The following abbreviations are used in the tables:

NF -The number of firms, where the explanatory variable has shown an impact.

5% -The number of equations in which the explanatory variable is significant at 5% level.

10% - The number of equations in which the explanatory variable is significant at 10% level.

EPI - Electric Power Industry (The numbers indicate the number of equations that are estimated)

AM - Adding model

CM - Constant model  
EM - Elimination model

TABLE I

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable : <i>CHANGE IN SALES (b<sub>1</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	3	2	4	NF	1	1	1
5%	6	1	7	5%	2	1	--
10%	2	1	3	10%	1	1	1
EPI	8	6	1	EPI	8	6	4
5%	8	6	1	5%	6	6	--
10%	--	--	--	10%	--	--	--

TABLE II

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable : <i>GROSS INTERNAL FUNDS (b<sub>2</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	3	2	2	NF	1	4	--
5%	10	6	4	5%	4	4	--
10%	1	1	--	10%	--	5	--
EPI	8	6	1	EPI	8	6	4
5%	6	1	1	5%	1	--	2
10%	--	--	--	10%	--	--	2

TABLE III

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable : <i>STOCK OF NET LIQUIDITY (b<sub>3</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	2	1	5	NF	1	1	--
5%	7	1	7	5%	4	1	--
10%	1	--	6	10%	--	--	--
EPI	8	6	1	EPI	8	6	4
5%	6	1	1	5%	--	--	--
10%	--	--	--	10%	--	--	--

TABLE IV

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable <i>DIVIDENDS (b<sub>4</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	3	--	2	NF	--	--	4
5%	6	--	4	5%	--	--	11
10%	1	--	--	10%	--	--	3
EPI	8	6	1	EPI	8	6	4
5%	5	--	1	5%	2	--	4
10%	--	--	--	10%	1	--	--

TABLE V

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 6)							
Explanatory variable <i>GROWTH OF EQUITY CAPITAL (b<sub>5</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	1	--	3	NF	--	3	--
5%	2	--	4	5%	--	1	--
10%	--	--	1	10%	--	2	--
EPI	8	6	1	EPI	8	6	4
5%	2	1	1	5%	4	1	4
10%	1	--	--	10%	--	--	--

TABLE VI

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable <i>GROWTH OF EQUITY CAPITAL (b<sub>5</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	2	2	3	NF	--	1	1
5%	6	1	9	5%	--	--	2
10%	--	1	--	10%	--	1	--
EPI	8	6	1	EPI	8	6	4
5%	3	1	1	5%	--	--	--
10%	--	--	--	10%	--	--	--

TABLE VII

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable <i>PROVISION FOR TAXES (b<sub>6</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	1	--	2	NF	--	5	5
5%	--	--	4	5%	--	1	18
10%	1	--	--	10%	--	4	8
EPI	8	6	1	EPI	8	6	4
5%	2	--	1	5%	2	1	4
10%	--	--	--	10%	1	--	--

TABLE VIII

ELECTRIC POWER INDUSTRY (TOTAL NO. OF FIRMS: 5)							
Explanatory variable <i>INTEREST ON BORROWED FUNDS (b<sub>8</sub>)</i>							
Gross Block (Y <sub>1</sub> )			Plant & Machinery (Y <sub>2</sub> )				
AM	CM	EM	AM	CM	EM	EM	
NF	2	--	4	NF	--	4	1
5%	1	--	9	5%	--	1	3
10%	1	--	1	10%	--	3	1
EPI	8	6	1	EPI	8	6	4
5%	--	--	--	5%	1	--	4
10%	1	--	1	10%	--	--	--

#### IV. ECONOMETRIC MODELS IN PRESENT STUDY

The regression coefficients of the explanatory variables are estimated using the technique of the Multiple Linear Regression. This Multiple Linear Regression method has some basic assumptions, which when violated, may result in some econometric problems. This part aims at understanding (i) the meaning of some important problems that would arise when the assumptions are violated; (ii) the reasons for the violation of these assumptions; (iii) the methods to detect the presence of these problems and (iv) the extent of the presence of the problems in the present study.

Three econometric problems were studied.

- Multicollinearity;
- Autocorrelation and
- Heteroscedasticity.

##### A. Multicollinearity

One of the conditions for the application of least squares is that the explanatory variables are not perfectly linearly correlated. The term 'multicollinearity' is used to denote the presence of linear relationships (or near linear relationships) among explanatory variables. If the correlation coefficient for the explanatory variables is equal to unity, that is, if the explanatory variables are perfectly linearly correlated, the parameters become indeterminate. It is impossible to obtain numerical values for each parameter separately and the method of least squares breaks down.

### Multicollinearity Problem in the Present Study

An attempt is made here to find out the presence of the multicollinearity problem in the present study. Though computations have been made and presented here to find its presence in all the 214 (relating to both dependent variables,  $Y_1$  &  $Y_2$ ) regression equations that are estimated, the analysis here confines only to the best models that are selected to explain the investment in fixed assets behavior of individual companies and industries. The objective in so doing is to know how far the best models are beset with the presence of the problem.

For finding out the multicollinearity problem in this study, Klein's test is followed. That is, the simple correlation coefficients of independent variables have been computed and also the multiple correlation coefficient is computed. If the set of simple correlation coefficients is less than the multiple correlation coefficient, it is considered that the multicollinearity is not harmful and is within tolerable limits. Even if a simple correlation coefficient is more than the multiple correlation coefficient, the problem is considered to be severe. The simple and multiple correlation coefficients are presented and analyzed here in all the cases.

Out of the six cases that are studied, i.e., industry aggregate and five individual companies, both in the case of Gross Block ( $Y_1$ ) and Plant & Machinery ( $Y_2$ ), in NONE of the equations, which are, selected as best models, the multicollinearity problem is present.

### B. Autocorrelation

One of the assumptions of ordinary least squares is that the successive values of the random variable 'u' are temporally independent, that is, that the value, which 'u' assumes in any one period is independent from the value which is assumed in any previous period. This assumption implies that the covariance of  $u_i$  and  $u_j$  is equal to zero.

$$\begin{aligned} \text{Cov}(u_i, u_j) &= E\{[u_i - E(u_i)][u_j - E(u_j)]\} \\ &= E(u_i, u_j) = 0 \text{ (for } i \neq j \text{)} \end{aligned}$$

Given that by assumption  $E(u_i) = E(u_j) = 0$

If this assumption is not satisfied, that is, if the value of 'u' in any particular period is correlated with its own preceding value (or values) it can be said there is autocorrelation or serial correlation of the random variable.

### Autocorrelation Problem in the Present Study

An attempt is made here to find out the presence of autocorrelation in the models that are selected as the best to explain the investment behavior in fixed assets of the companies/industries. As has been done earlier in the case of multicollinearity, here also, though Durbin-Watson statistic is computed for all the estimated equations, the analysis is done only in the case of best equations to know how many of the best equations are affected by the problem of autocorrelation.

The D. W. statistic was computed on the computer and it is compared with the corresponding  $d_U$  and  $(4 - d_U)$  at 5% level. If the computed statistic lies between these two values, it was

understood that there is no autocorrelation in the model. If the computed value is either less than  $d_U$  or more than  $(4 - d_U)$  it was understood that the problem of autocorrelation was present.

The major reason for not attempting to correct the problem is that the problem was found present only in 1 case ( $Y_1-4, Y_2-1$ ) i.e., one individual company in Electric Power Industry.

### C. Heteroscedasticity

One of the assumptions about the random variable 'u' is that its probability distribution remains the same overall observations of X, and in particular that the variance of each  $u_i$  is the same for all values of the explanatory variable.

Symbolically,

$$\text{Var}(u) = E[(u_i - E(u))^2] = E(u_i)^2 = \sigma^2 u \text{ constant.}$$

This assumption is known as the assumption of homoscedasticity or the assumption of constant variance of the u's. If it is not satisfied in any particular case it can be said that u's are heteroscedastic.

$$\text{Var}(u_i) = \sigma^2 u_i \text{ not constant.}$$

Where the subscript 'i' signifies the fact that the individual variances may all be different.

### Heteroscedasticity Problem in the Present Study

The assumption of homoscedasticity is found violated in one case only i.e. an individual company namely Surat Electricity Co. Ltd. (in case of both the dependent variables  $Y_1$  &  $Y_2$ ) in Electric Power Industry. To find out this problem of heteroscedasticity the following procedure is adopted.

The Spearman Rank Correlation Coefficient is constructed for each variable and its 't' value is also computed. For the given degrees of freedom the 't' value of the corresponding table value at 5% level of significance. In any equation if the 't' value of even one coefficient is more than the table value, the problem of heteroscedasticity is constructed to be present in the equation. The problem is also analyzed in the above cases.

## V. FINDINGS AND CONCLUSIONS

The Summary of the analysis is presented in the tables the following conclusions are drawn.

1. The major finding of the study is that, the elimination model is the most appropriate model in determining the behavior of investment in total fixed assets & plant and machinery separately.
2. The results of this analysis suggest that gross internal funds (retained earnings + depreciation) are more important for the fixed investment in almost all the companies in the present study.
3. Change in sales (growth rate in sales), stock of net liquidity, debt outstanding dividends are also significant determinants of fixed investment.

4. The study reveals that demand considerations in the long-run are of some importance in the entrepreneurial fixed investment decisions. Financial considerations seem to dominate over demand factors in fixed investment decisions
5. The implication of the results of the present study is that profitability is an important consideration in entrepreneurial investment decisions. Profits influence dividend policies and hence retained earnings. Retained earnings in turn influence investment. Profits influence dividends and dividends influence the flow of external finance. External finance in turn exerts its influence on investment. Thus profits both directly and indirectly influence investment, directly through retained earnings and indirectly through external finance.
6. As retained earnings is an important factor in the determination of investment, it is important to see that higher profitability is not dissipated through dividend disbursements. As self financing is non-inflationary, it may be desirable to encourage asset expansion through internal savings rather than through borrowings.

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