Financial Performance Evaluation of IT Companies through Two Stage- DEA

Sunil Kumar Parupati (Corresponding author)

Senior Academic Associate, Indian School of Business

Hyderabad, Telangana 500 111, India

Sudershan Kuntluru

Associate Professor, Finance, Accounting and Control Area, IIM Kozhikode

Kozhikode, Kerala 673570, India

T. Satyanaryana Chary

Professor, Department of Business Management, Telangana University

Nizamabad, Telangana, India

Abstract

Data Envelopment Analysis (DEA) is a nonparametric technique for evaluating the relative efficiency of a set of homogenous decision making units (DMU) by using a ratio of weighted sum of outputs to the weighted sum of inputs. There are numerous advances emerged in DEA in recent past based on the ever-changing needs of the business organizations. This study applies a novel two-stage DEA framework where projected or best-practice revenues are calculated in the first stage and are fed as inputs into the second stage. We use this method to examine the operational and stock market efficiency of select IT companies listed on National Stock Exchange in India for period of Ten years from 2007 to 2016. Results indicate that only two companies are on efficient frontier in the both stage I and II. Most companies are neither efficient in stage-I nor in stage-II. We discuss the intuition of the results as well as the implications for practice.

Keywords: DEA, operational efficiency, market efficiency, information technology

1. Introduction

Accounting research has long been interested in examining the relationship between accounting numbers and market performance. Research has examined the impact of accounting announcement on market performance based on traditional Data Envelopment Analysis (DEA) models (Ball, 1992; Abarbanell and Bushee, 1997; Kothari, 2001; Kim and Kross, 2005; Mian and Sankaraguruswamy, 2012). It is a nonparametric technique for evaluating the relative efficiency of a set of homogenous decision making units (DMU) by using a ratio of weighted sum of outputs to the weighted sum of inputs. Particularly, it determines a set of weights such that the efficiency of a target DMU relative to other DMUs is maximized. There are lot of developments and applications of DEA covering various diverse fields like finance, accounting, insurance, banking, health care, education, services, manufacturing, transportation and etc.

The basic limitations of data envelopment analysis a model is that they do not recognize important differences across activities and functional areas and therefore cannot identify which function are be the main source of inefficiencies. We propose that DMUs can have a two-stage structure where the first stage uses inputs to produce outputs. These outputs become inputs to the second stage. The second stage uses the first stage outputs to produce its outputs. The novel two-stage DEA model decomposes the overall efficiency of a decision-making unit into two components that is operational management efficiency (internal to the organization) and market performance efficiency (external to the organizations (Premchandra, et. al. 2012).

In finance and accounting domain, fundamental analysis can be understood in different ways. One interpretation is that fundamental analysis is predictive, examining information from financial statements and generating a forecast of its market value. This essentially means that financial statement information influences market value. Alternatively, we examine whether two-stage DEA model (Cristina, et. al. 2004; Kao and Hwang, 2008; Chen, et. al. 2009; Cook, et. al. 2010; Cao and Yang, 2011; Liu and Lu, 2012; Wang, et. al. 2014;) can be applied to link between operational efficiency and market efficiency by taking into account the connecting or linking variable, which is expected earnings that is an output from Stage I DEA procedure. Using this procedure, market efficiency can be computed based on expected or projected earnings along with other input variables and market capital as an output variable in Stage II. However, the market performance cannot be explained solely based on only operational efficiency but also how well these projected earnings is factored along with noise.

Thus, the present study proposes an application of novel two-stage multi-criteria procedure of DEA on Information Technology (IT) companies in an Indian context to evaluate fundamental value of stocks by linking financial data to firm value in two consecutive steps, firstly, prediction of future earnings link (predictive information link) connecting current financial data to future earnings, and secondly, a market evaluation link (valuation link) by connecting the future earnings to firm value. The empirical results indicate that there is a scope for efficiency improvement in both profitability and stock market performance. The remainder of

the paper proceeds as follows. Section 2 discusses the related literature. We discuss the sample selection and methodology in Section 3. Our findings are discussed in Section 4. It is concluded in Section 5.

2. Review of Literature

The existing literature on application of DEA models to finance and accounting decisions is limited. Christina, et. al. (2004) employs a novel twist to mathematical frontier analysis to show how a two-stage DEA model can be used for the purpose of fundamental analysis. The procedure is illustrated by a numerical example, analyzing select 30 stocks in the Spanish manufacturing industry in the years 1991-1996. Cook, et. al. (2010) explores literature related to the evaluation of two-stage processes of DEA. They show all the existing approaches categorized as using either leader-follower or cooperative game concept. Kao and Hwang (2008) and Chen, et. al. (2009) develop an additive efficiency decomposition approach where in the overall efficiency is express as sum of the efficiencies of the individual stages and applied the same in case of Taiwanese non-life insurance companies. Lin, et. al. (2009) applies a two-stage DEA analysis approach to investigate whether distinct corporate governance practices affect productive efficiency among listed manufacturing firms in China. They found that firm efficiency is negatively related to state ownership while positively related to public and employee ownership.

Further, Cook, et. al. (2010) examines the more general problem of an open multistage process and finds that it allows one to evaluate not only the overall performance of the network but as well represent how that performance decomposes into the measures for the individual components of the network. In case of internet companies, there is a two stage production process i.e. marketability and profitability, hence, Cao and Yang (2011) employ two-stage DEA model to assess the efficiency of 40 dot com firms and found that model performs better in measuring efficiency, is able to discriminate the causes of inefficiency. Liu and Lu (2012) laid out the mathematical formulation for the method to work under two-stage DEA context and then applied to banking industry. They propose that the methodology greatly increases the value of DEA, especially for practitioners who are seeking unambiguous DEA results.

Premchandra, et. al. (2012) applies a novel two-stage DEA model for assessing the relative performance of 66 large mutual fund families in the US over the period 1993-2008 and found the best performers, the families that deteriorated in performance, and those that improved in their performance over the sample period. Wang, et. al. (2014) have adopted two-stage DEA to explore measuring the improving the efficiency of the Chinese commercial banking system. They find that the two-stage DEA model is more effective than the conventional black box DEA model in identifying the inefficiencies in banking system. Wanke and Barros (2014) adopted network-DEA centralized efficiency model to optimize both the stages simultaneously and showed that Brazilian banks are heterogeneous with some focusing on cost efficiency and others on productive efficiency.

Much of the extant research on application of two-stage DEA model is focused on service sector particularly banking and insurance firms. Few of the studies focus on IT sectors and

context of linking the operational and market performance. Cristina, et. al. (2004) proposes the new two-stage multi-criteria procedure, drawing on the techniques of data envelopment analysis. At each stage, a piecewise linear efficiency frontier is fitted to the observed data to numerical example based on Spanish manufacturing industry.

3. Research Methodology

As per the two-stage DEA model, at each stage, a piecewise linear efficiency frontier is fitted to the observed data of IT firms in India for a period of 10 years i.e. from 2007 to 2016. In the first stage, operational efficiency is analyzed to find the efficient and inefficient companies in the group. For the inefficient firms by using slacks, the future revenues (future revenues for efficient firms are equal to the actual revenues) are projected. In the second stage, the market efficiency by linking with the first stage outputs i.e. the predicted revenues as inputs along with other variables is analyzed. The results are presented in terms of leaders, followers and laagers, through the analysis.

3.1 Two-stage DEA Model

DEA is known as an approach for measuring the relative efficiency of peer decision making units that have multiple inputs and outputs. The results of DEA indicate that how efficient each DMU in performance when compared to other DMUs in converting inputs to outputs. The issue with regard to inefficient DMUs is finding factors that cause the inefficiency. Alternatively overall efficiency when divided into components so that the sources of inefficiency can be identified easily. One type of decomposition that focuses on the structure of the DEA model as put further by Banker et al. (1984) divides the overall efficiency of a DMU into the product of scale efficiency and technical efficiency. Byrnes et al. (1984) further separated the congestion effect from the technical efficiency, also Kao (2008) decomposes the overall efficiency into a weighted arithmetic mean of the efficiencies of individual outputs. A similar decomposition from the input side is also derived. Another type of decomposition emphasizes the stages of the production process. The overall complicated process is divided into sub-processes, in that some intermediate products are the outputs of sub-processes on the one hand and the inputs of another sub-process on the other hand.

In this paper, we made an attempt to investigate that how operational efficiency of a firm can be linked with its market efficiency based on financial statement data of IT companies which is used for fundamental analysis, where, operational efficiency is measured based on firm's specific controlled variables. We argue that market efficiency can be linked based on causal process as described below.

Financial Accounting data --- » » »- Projected earnings --- » » »-Market Value

Based on the above discussion, the proposed two-stage DEA model framework is presented as below.
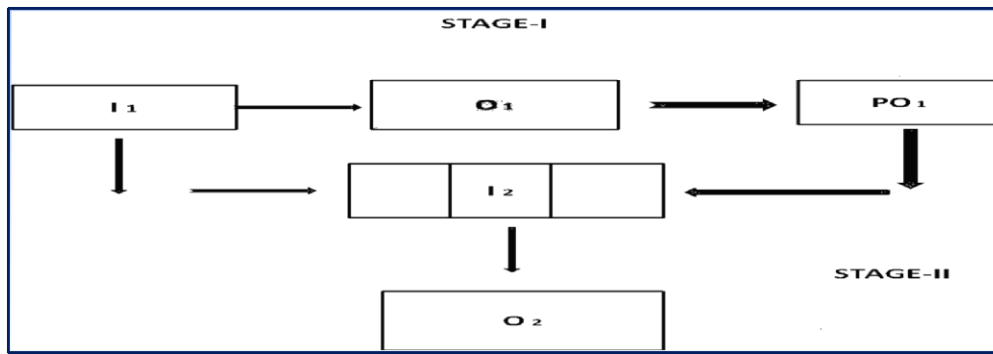
Figure 1. Framework of Two Stage DEA evaluation process

Source: Composed by the authors.

Mathematical notation: There are $j = 1…., n$ stocks. For each stock j, the inputs into the first stage $I_{1\,(Xij)}$, $i=1,...,m$ and the outputs from the first stage $O_{1(Ykj)}$, $k \in K1 \supset K$ are recorded. (The index k runs over all elements in the set $K1$, which is the set of all outputs from the first stage.)

The inputs into the second stage are written $I_{2\,(Ykj)}$, $k \in K2 \supset K$. (This time, the index k runs over the elements of the set I_2, which is the set of all inputs into the second stage. The sets I_1 and I_2 are not necessarily identical: the set I_1 may contain elements that are not fed into the second stage; similarly, the set I_2 may contain elements that were not brought from the first stage. The set of all outputs from the first stage and all inputs into the second stage is the set I_2. The outputs from the second stage are written as O_2.

For the first stage, consider the output-oriented BCC model (1)

$$\text{Maximize } \psi$$
$$\text{Subject to } \psi Y_{k0} - \sum_j \lambda_j Y_{kj} \leq 0, \quad k \in K1,$$
$$\sum_j \lambda_j \leq X_{i0}, \quad i = I,2,3…..m,$$
$$\sum_j \lambda_j = 1,$$
$$\lambda_j \geq 0, \quad j = 1,2,3……n,$$

Turning to the general case and the mathematical treatment, note that the projected outputs of the first-stage program (1) are

$$Y^*_{k0} = \sum_j \lambda_j{}^* Y_{kj}, \quad k \in K1,$$

Where, the asterisk denotes the optimal solution to program (1). In the next step, the projected outputs are considered as inputs into the second-stage program (2)

$$\text{Maximize } \psi$$
$$\text{Subject to } \psi Z_{r0} - \sum_j \lambda_j Z_{rj} \leq 0, \quad r = 1,2,3…..s$$
$$\sum_j \lambda_j Y^*_{kj} \leq Y^*_{k0}, \quad k \in K1 \cap k2$$
$$\sum_j \lambda_j Y_{kj} \leq Y_{k0}, \quad k \in K2 - (K1 \cap k2),$$
$$\sum_j \lambda_j = 1,$$
$$\lambda_j \geq 0, \quad j = 1,…..n$$

The novel feature in program (2) is the set of constraints

$$\sum_j \lambda_j \, Y^*_{kj} + S^-_k = Y^*_{k0}, \, k \, \epsilon \, K1 \cap K2$$

These constraints feed the projected outputs Y^*_{kj} from stage 1 as inputs into stage 2, rather than the observed inputs Y_{kj}, $k \, \epsilon \, K1$.

3.2 Variables Selection

The study considered five variables for Stage –I and five variables for stage-II (see **Table-1**). As described above and in the model framework, stage-1 output variables are modified and used as inputs in the stage-II. These variables are identified from the extant literature based on application of traditional and two-stage DEA.

Table 1. Inputs and outputs for the stage-I and stage–II

Inputs and Outputs for Stage – I	
Inputs	**Outputs**
Shareholder funds (I1)	Net Sales (O1)
Debt (I1)	Net Operating Cash flows (O1)
Operating Expenses (I1)	
Inputs and Outputs for Stage -II	
Inputs	**Outputs**
Projected Net Sales (I2)	Market Capitalization (O2)
Projected Net Operating Cash flows (I2)	
Operating Expenses (I2)	
Book Value (I2)	

Source: Based on the literature review

4. Results and Analysis

The two-Stage DEA is applied to analyze the operational efficiency as well as market efficiency of each select company. In stage-I, analysis made over the operational or managerial relative efficiency of the company at given level of inputs to produce the maximum outputs. The company tangible to efficient frontier connotes that the company has utilized the resources effectively comparatively with the other stocks in the data set.

The results show that for the first stage efficient firm's actual net sales and cash flows from the operations are the same as projected. It means that the companies efficiently used the given inputs to achieve maximum output among all the industry peers. In other words, the inefficient companies projected net sales and cash flows are greater than the actual values. Further, the results also show that the possible ways through which the inputs can be altered to be efficient or be on the efficient frontier.

4.1 Operational Efficiency

As demonstrated in Table 2, it is observed that the companies Infosys, RS software, Rolata and TVS reported a consistent stay on the efficient frontier over the study period. These companies' actual revenues and the projected revenues are almost same that implies the companies' managing their recourses efficiently. Some companies namely Aurionpro, Axicades, Cyient, Datamatics, FirstSource, Hexware, Mindtree, NIIT Ltd, Nucleus, Polaris, Ramco, Wipro and Zensar are inefficient for all the years. These companies' projected revenues are obtained by (reducing/ increasing adjusting) the inputs to become the efficient one when compared with best managed companies in the industry. The other companies namely, HCL Info and Tanla solutions companies are initially are on efficient frontier and later moved out of it. In the year 2007 there were 10 companies found efficient and in 2016 the number of efficient companies is reduced to 7 companies.

Tables 3 and 4 present the actual revenues, actual cash flow from operations and the projected revenues side by side. The revenues and cash flows of the efficient companies remain same at par with the actual revenues and cash flows, whereas the inefficient companies' revenues and cash flows are different from the projected revenues and cash flows. So it is assumed that in the stage 1 these are the companies found inefficient when compared with the other peer group of companies, by adjusting the inefficiency it is expected that expecting the future revenues will increase and in turn the companies made as efficient. For example in Table 3, the actual revenues and projected revenues are the same for the Infosys Company over the study period except in the year 2015 and 2016. As shown in the table the company is efficient in 2006 to 2014, but in the years 2015 and 2016 the company was found inefficient with 0.19 and 0.11 scores when compared to the peer group, Thus the revenues are projected and they are used in second stage as input to check whether the projected revenues are already reflected in the market efficiency or value of the company. Similarly the other output i.e. cash flow from operations was projected the future cash flows and used as an input in the second stage.

4.2 Market Efficiency

This efficiency measures the information regarding how the future/projected revenues are reflected on the stock prices. Table 5 presents that the DEA scores for stage- II of the select IT companies. The results state that the companies, 63 moons, Nelco and TCS have consistently efficient in the given period. But if we observe that these companies are inefficient in the stage I and now moved to the efficient frontier, it means that their revenues are already reflected in the market price or the company's performance gave the expected by the investors.

The results also show that the companies 63 moons and Infosys are consistently moved on efficient frontier in both stages during the study period except in 2 years. It means that the company 63 moons and Infosys are operationally efficient and also able to reflect positive impact on the projected revenues and market prices. Whereas, Axicades is found inefficient in stage–I and efficient in stage –II for most of the years over the study period, which states that the company is operationally inefficient but able to do best in the market due to the top management, which is able to communicate to shareholders and prospective investors

effectively. Table 6 presents that, few companies namely Zensar, Aurionopro, Cyient, Mindtree, NIIT, Nucleus and Polaris are never on efficient frontier in both the stages and their performance is also very poor compared to industry competitors.

Table 2. Efficiency Scores and Ranks of IT companies under Stage-I model

Company	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
3I Infotech Ltd.	0.89	15	0.77	27	1.00	1	0.97	15	0.72	28	0.45	38	0.58	37	0.60	37	1.00	1	1.00	1
63 Moons Technologies Ltd.	0.96	14	1.00	1	1.00	1	1.00	1	0.70	30	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Accelya Kale Solutions Ltd.	0.76	28	0.84	22	0.81	33	0.91	22	0.78	20	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Aurionpro Solutions Ltd.	0.47	38	0.51	37	0.75	37	0.78	38	0.39	39	0.43	39	0.59	35	0.58	39	0.52	35	0.57	38
Axiscades Engineering Technologies Ltd.	0.37	39	0.42	38	0.71	38	0.76	39	0.74	25	0.81	17	0.72	18	0.62	35	0.67	26	0.69	25
Cyient Ltd.	0.85	19	0.57	36	0.82	32	0.88	29	0.74	23	0.66	26	0.77	16	0.80	18	0.73	21	0.76	15
Datamatics Global Services Ltd.	0.67	32	0.70	30	0.70	39	0.80	37	0.60	35	0.63	32	0.68	25	0.66	30	0.43	40	0.65	29
Firstsource Solutions Ltd.	0.51	36	0.65	33	0.91	19	0.84	34	0.54	37	0.64	28	0.69	24	0.64	31	0.48	38	0.64	32
H C L Infosystems Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.94	9	0.83	16	0.71	24	0.58	37
H C L Technologies Ltd.	0.81	22	0.88	18	0.93	17	0.88	27	0.83	16	0.87	13	0.85	11	1.00	1	0.77	17	0.87	10
Hexaware Technologies Ltd.	0.61	33	0.60	35	0.75	36	0.93	20	0.50	38	0.64	29	0.86	10	0.92	12	0.75	20	0.82	12
Infosys Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.97	7	1.00	1	0.81	13	0.89	9
K P I T Technologies Ltd.	0.81	23	0.84	20	1.00	1	0.93	19	0.56	36	0.65	27	0.70	22	0.69	27	0.63	29	0.70	23
Lycos Internet Ltd.	0.73	30	0.87	19	0.87	25	1.00	1	0.89	14	0.45	37	0.57	38	0.56	40	0.49	37	0.51	40
Mastek Ltd.	0.99	12	1.00	1	1.00	1	0.82	36	0.69	31	0.61	33	0.63	32	0.68	29	0.76	18	0.64	31
Mindtree Ltd.	0.79	25	0.78	25	0.94	16	0.98	13	0.79	18	0.82	16	0.70	23	0.78	20	0.71	23	0.70	24
Moser Baer India Ltd.	0.70	31	0.64	34	0.87	26	0.89	26	0.69	32	0.90	12	0.82	12	1.00	1	1.00	1	1.00	1
Mphasis Ltd.	0.76	27	0.84	23	0.85	28	1.00	1	0.90	13	0.69	24	0.72	19	0.71	23	0.58	31	0.67	28
N I I T Ltd.	0.74	29	0.77	28	0.84	29	0.86	30	0.78	21	0.84	14	0.61	34	0.61	36	0.45	39	0.54	39
N I I T Technologies Ltd.	0.86	18	0.94	14	0.95	14	0.90	24	0.74	22	0.78	20	0.71	20	0.69	28	0.66	28	0.71	22
Nelco Ltd.	0.99	11	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.91	10	0.73	18
Nucleus Software Exports Ltd.	0.79	24	0.89	17	0.85	27	0.85	32	0.60	33	0.46	36	0.70	21	0.75	21	0.58	30	0.65	30
Oracle Financial Services Software Ltd.	0.58	34	0.65	32	0.82	31	0.93	18	1.00	1	0.76	21	0.97	8	0.94	10	0.84	12	0.92	8
Polaris Consulting & Services Ltd.	0.89	16	0.90	16	0.90	21	0.86	31	0.73	27	0.69	23	0.62	33	0.63	34	0.86	11	0.71	20
R S Software (India) Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.62	35
Ramco Systems Ltd.	0.48	37	0.70	31	0.89	23	0.61	40	0.60	34	0.56	34	0.56	39	0.63	33	0.52	36	0.67	27
Rolta India Ltd.	0.58	35	0.77	26	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Sasken Technologies Ltd.	0.76	26	0.79	24	0.88	24	0.88	28	0.80	17	0.63	30	0.67	26	0.82	17	1.00	1	1.00	1
Smartlink Network Systems Ltd.	0.88	17	0.84	21	0.80	34	0.83	35	1.00	1	1.00	1	0.58	36	0.63	32	0.73	22	0.63	34
Sonata Software Ltd.	1.00	1	1.00	1	0.91	20	0.89	25	1.00	1	0.50	35	0.66	28	0.70	25	0.78	16	0.74	16
Subex Ltd.	0.34	40	0.26	40	0.63	40	1.00	1	0.72	29	0.79	19	0.51	40	0.59	38	0.55	33	0.64	33
T V S Electronics Ltd.	0.98	13	1.00	1	0.83	30	0.93	17	0.98	12	0.99	10	1.00	1	1.00	1	1.00	1	1.00	1
Tanla Solutions Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.63	31	0.64	29	0.80	19	0.52	34	0.60	36
Tata Consultancy Services Ltd.	1.00	1	1.00	1	0.95	15	1.00	1	1.00	1	0.83	15	0.81	13	0.89	14	0.79	15	0.84	11
Tata Elxsi Ltd.	1.00	1	0.99	13	1.00	1	0.95	16	1.00	1	0.91	11	0.77	15	0.90	13	0.92	9	0.78	14
Tech Mahindra Ltd.	1.00	1	1.00	1	1.00	1	0.99	12	0.74	24	0.74	22	0.64	30	0.70	24	0.67	25	0.71	21
Trigyn Technologies Ltd.	1.00	1	0.35	39	0.79	35	0.91	21	0.32	40	0.27	40	0.63	31	0.86	15	0.57	32	0.72	19
Vakrangee Ltd.	1.00	1	1.00	1	0.98	13	0.85	33	0.85	15	1.00	1	0.79	14	0.74	22	0.76	19	0.74	17
Wipro Ltd.	0.82	21	0.77	29	0.89	22	0.90	23	0.73	26	0.69	25	0.67	27	0.69	26	0.66	27	0.68	26
Zensar Technologies Ltd.	0.85	20	0.93	15	0.93	18	0.97	14	0.79	19	0.81	18	0.74	17	0.93	11	0.81	14	0.78	13

Source: Calculated and compiled by the authors

Table 3. Actual revenues vs projected revenues of IT companies (2007-2016) under stage-I model

Company Name (BCC)	2007 Rev	2007 Pro Rev	2008 Rev	2008 Pro Rev	2009 Rev	2009 Pro Rev	2010 Rev	2010 Pro Rev	2011 Rev	2011 Pro Rev	2012 Rev	2012 Pro Rev	2013 Rev	2013 Pro Rev	2014 Rev	2014 Pro Rev	2015 Rev	2015 Pro Rev	2016 Rev	2016 Pro Rev
3I Infotech Ltd.	523.05	584.46	570.84	741.90	890.44	890.44	950.88	979.22	917.78	1269.87	811.59	1820.14	711.44	1231.85	564.99	941.36	517.58	517.58	867.34	867.34
63 Moons Technologies Ltd.	183.88	183.88	1355.07	1355.07	718.30	718.30	654.37	654.37	574.64	574.64	870.57	870.57	660.37	660.37	618.76	618.76	1926.35	1926.35	820.07	820.07
Accelya Kale Solutions Ltd.	80.83	106.93	98.44	117.54	103.66	127.40	127.72	141.07	178.51	227.51	187.28	187.28	267.11	267.11	304.82	304.82	297.94	297.94	320.59	320.59
Aurionpro Solutions Ltd.	31.25	66.36	61.45	120.49	77.64	103.92	54.40	71.87	117.65	304.07	160.11	374.61	206.21	351.34	256.12	438.10	276.05	535.29	176.33	309.87
Axiscades Engineering Technolog	5.77	15.46	7.51	17.99	12.24	17.17	20.34	26.77	37.62	51.12	48.23	59.21	54.78	76.36	185.18	300.00	189.58	281.26	238.00	345.18
Cyient Ltd.	355.00	416.57	455.07	799.22	600.73	735.35	607.94	694.39	679.72	921.93	934.81	1424.48	1090.57	1416.23	1311.84	1643.86	1405.54	1915.67	1362.57	1796.33
Datamatics Global Services Ltd.	74.34	111.08	75.48	107.72	170.12	244.31	145.40	181.44	154.52	258.21	172.95	276.50	200.35	293.44	222.39	335.25	196.47	457.02	298.46	458.81
Firstsource Solutions Ltd.	445.98	875.90	516.44	796.20	837.76	917.79	833.87	996.43	769.62	1427.54	967.08	1506.56	1055.47	1520.64	987.72	1535.26	937.37	1942.88	900.54	1403.31
H C L Infosystems Ltd.	11877.33	11877.33	12415.12	12415.12	12371.13	12371.13	12121.23	12121.23	11146.48	11146.48	10479.95	10479.95	8810.43	9399.53	5859.24	7082.18	4487.53	6361.16	2629.03	4532.73
H C L Technologies Ltd.	4208.04	5207.08	4786.24	5455.38	4941.59	5298.17	5255.97	5943.57	6961.05	8373.09	9208.44	10581.92	12896.94	15208.97	17156.88	17156.88	18353.34	23830.61	14402.11	16639.22
Hexaware Technologies Ltd.	492.47	800.78	524.33	868.03	522.04	693.49	520.90	563.08	543.34	1095.92	757.48	1187.56	959.97	1117.67	1054.42	1142.09	1214.27	1608.75	1312.40	1609.46
Infosys Ltd.	13655.00	13655.00	16623.00	16623.00	21478.00	21478.00	22426.00	22426.00	26532.00	26532.00	33661.00	33661.00	39065.00	40148.10	46936.00	46936.00	51210.00	62840.15	60404.00	68059.69
K P I T Technologies Ltd.	325.74	404.58	496.00	588.78	649.62	649.62	434.50	468.28	534.27	946.01	628.85	960.70	732.16	1049.17	959.88	1394.01	1280.96	2036.65	1290.58	1845.28
Lycos Internet Ltd.	45.56	62.39	136.66	157.84	189.16	216.88	240.91	240.91	298.91	335.36	513.15	1136.00	602.13	1050.96	610.07	1080.01	502.83	1035.63	464.33	905.59
Mastek Ltd.	559.76	566.91	608.22	608.22	601.11	601.11	450.94	551.40	423.58	616.11	466.22	764.41	431.77	690.01	582.49	859.98	714.90	941.90	400.55	623.80
Mindtree Ltd.	597.72	760.95	762.65	976.01	1020.50	1080.99	1315.20	1347.87	1555.10	1971.01	1953.60	2394.93	2396.80	3440.93	3081.00	3942.68	3630.50	5125.07	4450.40	6365.68
Moser Baer India Ltd.	2155.57	3066.85	2090.59	3256.02	2577.27	2963.58	2366.04	2671.36	1967.54	2866.34	2188.79	2422.97	1620.74	1985.76	1039.97	1039.97	1053.84	1053.84	834.47	834.47
Mphasis Ltd.	1104.86	1452.37	1726.13	2061.66	1495.95	1766.27	3460.99	3460.99	3881.54	4313.84	3668.50	5306.83	3713.42	5183.46	3550.79	4984.51	3200.64	5535.68	3089.01	4623.29
N I I T Ltd.	407.89	554.02	504.11	656.47	587.30	696.41	657.00	759.90	698.24	896.52	912.18	1090.59	711.98	1165.73	594.40	974.17	439.96	978.58	425.95	788.54
N I I T Technologies Ltd.	312.05	363.82	505.54	537.73	542.35	570.37	504.91	561.91	752.31	1016.42	858.05	1105.43	1141.20	1604.62	1389.16	2020.23	1401.13	2129.57	1508.91	2135.01
Nelco Ltd.	68.92	69.34	213.42	213.42	374.23	374.23	203.95	203.95	121.98	121.98	153.62	153.62	114.80	114.80	121.86	121.86	150.58	165.37	150.58	206.93
Nucleus Software Exports Ltd.	151.19	190.53	219.37	247.64	225.98	266.09	209.79	245.47	230.17	381.00	227.84	496.96	226.27	323.93	272.08	363.09	308.85	533.62	329.13	509.52
Oracle Financial Services Softwar	1589.42	2740.90	1879.67	2874.16	2380.92	2894.79	2335.10	2512.99	2522.72	2522.72	3308.44	4336.58	3442.29	3556.26	3804.22	4025.96	3759.33	4449.00	3708.62	4036.00
Polaris Consulting & Services Ltd	909.26	1023.14	962.35	1067.11	1203.06	1339.51	1160.96	1344.11	1449.02	1984.81	1806.06	2612.11	1897.36	3045.46	2126.69	3402.61	1717.55	1987.07	1854.83	2599.20
R S Software (India) Ltd.	101.33	101.33	101.12	101.12	149.83	149.83	162.42	162.42	188.57	188.57	248.15	248.15	297.67	297.67	359.00	359.00	357.10	357.10	186.92	301.85
Ramco Systems Ltd.	86.87	181.31	170.54	244.38	164.05	184.22	109.68	179.39	157.75	261.95	160.85	287.95	176.62	314.72	173.64	277.17	224.77	436.00	272.14	406.66
Rolta India Ltd.	607.67	1051.29	898.88	1161.28	1024.26	1024.26	1199.87	1199.87	1603.24	1603.24	1578.31	1578.31	1377.82	1377.82	1255.70	1255.70	2023.02	2023.02	1879.78	1879.78
Sasken Technologies Ltd.	383.42	501.36	414.55	525.27	491.56	556.05	454.37	518.41	411.96	513.17	411.62	654.77	387.68	575.28	417.14	510.55	639.02	639.02	731.39	731.39
Smartlink Network Systems Ltd.	317.36	359.95	318.50	379.00	178.51	222.83	182.88	219.85	208.63	208.63	588.84	588.84	158.47	272.41	183.86	291.22	134.43	184.87	106.64	170.15
Sonata Software Ltd.	200.00	200.00	223.44	223.44	260.24	286.85	271.74	305.31	303.92	303.92	270.55	539.58	281.04	425.11	381.77	544.16	508.06	652.91	549.52	740.64
Subex Ltd.	237.29	687.94	207.51	806.03	318.63	504.17	418.22	418.22	329.94	461.36	344.55	437.99	266.77	528.07	299.57	511.93	309.90	568.42	435.46	679.66
T V S Electronics Ltd.	297.40	304.63	236.25	236.25	197.74	239.32	197.18	211.59	184.71	188.83	221.69	224.66	239.05	239.05	251.06	251.06	273.31	273.31	599.89	599.89
Tanla Solutions Ltd.	91.12	91.12	152.00	152.00	179.63	179.63	57.75	57.75	29.25	29.25	37.32	59.40	35.18	55.12	31.18	39.22	137.81	264.95	280.43	470.74
Tata Consultancy Services Ltd.	15161.23	15161.23	19371.60	19371.60	22799.06	24043.81	23455.21	23455.21	29931.12	29931.12	41282.37	49656.26	50657.35	62392.96	68540.40	76971.01	78082.95	99209.34	89623.63	106203.42
Tata Elxsi Ltd.	308.38	308.38	406.96	413.00	418.66	418.66	377.32	396.10	414.88	414.88	532.59	585.17	611.79	792.72	812.14	906.20	862.85	942.93	1087.07	1397.51
Tech Mahindra Ltd.	2826.90	2826.90	3724.30	3724.30	4403.60	4403.60	4591.10	4629.69	5133.80	6970.19	5382.80	7285.66	6078.00	9543.74	17182.40	24405.64	19706.90	29221.00	22636.00	31769.57
Trigyn Technologies Ltd.	44.20	44.20	15.86	45.54	28.32	35.86	32.39	35.77	29.31	91.73	34.97	131.78	42.14	67.06	215.68	249.58	154.73	270.65	154.70	214.80
Vakrangee Ltd.	121.32	121.32	225.94	225.94	294.73	299.51	410.07	482.59	853.78	999.21	1356.38	1356.38	1563.52	1977.99	1974.65	2686.18	2784.94	3686.46	3181.99	4307.38
Wipro Ltd.	14047.20	17198.34	18132.50	23658.53	22187.50	24801.20	23920.60	26559.83	27140.90	37037.60	33109.10	48067.79	34641.70	51898.14	40675.90	59030.11	43807.00	66468.58	47594.40	69487.10
Zensar Technologies Ltd.	285.46	337.65	351.55	379.15	430.63	463.18	507.58	522.30	591.82	751.25	740.67	915.28	872.31	1179.90	962.04	1034.51	1102.42	1356.22	1300.53	1660.96

Source: Calculated and compiled by the authors

Table 4. Actual NCFO vs projected NCFO of IT companies under stage-I

Company Name (BCC)	2007 NCFO	2007 PRO NCFO	2008 NCFO	2008 PRO NCFO	2009 NCFO	2009 PRO NCFO	2010 NCFO	2010 PRO NCFO	2011 NCFO	2011 PRO NCFO	2012 NCFO	2012 PRO NCFO	2013 NCFO	2013 PRO NCFO	2014 NCFO	2014 PRO NCFO	2015 NCFO	2015 PRO NCFO	2016 NCFO	2016 PRO NCFO
3I Infotech Ltd.	112.72	242.16	199.35	259.09	414.72	414.72	194.80	200.61	233.73	323.40	-81.36	123.45	36.45	1139.58	-72.54	352.13	73.99	73.99	34.74	34.74
63 Moons Technologies Ltd.	12.27	120.45	0.00	0.00	103.12	103.12	110.17	110.17	-51.66	46.74	310.23	310.23	323.33	323.33	76.08	76.08	0.00	0.00	0.00	0.00
Accelya Kale Solutions Ltd.	15.34	39.17	10.83	19.73	24.27	33.36	20.73	29.61	18.25	23.26	47.04	47.04	96.49	96.49	92.72	92.72	62.85	62.85	73.29	73.29
Aurionpro Solutions Ltd.	5.03	50.96	10.82	21.22	24.36	32.61	26.11	33.59	3.65	17.95	6.96	16.28	0.00	171.99	0.00	141.66	0.00	72.54	0.00	46.47
Axiscades Engineering Technologies Ltd.	0.00	8.07	0.00	2.67	1.53	4.11	0.00	4.54	-0.76	3.81	9.71	11.92	16.99	30.21	12.63	89.88	17.71	57.64	26.36	69.87
Cyient Ltd.	67.39	141.55	52.16	91.61	107.13	188.24	129.39	178.40	56.75	127.77	113.18	172.47	122.67	517.74	144.00	493.56	213.75	525.77	0.00	382.46
Datamatics Global Services Ltd.	31.70	47.37	5.02	24.48	4.11	53.86	14.54	50.95	6.33	31.64	35.71	57.09	19.71	110.43	29.67	88.46	17.19	44.20	60.86	93.56
Firstsource Solutions Ltd.	6.37	554.28	82.65	127.42	46.87	366.08	157.40	188.09	78.49	145.59	91.55	142.62	329.96	599.49	0.00	426.11	50.58	213.92	76.93	218.72
H C L Infosystems Ltd.	18.68	18.68	152.67	152.67	267.55	267.55	0.00	0.00	-80.79	-80.79	0.00	0.00	239.40	1448.26	0.00	1400.52	0.00	1097.90	0.00	866.17
H C L Technologies Ltd.	988.76	1970.53	1038.90	1184.14	529.05	1424.41	725.71	1236.12	1483.45	1784.37	2134.34	2452.69	3995.48	6208.52	5966.69	5966.69	5066.20	6578.13	2938.50	3394.94
Hexaware Technologies Ltd.	121.66	399.28	81.02	134.13	34.23	194.41	125.61	151.70	-2.99	85.16	115.88	181.67	197.21	420.02	268.49	328.26	323.19	428.18	287.61	352.71
Infosys Ltd.	3241.00	3241.00	3816.00	3816.00	5152.00	5152.00	5855.00	5855.00	4270.00	4270.00	5861.00	5861.00	6942.00	10106.09	9148.00	9148.00	7955.00	17674.14	9399.00	15074.17
K P I T Technologies Ltd.	37.48	58.68	50.70	60.18	123.25	123.25	109.84	118.38	31.64	64.16	96.24	147.03	116.39	541.28	80.24	463.11	209.98	333.86	362.09	517.72
Lycos Internet Ltd.	0.00	13.02	8.58	12.37	3.15	47.40	75.52	75.52	10.52	28.74	0.00	0.00	23.95	605.69	29.78	360.14	73.70	155.11	11.22	183.70
Mastek Ltd.	64.22	116.50	109.82	109.82	119.92	119.92	32.60	114.61	-12.97	66.91	0.00	65.34	25.91	249.99	88.90	229.83	9.50	190.05	39.63	141.62
Mindtree Ltd.	82.02	253.47	90.63	115.99	143.28	280.93	239.60	253.85	43.80	159.19	206.60	253.27	266.30	1252.38	322.50	961.72	597.70	1101.86	405.10	1416.19
Moser Baer India Ltd.	706.98	1005.86	307.71	479.25	509.88	820.50	375.30	423.73	201.02	292.85	294.97	326.53	44.99	560.64	31.32	31.32	63.10	63.10	48.81	48.81
Mphasis Ltd.	132.65	501.97	175.34	209.42	136.62	504.40	874.33	874.33	661.74	735.44	624.98	904.09	726.60	2013.54	763.06	1488.85	338.46	943.04	383.88	868.15
N I I T Ltd.	68.04	118.99	85.98	111.97	51.90	170.19	1.30	79.13	70.78	90.88	96.84	115.78	55.25	544.08	4.38	315.31	37.04	107.48	48.69	137.52
N I I T Technologies Ltd.	108.15	185.03	126.15	134.18	88.39	144.93	79.86	134.10	31.81	92.24	170.28	219.37	123.39	585.83	42.69	609.35	273.29	415.37	375.78	531.70
Nelco Ltd.	4.80	10.10	32.30	32.30	4.14	4.14	0.00	0.00	40.66	40.66	0.00	0.00	21.87	21.87	24.15	24.15	4.18	21.28	4.18	41.19
Nucleus Software Exports Ltd.	19.74	68.56	17.10	43.00	19.95	67.62	29.17	61.26	24.51	40.57	3.32	7.24	63.31	122.45	36.09	104.41	42.42	73.29	11.50	96.05
Oracle Financial Services Software Ltd.	0.00	1394.37	333.97	510.67	431.14	626.51	676.38	727.91	716.63	716.63	477.79	626.27	1177.49	1354.20	759.08	1092.22	974.89	1153.74	755.47	822.16
Polaris Consulting & Services Ltd.	72.62	175.87	80.08	143.36	196.29	276.03	240.03	318.04	104.10	152.39	0.00	78.37	112.72	1212.50	323.38	997.65	41.46	383.12	156.33	523.78
R S Software (India) Ltd.	17.58	17.58	12.81	12.81	15.22	15.22	16.13	16.13	16.85	16.85	39.54	39.54	5.07	5.07	49.25	49.25	59.12	59.12	0.00	68.15
Ramco Systems Ltd.	0.00	75.27	0.00	15.09	0.00	52.41	14.27	37.72	19.33	32.10	14.72	26.35	0.00	175.45	0.00	95.64	30.06	58.31	57.58	86.04
Rolta India Ltd.	228.29	708.59	339.92	439.15	374.62	374.62	547.82	547.82	761.60	761.60	1090.41	1090.41	1623.84	1623.84	699.77	699.77	2019.46	2019.46	269.74	269.74
Sasken Technologies Ltd.	30.51	133.22	43.44	116.97	102.82	142.46	112.35	128.18	60.47	75.33	52.03	82.76	35.74	185.88	22.40	116.63	182.25	182.25	246.14	246.14
Smartlink Network Systems Ltd.	43.55	60.85	37.17	71.90	3.88	48.08	28.21	53.10	11.96	11.96	0.00	0.00	0.00	99.15	0.00	64.54	4.62	49.27	0.00	38.86
Sonata Software Ltd.	44.05	44.05	42.31	42.31	56.33	70.51	42.82	79.15	45.18	45.18	7.25	23.95	22.19	156.46	57.83	162.86	83.41	147.78	82.41	155.11
Subex Ltd.	36.17	503.08	0.00	15.45	43.93	211.72	0.00	0.00	52.74	73.75	25.84	32.85	0.00	380.67	36.65	182.44	49.30	90.43	35.43	96.22
T V S Electronics Ltd.	11.85	29.24	39.68	39.68	1.80	27.68	17.17	18.43	23.60	24.13	3.41	3.46	9.51	9.51	12.36	12.36	10.34	10.34	29.48	29.48
Tanla Solutions Ltd.	0.00	0.00	38.92	38.92	83.83	83.83	36.64	36.64	25.02	25.02	10.82	17.22	8.64	22.06	0.00	11.09	46.62	89.63	18.63	96.09
Tata Consultancy Services Ltd.	3551.26	3551.26	3827.91	3827.91	4834.36	6297.87	6080.20	6080.20	5719.88	5719.88	3174.63	3818.59	9156.95	22761.23	12941.93	21600.24	16319.89	20735.46	17996.31	22902.21
Tata Elxsi Ltd.	61.11	61.11	14.56	14.78	79.45	79.45	14.19	68.77	71.73	71.73	56.25	61.80	36.79	210.26	126.16	267.33	143.38	183.55	121.07	307.23
Tech Mahindra Ltd.	3.20	3.20	209.70	209.70	1200.30	1200.30	1412.30	1424.17	470.60	638.94	665.40	900.62	642.10	4638.48	1294.20	7607.26	2107.80	5772.34	2882.80	6957.63
Trigyn Technologies Ltd.	38.96	38.96	0.00	4.15	9.04	11.45	2.01	9.05	0.97	5.26	0.00	0.00	1.65	25.52	0.00	60.03	0.00	68.80	4.26	49.11
Vakrangee Ltd.	37.72	37.72	147.15	147.15	14.87	73.04	12.95	99.52	-40.84	82.88	205.31	205.31	80.02	673.98	233.00	835.74	0.00	739.67	244.24	935.40
Wipro Ltd.	2674.60	5307.87	715.90	934.08	4344.50	6253.88	4477.40	4971.40	3711.20	5064.46	2997.90	4352.35	6588.60	18170.56	7703.60	11688.71	6686.70	14428.99	6686.70	14428.99
Zensar Technologies Ltd.	30.72	96.53	56.16	63.12	63.12	84.45	61.66	102.43	49.39	65.02	74.19	91.68	153.22	234.54	131.74	314.68	140.75	360.95	140.75	360.95

Source: Calculated and compiled by the authors

Table 5. Market efficiency scores and ranks of IT companies under stage-II model

Company	2007 Score	2007 Rank	2008 Score	2008 Rank	2009 Score	2009 Rank	2010 Score	2010 Rank	2011 Score	2011 Rank	2012 Score	2012 Rank	2013 Score	2013 Rank	2014 Score	2014 Rank	2015 Score	2015 Rank	2016 Score	2016 Rank
3I Infotech Ltd.	0.13	30	0.34	23	0.15	33	0.22	28	0.12	36	1.00	1	0.07	38	0.11	35	1.00	1	0.76	12
63 Moons Technologies Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Accelya Kale Solutions Ltd.	0.05	38	0.12	38	0.09	37	0.14	32	0.15	30	0.28	24	0.80	11	1.00	1	1.00	1	1.00	1
Aurionpro Solutions Ltd.	0.22	18	0.69	11	0.24	18	0.78	11	0.32	16	0.20	30	0.10	36	0.17	30	0.20	35	0.47	16
Axiscades Engineering Technologies Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.08	38	0.82	14	0.63	15
Cyient Ltd.	0.18	22	0.39	21	0.18	26	0.40	16	0.31	17	0.27	25	0.27	22	0.42	18	0.49	19	0.38	20
Datamatics Global Services Ltd.	0.06	36	0.10	40	0.10	36	0.12	37	0.12	35	0.13	32	0.12	31	0.22	26	0.46	21	0.14	36
Firstsource Solutions Ltd.	0.27	13	0.49	17	0.22	20	0.20	31	0.12	34	0.07	39	0.09	35	0.22	27	0.37	25	0.30	27
H C L Infosystems Ltd.	0.13	29	0.41	20	0.31	14	1.00	1	1.00	1	1.00	1	0.05	39	0.05	40	0.05	40	0.05	40
H C L Technologies Ltd.	0.47	11	0.76	9	0.46	10	0.69	12	0.54	11	0.67	14	0.75	12	1.00	1	1.00	1	1.00	1
Hexaware Technologies Ltd.	0.20	20	0.22	29	0.16	31	0.23	27	0.47	13	0.75	13	0.47	15	0.80	11	0.97	12	0.72	13
Infosys Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	0.78	15	0.84	11
K P I T Technologies Ltd.	0.18	24	0.34	24	0.29	15	0.30	22	0.49	12	0.35	20	0.40	16	0.48	15	0.45	22	0.23	29
Lycos Internet Ltd.	0.13	28	0.47	18	0.18	27	0.31	21	0.09	39	1.00	1	0.29	21	0.15	32	0.35	27	0.17	34
Mastek Ltd.	0.10	33	0.45	19	0.22	19	0.28	24	0.11	37	0.07	38	0.10	33	0.12	33	0.21	32	0.10	39
Mindtree Ltd.	0.27	15	0.37	22	0.36	13	0.36	17	0.23	27	0.23	26	0.31	20	0.33	22	0.43	23	0.36	24
Moser Baer India Ltd.	0.12	31	0.20	31	0.13	34	0.10	38	0.06	40	0.04	40	0.02	40	1.00	1	1.00	1	1.00	1
Mphasis Ltd.	0.27	14	0.64	13	0.85	6	0.64	13	0.29	19	0.35	19	0.33	18	0.32	23	0.35	26	0.33	25
N I I T Ltd.	0.14	26	0.66	12	0.21	21	0.35	19	0.25	23	0.21	29	0.08	37	0.10	36	0.21	34	0.32	26
N I I T Technologies Ltd.	0.18	21	0.25	27	0.25	17	0.27	26	0.27	21	0.32	22	0.24	24	0.26	25	0.21	33	0.21	31
Nelco Ltd.	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Nucleus Software Exports Ltd.	0.32	12	0.55	15	0.20	23	0.27	25	0.16	29	0.36	18	0.17	26	0.45	17	0.28	31	0.26	28
Oracle Financial Services Software Ltd.	0.82	8	0.52	16	0.60	8	0.99	7	0.95	9	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Polaris Consulting & Services Ltd.	0.14	27	0.20	32	0.15	32	0.21	30	0.28	20	0.33	21	0.11	32	0.16	31	0.19	36	0.12	38
R S Software (India) Ltd.	0.10	32	0.22	30	0.16	30	0.13	34	0.14	32	0.10	37	1.00	1	0.29	24	0.31	29	0.18	33
Ramco Systems Ltd.	0.04	40	0.22	28	0.12	35	0.13	36	0.15	31	0.15	31	0.17	27	0.39	19	1.00	1	1.00	1
Rolta India Ltd.	0.24	17	0.60	14	0.26	16	0.33	20	0.26	22	0.21	27	0.26	23	0.35	21	0.50	18	0.21	30
Sasken Technologies Ltd.	0.15	25	0.11	39	0.09	38	0.13	35	0.13	33	0.11	35	0.12	30	0.19	28	0.13	37	0.13	37
Smartlink Network Systems Ltd.	0.04	39	0.15	36	0.20	24	0.09	39	0.40	14	1.00	1	0.13	28	0.12	34	1.00	1	1.00	1
Sonata Software Ltd.	0.18	23	0.29	25	0.19	25	0.29	23	0.23	26	0.13	33	0.13	29	0.18	29	0.54	17	0.37	22
Subex Ltd.	0.21	19	0.18	34	0.05	40	0.99	8	0.16	28	0.10	36	0.09	34	0.08	39	0.08	39	0.18	32
T V S Electronics Ltd.	0.05	37	0.14	37	0.17	29	0.14	33	0.11	38	0.11	34	1.00	1	1.00	1	1.00	1	1.00	1
Tanla Solutions Ltd.	1.00	1	1.00	1	0.47	9	0.97	9	1.00	1	1.00	1	1.00	1	1.00	1	0.33	28	0.15	35
Tata Consultancy Services Ltd.	1.00	1	1.00	1	0.92	5	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1	1.00	1
Tata Elxsi Ltd.	0.26	16	0.71	10	0.42	11	0.59	14	0.40	15	0.38	16	0.33	19	0.59	13	0.86	13	0.71	14
Tech Mahindra Ltd.	1.00	1	1.00	1	0.40	12	0.36	18	0.31	18	0.29	23	0.34	17	0.51	14	0.46	20	0.37	23
Trigyn Technologies Ltd.	0.62	10	0.17	35	0.21	22	0.41	15	1.00	1	1.00	1	1.00	1	0.10	37	0.10	38	0.45	18
Vakrangee Ltd.	0.09	34	0.29	26	0.05	39	0.08	40	0.24	25	0.37	17	0.69	13	0.59	12	0.30	30	0.46	17
Wipro Ltd.	0.68	9	1.00	1	0.68	7	0.81	10	0.56	10	0.49	15	0.47	14	0.48	16	0.55	16	0.44	19
Zensar Technologies Ltd.	0.09	35	0.19	33	0.18	28	0.21	29	0.24	24	0.21	28	0.22	25	0.37	20	0.38	24	0.37	21

Source: Calculated and compiled by the authors

Table 6. Operating efficiency (stage-I) vs market efficiency (stage-II) scores of IT companies

Companies	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II	Stage-I	Stage-II
3I Infotech Ltd.	0.895	0.129	0.769	0.338	1.000	0.146	0.971	0.217	0.723	0.117	0.446	1.000	0.578	0.075	0.600	0.112	1.000	1.000	1.000	0.765
63 Moons Technologies Ltd.	0.965	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.705	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Accelya Kale Solutions Ltd.	0.756	0.051	0.837	0.121	0.814	0.093	0.905	0.144	0.785	0.153	1.000	0.276	1.000	0.801	1.000	1.000	1.000	1.000	1.000	1.000
Aurionpro Solutions Ltd.	0.471	0.223	0.510	0.687	0.747	0.241	0.777	0.777	0.387	0.315	0.427	0.201	0.587	0.100	0.585	0.174	0.516	0.198	0.569	0.471
Axiscades Engineering Technologies Ltd.	0.373	1.000	0.418	1.000	0.713	1.000	0.760	1.000	0.736	1.000	0.814	1.000	0.717	1.000	0.617	0.081	0.674	0.822	0.689	0.628
Cyient Ltd.	0.852	0.183	0.569	0.392	0.817	0.183	0.876	0.400	0.737	0.314	0.656	0.271	0.770	0.271	0.798	0.417	0.734	0.487	0.759	0.375
Datamatics Global Services Ltd.	0.669	0.059	0.701	0.096	0.696	0.100	0.801	0.124	0.598	0.121	0.625	0.126	0.683	0.117	0.663	0.219	0.430	0.455	0.651	0.144
Firstsource Solutions Ltd.	0.509	0.275	0.649	0.487	0.913	0.216	0.837	0.201	0.539	0.121	0.642	0.067	0.694	0.093	0.643	0.216	0.482	0.367	0.642	0.297
H C L Infosystems Ltd.	1.000	0.130	1.000	0.406	1.000	0.314	1.000	1.000	1.000	1.000	1.000	1.000	0.937	0.048	0.827	0.054	0.705	0.046	0.580	0.046
H C L Technologies Ltd.	0.808	0.466	0.877	0.761	0.933	0.460	0.884	0.695	0.831	0.542	0.870	0.674	0.848	0.755	1.000	1.000	0.770	1.000	0.866	1.000
Hexaware Technologies Ltd.	0.615	0.197	0.604	0.216	0.753	0.158	0.925	0.231	0.496	0.468	0.638	0.755	0.859	0.466	0.923	0.795	0.755	0.974	0.815	0.721
Infosys Ltd.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.973	1.000	1.000	1.000	0.815	0.784	0.888	0.838
K P I T Technologies Ltd.	0.805	0.176	0.842	0.338	1.000	0.285	0.928	0.296	0.565	0.486	0.655	0.348	0.698	0.403	0.689	0.481	0.629	0.449	0.699	0.230
Lycos Internet Ltd.	0.730	0.135	0.866	0.469	0.872	0.180	1.000	0.309	0.891	0.086	0.452	1.000	0.573	0.293	0.565	0.149	0.486	0.346	0.513	0.169
Mastek Ltd.	0.987	0.096	1.000	0.451	1.000	0.218	0.818	0.279	0.688	0.113	0.610	0.073	0.626	0.096	0.677	0.123	0.759	0.211	0.642	0.102
Mindtree Ltd.	0.785	0.270	0.781	0.366	0.944	0.361	0.976	0.362	0.789	0.231	0.816	0.228	0.697	0.305	0.781	0.331	0.708	0.431	0.699	0.357
Moser Baer India Ltd.	0.703	0.125	0.642	0.201	0.870	0.125	0.886	0.099	0.686	0.056	0.903	0.035	0.816	0.021	1.000	1.000	1.000	1.000	1.000	1.000
Mphasis Ltd.	0.761	0.272	0.837	0.640	0.847	0.850	1.000	0.638	0.900	0.289	0.691	0.353	0.716	0.328	0.712	0.321	0.578	0.347	0.668	0.328
N I I T Ltd.	0.736	0.145	0.768	0.656	0.843	0.209	0.865	0.353	0.779	0.252	0.836	0.207	0.611	0.080	0.610	0.103	0.450	0.207	0.540	0.318
N I I T Technologies Ltd.	0.858	0.184	0.940	0.245	0.951	0.251	0.899	0.268	0.740	0.267	0.776	0.321	0.711	0.236	0.688	0.264	0.658	0.210	0.707	0.211
Nelco Ltd.	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.911	1.000	0.728	1.000
Nucleus Software Exports Ltd.	0.794	0.320	0.886	0.550	0.849	0.198	0.855	0.269	0.604	0.156	0.458	0.360	0.699	0.168	0.749	0.450	0.579	0.285	0.646	0.260
Oracle Financial Services Software Ltd.	0.580	0.820	0.654	0.524	0.822	0.600	0.929	0.993	1.000	0.947	0.763	1.000	0.968	1.000	0.945	1.000	0.845	1.000	0.919	1.000
Polaris Consulting & Services Ltd.	0.889	0.143	0.902	0.196	0.898	0.152	0.864	0.208	0.730	0.275	0.691	0.329	0.623	0.108	0.625	0.158	0.864	0.186	0.714	0.124
R S Software (India) Ltd.	1.000	0.099	1.000	0.215	1.000	0.159	1.000	0.134	1.000	0.144	1.000	0.104	1.000	1.000	1.000	0.291	1.000	0.307	0.619	0.176
Ramco Systems Ltd.	0.479	0.038	0.698	0.218	0.891	0.116	0.611	0.129	0.602	0.145	0.559	0.152	0.561	0.167	0.626	0.391	0.516	1.000	0.669	1.000
Rolta India Ltd.	0.578	0.240	0.774	0.603	1.000	0.260	1.000	0.327	1.000	0.258	1.000	0.210	1.000	0.260	1.000	0.351	1.000	0.502	1.000	0.213
Sasken Technologies Ltd.	0.765	0.145	0.789	0.110	0.884	0.090	0.876	0.132	0.803	0.129	0.629	0.105	0.674	0.119	0.817	0.191	1.000	0.131	1.000	0.134
Smartlink Network Systems Ltd.	0.882	0.039	0.840	0.150	0.801	0.197	0.832	0.091	1.000	0.404	1.000	1.000	0.582	0.133	0.631	0.118	0.727	1.000	0.627	1.000
Sonata Software Ltd.	1.000	0.181	1.000	0.293	0.907	0.185	0.890	0.285	1.000	0.231	0.501	0.126	0.661	0.132	0.702	0.185	0.778	0.538	0.742	0.371
Subex Ltd.	0.345	0.208	0.257	0.178	0.632	0.047	1.000	0.990	0.715	0.161	0.787	0.105	0.505	0.094	0.585	0.075	0.545	0.082	0.641	0.178
T V S Electronics Ltd.	0.976	0.053	1.000	0.141	0.826	0.166	0.932	0.140	0.978	0.113	0.987	0.107	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Tanla Solutions Ltd.	1.000	1.000	1.000	1.000	1.000	0.472	1.000	0.971	1.000	1.000	0.628	1.000	0.638	1.000	0.795	1.000	0.520	0.328	0.596	0.153
Tata Consultancy Services Ltd.	1.000	1.000	1.000	1.000	0.948	0.922	1.000	1.000	1.000	1.000	0.831	1.000	0.812	1.000	0.890	1.000	0.787	1.000	0.844	1.000
Tata Elxsi Ltd.	1.000	0.255	0.985	0.706	1.000	0.421	0.953	0.591	1.000	0.398	0.910	0.376	0.772	0.327	0.896	0.588	0.915	0.856	0.778	0.713
Tech Mahindra Ltd.	1.000	1.000	1.000	1.000	1.000	0.404	0.992	0.361	0.737	0.306	0.739	0.291	0.637	0.343	0.704	0.508	0.674	0.460	0.713	0.367
Trigyn Technologies Ltd.	1.000	0.624	0.348	0.166	0.790	0.208	0.906	0.414	0.320	1.000	0.265	1.000	0.628	1.000	0.864	0.102	0.572	0.101	0.720	0.454
Vakrangee Ltd.	1.000	0.091	1.000	0.290	0.984	0.052	0.850	0.085	0.854	0.236	1.000	0.375	0.790	0.690	0.735	0.590	0.755	0.302	0.739	0.465
Wipro Ltd.	0.817	0.677	0.766	1.000	0.895	0.675	0.901	0.813	0.733	0.559	0.689	0.493	0.667	0.470	0.689	0.481	0.659	0.550	0.685	0.438
Zensar Technologies Ltd.	0.845	0.088	0.927	0.192	0.930	0.179	0.972	0.209	0.788	0.240	0.809	0.210	0.739	0.220	0.930	0.369	0.813	0.379	0.783	0.372

Source: Calculated and compiled by the authors

Table 7. Operating efficiency (stage-I) vs market efficiency (stage-II) ranks of IT companies

Company	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank
3I Infotech Ltd.	15	30	27	23	1	33	15	28	28	36	38	1	37	38	37	35	1	1	1	12
63 Moons Technologies Ltd.	14	1	1	1	1	1	1	1	30	1	1	1	1	1	1	1	1	1	1	1
Accelya Kale Solutions Ltd.	28	38	22	38	33	37	22	32	20	30	1	24	1	11	1	1	1	1	1	1
Aurionpro Solutions Ltd.	38	18	37	11	37	18	38	11	39	16	39	30	35	36	39	30	35	35	38	16
Axiscades Engineering Technologies Ltd.	39	1	38	1	38	1	39	1	25	1	17	1	18	1	35	38	26	14	25	15
Cyient Ltd.	19	22	36	21	32	26	29	16	23	17	26	25	16	22	18	18	21	19	15	20
Datamatics Global Services Ltd.	32	36	30	40	39	36	37	37	35	35	32	32	25	31	30	26	40	21	29	36
Firstsource Solutions Ltd.	36	13	33	17	19	20	34	31	37	34	28	39	24	35	31	27	38	25	32	27
H C L Infosystems Ltd.	1	29	1	20	1	14	1	1	1	1	1	1	9	39	16	40	24	40	37	40
H C L Technologies Ltd.	22	11	18	9	17	10	27	12	16	11	13	14	11	12	1	1	17	1	10	1
Hexaware Technologies Ltd.	33	20	35	29	36	31	20	27	38	13	29	13	10	15	12	11	20	12	12	13
Infosys Ltd.	1	1	1	1	1	1	1	1	1	1	1	1	7	1	1	1	13	15	9	11
K P I T Technologies Ltd.	23	24	20	24	1	15	19	22	36	12	27	20	22	16	27	15	29	22	23	29
Lycos Internet Ltd.	30	28	19	18	25	27	1	21	14	39	37	1	38	21	40	32	37	27	40	34
Mastek Ltd.	12	33	1	19	1	19	36	24	31	37	33	38	32	33	29	33	18	32	31	39
Mindtree Ltd.	25	15	25	22	16	13	13	17	18	27	16	26	23	20	20	22	23	23	24	24
Moser Baer India Ltd.	31	31	34	31	26	34	26	38	32	40	12	40	12	40	1	1	1	1	1	1
Mphasis Ltd.	27	14	23	13	28	6	1	13	13	19	24	19	19	18	23	23	31	26	28	25
N I I T Ltd.	29	26	28	12	29	21	30	19	21	23	14	29	34	37	36	36	39	34	39	26
N I I T Technologies Ltd.	18	21	14	27	14	17	24	26	22	21	20	22	20	24	28	25	28	33	22	31
Nelco Ltd.	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	1	18	1
Nucleus Software Exports Ltd.	24	12	17	15	27	23	32	25	33	29	36	18	21	26	21	17	30	31	30	28
Oracle Financial Services Software Ltd.	34	8	32	16	31	8	18	7	1	9	21	1	8	1	10	1	12	1	8	1
Polaris Consulting & Services Ltd.	16	27	16	32	21	32	31	30	27	20	23	21	33	32	34	31	11	36	20	38
R S Software (India) Ltd.	1	32	1	30	1	30	1	34	1	32	1	37	1	1	1	24	1	29	35	33
Ramco Systems Ltd.	37	40	31	28	23	35	40	36	34	31	34	31	39	27	33	19	36	1	27	1
Rolta India Ltd.	35	17	26	14	1	16	1	20	1	22	1	27	1	23	1	21	1	18	1	30
Sasken Technologies Ltd.	26	25	24	39	24	38	28	35	17	33	30	35	26	30	17	28	1	37	1	37
Smartlink Network Systems Ltd.	17	39	21	36	34	24	35	39	1	14	1	1	36	28	32	34	22	1	34	1
Sonata Software Ltd.	1	23	1	25	20	25	25	23	1	26	35	33	28	29	25	29	16	17	16	22
Subex Ltd.	40	19	40	34	40	40	1	8	29	28	19	36	40	34	38	39	33	39	33	32
T V S Electronics Ltd.	13	37	1	37	30	29	17	33	12	38	10	34	1	1	1	1	1	1	1	1
Tanla Solutions Ltd.	1	1	1	1	1	9	1	9	1	1	31	1	29	1	19	1	34	28	36	35
Tata Consultancy Services Ltd.	1	1	1	1	15	5	1	1	1	1	15	1	13	1	14	1	15	1	11	1
Tata Elxsi Ltd.	1	16	13	10	1	11	16	14	1	15	11	16	15	19	13	13	9	13	14	14
Tech Mahindra Ltd.	1	1	1	1	1	12	12	18	24	18	22	23	30	17	24	14	25	20	21	23
Trigyn Technologies Ltd.	1	10	39	35	35	22	21	15	40	1	40	1	31	1	15	37	32	38	19	18
Vakrangee Ltd.	1	34	1	26	13	39	33	40	15	25	1	17	14	13	22	12	19	30	17	17
Wipro Ltd.	21	9	29	1	22	7	23	10	26	10	25	15	27	14	26	16	27	16	26	19
Zensar Technologies Ltd.	20	35	15	33	18	28	14	29	19	24	18	28	17	25	11	20	14	24	13	21

Source: Calculated and compiled by the authors

*1st column of every year represents stage-I ranks and 2nd Column of every year represents stage-II ranks.

4.3 Additional Analysis

Table 6 also indicates that the companies that are efficient in stage-II reported the actual and projected market capitalization is same. In the case of inefficient companies, the actual market capitalization is lower than the projected capitalization. As shown in the Figure 3, stage–I efficiency was low in the year 2012, but in the second stage it becomes efficient from inefficiency to efficiency by adjusting the slacks. We can observe that, from the Figure 5, the 63 moons actual and projected market capitalization as equal during the ten years period. This company is found efficient in both operational and market efficiency. Hence, Figure 2 indicates that the Tech Mahindra's efficiency score for the first two years was 1 at both the stages, but later the years the performance was never achieved the efficient frontier. It can

also be seen that the inefficiency of Polaris Software Company in all the ten years period as demonstrated in Figure 4.

As discussed in theory and shown in the figures, the company 63 moons's actual and market capitalization moved on the same line. Hence, Figure 8 portrays that company TCS presents itself with a thicker line for all the years except in the year 2009. The actual market capitalization is less than the projected market capitalization for this year. Thus company 63 Moons and TCS are example for such type of success stories. Figure 6 presents mixed results curve for the years 20015 and 2016 where the actual and projected capitalization was equal and later moved differently. Thus, Infosys can be sighted as an example for mixed results. In Figure 7, the Zensar company reported that its actual capitalization is much lower than the projected for all the years that implies that the company's stage–I projected revenues are not reflected by the market. Thus, company Zensar is example for the laggards.

The robustness of the results can be examined with additional analysis based on market to book value ratio of select sample companies. Table 8 presents the ratios of sample companies based on market to book value ratio which are compared with stage-II results for the purpose of analysis. The companies which are consistently efficient in stage II are also consistently ranked high on Market to Book value rankings for the ten years of study period. Further, the stage-II DEA model ranking of companies is mostly same as that of Market to Book Value rankings.

Figure: 2. Tech Mahindra operating efficiency vs Market efficiency

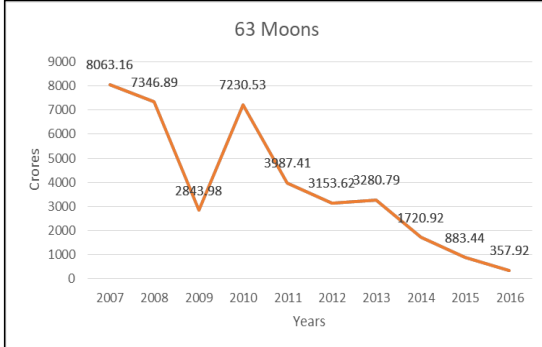Tech Mahindra Operating efficiency vs Market Efficiency
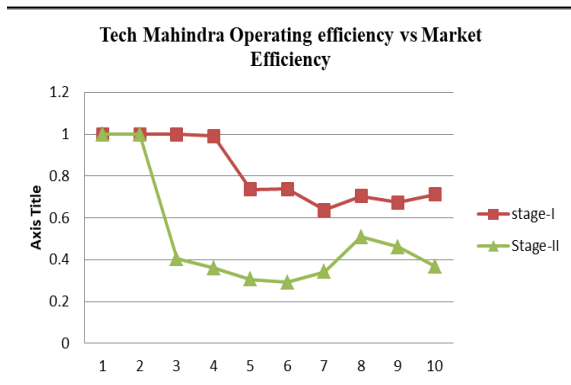
Figure-3: 63 Moons Operating efficiency vs market efficiency
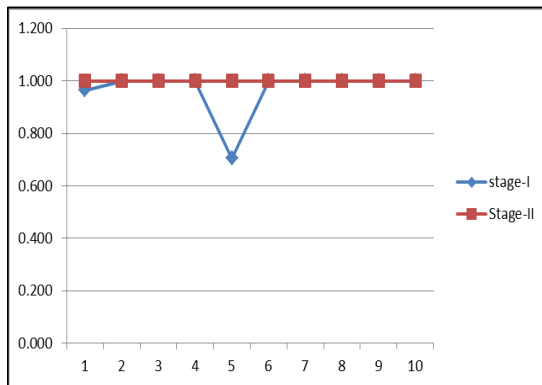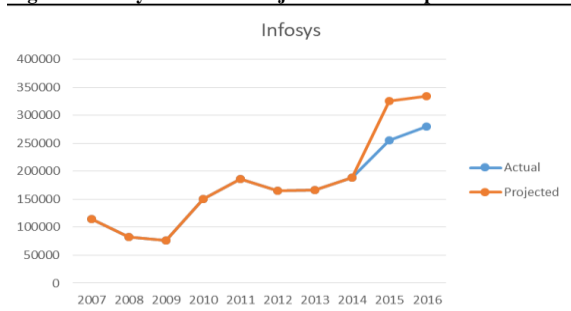

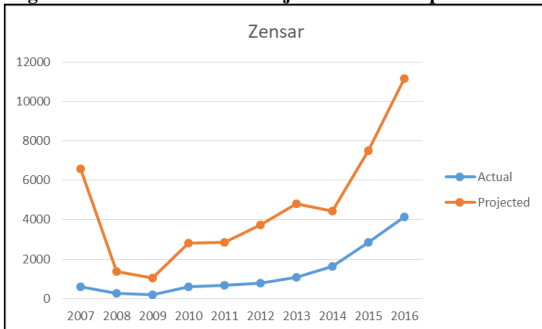**Figure-4. Polaris software Co. operating efficiency vs market efficiency**
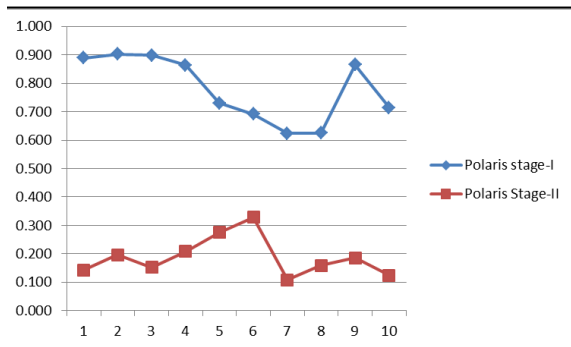
Figure-5. 63 Moons Actual Vs Projected market Capitalization

63 Moons

Figure-6. Infosys Actual Vs Projected market Capitalization

Infosys

Figure-.7. Zensar Actual Vs Projected market Capitalization

Zensar

Figure-8. TCS Actual Vs Projected market capitalization

Tata Consultancy Services
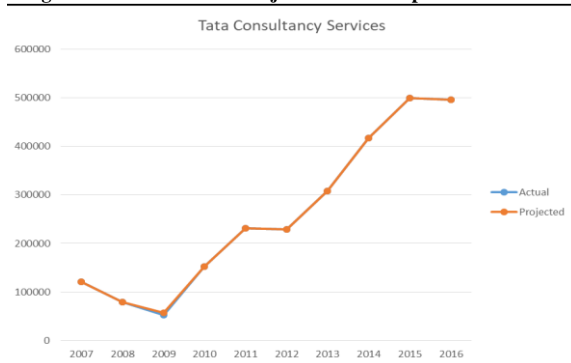
Table 8. Book to Market ratio of IT companies

Company Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
3I Infotech Ltd.	3.95	2.33	0.66	1.67	0.87	0.34	0.28	0.84	0	0
63 Moons Technologies Ltd.	35.85	5.01	1.63	3.54	1.94	1.4	1.24	0.71	0.32	0.13
Accelya Kale Solutions Ltd.	1.76	0.69	0.34	1.09	1.18	1.56	3.56	7.55	10.35	8.39
Aurionpro Solutions Ltd.	4.02	3.23	0.43	2.3	1.22	0.74	0.45	0.96	1.05	0.69
Axiscades Engineering Technologies Ltd.	1.04	2.36	1.25	6.22	5.43	5.37	2.3	1.21	10.42	6.74
Cyient Ltd.	6.52	2.68	0.68	2.52	1.97	1.71	1.61	2.64	3.58	2.84
Datamatics Global Services Ltd.	0.89	0.46	0.3	0.6	0.55	0.48	0.43	0.74	0.95	0.72
Firstsource Solutions Ltd.	3.38	3.04	0.7	1.24	0.84	0.43	0.55	1.2	1.26	1.28
H C L Infosystems Ltd.	4.66	2.53	1.09	1.44	1.07	0.51	0.44	0.46	0.79	0.79
H C L Technologies Ltd.	6.17	3.99	1.7	5.62	5.68	4.95	6.9	6.83	6.67	5.34
Hexaware Technologies Ltd.	3.99	1.26	0.62	1.28	2.09	4.02	2.57	4.59	8.49	6.84
Infosys Ltd.	12.02	6.06	4.26	6.81	7.58	5.45	4.54	4.47	5.3	4.89
K P I T Technologies Ltd.	5.57	2.22	1.16	2.33	2.54	2.29	2.66	2.98	3.54	2.45
Lycos Internet Ltd.	2.4	2.72	0.66	2.86	0.89	1.84	2.01	1.18	2.25	1.51
Mastek Ltd.	3.7	2.65	0.89	2.3	0.86	0.7	0.83	1.34	2.19	1.67
Mindtree Ltd.	7.33	2.37	1.52	3.6	2.03	2.1	3.03	3.35	5.43	4.53
Moser Baer India Ltd.	1.6	1.3	0.53	0.73	0.54	0.27	0.15	0.16	0.18	0.7
Mphasis Ltd.	7.45	4.25	3.07	5.74	2.8	2.39	2.18	2.2	1.98	2.27
N I I T Ltd.	4.42	4.44	0.87	2.42	2.31	1.91	0.71	1.06	0.73	1.61
N I I T Technologies Ltd.	5.85	1.55	1.04	2.11	1.88	2.43	2.23	2.63	2.09	2.65
Nelco Ltd.	12.42	7.6	18.73	15.81	4.14	4.33	4.65	29.41	28.23	48.52
Nucleus Software Exports Ltd.	11.72	3.3	0.8	1.92	1.01	0.68	0.73	1.98	1.4	1.47
Oracle Financial Services Software Ltd.	7.98	2.81	1.77	4.62	3.23	3.83	3.06	3.07	9.22	10.02
Polaris Consulting & Services Ltd.	2.96	1.29	0.64	2.09	2.04	1.54	0.97	1.63	2.78	2.95
R S Software (India) Ltd.	2.4	1.25	0.49	1.15	1.21	1.03	1.39	1.34	2.06	0.98
Ramco Systems Ltd.	1.22	1.15	0.41	0.87	1.01	1.01	1.22	2.39	5.94	3.45
Rolta India Ltd.	2.41	3.11	0.59	1.53	0.97	0.61	0.42	0.6	0.97	0.43
Sasken Technologies Ltd.	3.45	0.68	0.37	0.97	1.02	0.69	0.75	1.1	1.04	1.21
Smartlink Network Systems Ltd.	1.13	1.04	0.78	0.81	1.22	0.26	0.39	0.32	0.46	0.7
Sonata Software Ltd.	3.57	1.69	0.75	2.04	1.43	0.57	0.8	1.45	5.24	4.24
Subex Ltd.	9.01	0.93	0.13	0.84	1.19	0.58	0.44	0.55	0.64	0.7
T V S Electronics Ltd.	1.74	1.08	0.55	1.15	0.91	0.73	0.76	0.72	1.66	4.37
Tanla Solutions Ltd.	3.84	4.6	0.5	0.7	0.27	0.11	0.05	0.07	0.26	0.61
Tata Consultancy Services Ltd.	14.54	7.28	3.96	10.18	11.88	8.19	8.91	9.46	10.98	8.42
Tata Elxsi Ltd.	8.8	4.13	1.69	5.73	4.38	2.94	2.94	7.22	12.73	15.18
Tech Mahindra Ltd.	15.12	6.98	1.72	3.64	2.52	2.44	3.43	4.88	5.37	3.4
Trigyn Technologies Ltd.	0.95	0.7	0.27	0.63	0.63	0.38	0.19	0.5	0.64	1.19
Vakrangee Ltd.	1.97	1.57	0.2	0.78	2.38	3.43	6.85	7.15	5.28	6.79
Wipro Ltd.	9.63	5.38	2.87	5.87	5.51	4.13	3.78	4.56	4.48	3.4
Zensar Technologies Ltd.	3.55	1.3	0.73	2	1.86	1.77	2.06	2.54	3.69	4.4

Source: Calculated and compiled by the authors

5. Conclusions

The present study employs two-stage DEA framework for modeling the operational and stock market performance of select IT companies listed on National Stock Exchange in India. The analysis use data over a 10 year period that is from 2007-08 to 2016-17. The financial data is collected from prowess data base. The empirical results indicate that there is a scope for efficiency improvement in both profitability and stock market performance. Moreover, based on the derived DEA scores, it can be said that the sample companies could be proposed as benchmark firms as every aspect in performance dimensions are very favorable.

An implication of the analysis is that the efficiency measures can allow firm managers to set their own priorities and to seek out improvements along the two performance dimensions: operational efficiency and market efficiency. The findings of the study have practical

implications for shareholders, prospective investors, financial institutions, analysts, regulators and academicians.

References

Abarbanell, S.J., & Bushee, J. B. (1997). Fundamental Analysis, Future Earnings, and Stock Prices. *Journal of Accounting Research, 35*(1).

Ball, R. (1992). The earnings-price anomaly. *Journal of Accounting and Economics, 15,* 319-345.

Banker, R.D., Charnes, A., & Cooper, W.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*(9), 1078-1092.

Beneish, M.D. (1997). Detecting GAAP violation: Implications for assessing earnings management among firms with extreme financial performance. *Journal of Accounting and Public Policy, 16*(3), 271-309.

Bowlin, F. W. (1999). An analysis of the financial performance of defense business segments using data envelopment analysis. *Journal of Accounting and Public Policy, 18*, 287-310.

Byrnes, P., Fare, R., & Grosskopf. (1984). Measuring productive efficiency an application to Illinois strip mines. *Management Science, 23,* 671-681.

Cao, K., & Yang, F. (2011). Measuring the performance of Internet companies using a two-stage data envelopment analysis model. *Enterprise Information System, 5*(2), 207-217.

Charnes, A., Cooper, W.W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2,* 429–444.

Chen, Y, Cook, W.D., Li, N., & Zhu, J. (2009). Additive efficiency decomposition in two-stage DEA. *European Journal of Operation Research, 196*, 1170-1176.

Cook, W.D., Liang, L., & Zhu, J. (2010). Measuring Performance of two-stage network structures by DEA: A review and future perspective. *Omega, 38*, 423-430.

Cristina A, Thore, S.A., & Laffarga, J. (2004). Fundamental Analysis of stocks by Two stage DEA. *Managerial Decision Economics, 25*(5), 231-241.

Edward, I. A. (1968). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *Journal of Banking and Finance,* (1), 29-54.

Halkos, E. G., & Salmouris, S. D. (2004). Efficiency measurement of the Greek commercial banks with the use of financial ratios-- a data envelopment analysis approach. *Management Accounting Review, 15*, 201-224.

Kao, C., & Hwang, S.N. (2008). Efficiency decomposition in two-stage data envelopment analysis: An application to non-life insurance companies in Taiwan. *European Journal of Operational Research, 185*(1), 418–429.

Kim, M., & Kross, W. (2005). The ability of earnings to predict future operating cash flows has been increasing-not decreasing. *Journal of Accounting Research, 43*(5), 753-780.

Kothari, S. P. (2001). Capital market research in accounting. *Journal of Accounting and Economics, 31*, 105–231.

Lin, C., Ma, Y., & Su, D. (2009). Corporate Governance and Firm Efficiency: Evidence from China's publicly listed firms. *Managerial and Decision Economics, 30*, 193-209.

Liu, J.S., & Lu, W.M. (2012). Network-based method for ranking of efficient units in two-stage DEA models. *Journal of the Operational Research Society, 63*, 1153-1164.

Mian, G.M., & Sankaraguruswamy, S. (2012). Investor Sentiment and Stock Market Response to Earnings News. *The Accounting Review, 87*(4).

Premchandra, I.M., Zhu, J., Watson, J., & Galagedera, U.A. Don. (2012). Best-performing US mutual fund families from 1993 to 2008: Evidence from a novel two-stage DEA model for efficiency decomposition. *Journal of Banking and Finance, 36,* 3302-3317.

Sherman, D., & Gold, F. (1990). Bank branch operating efficiency: evaluation with data envelopment analysis approach. *Journal of Banking and Finance, 9,* 297-315.

Smith, P. (1990). Data envelopment analysis applied to financial statements. *Omega, The International Journal of Management Science, 18*(2), 131-138.

Wang, K., Huang, W., Wu, J., & Liu, Y. (2014). Efficiency measures of the Chinese commercial banking system using an additive two-stage DEA. *Omega, 44*, 5-20.

Wanke, P., & Barros, C. (2014). Two Stage DEA: An application to major Brazilian Banks. *Expert Systems with Applications, 41,* 2337-2344.

Copyright Disclaimer