COMPUTER PROJECT REPORT
ON

Computational & Interpretational Aspects Of Data Envelopment Analysis

IN PARTIAL FULFILLMENT OF THE COURSE –COMPUTER PROJECT: BITS C335
UNDER THE GUIDANCE OF Dr. Aswini Kumar Misra

By
Rachit Maheshwari
2009B3A7568G

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to all those who gave me the possibility to work on this topic. I would like to thank Dr .Aswini Kumar Mishra Sir for helping me choose this topic and guiding me throughout the course. I would also like to thank all the researchers who published wonderful papers on the topic, which were used for understanding the topic in more detail.

INTRODUCTION

Theme of the project

Raw data as such is not useful. It needs to be analyzed before it can be used. Data when analyzed properly becomes information which can then be used to improve the present capabilities of the information user .Data analysis tools are used to extract useful information from data. DEA is one such tool.

Data Envelopment Analysis (DEA) is a relatively new “data oriented” approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs) which convert multiple inputs into multiple outputs.

Data envelopment analysis (DEA) is a linear programming methodology to measure the efficiency of multiple decision-making units (DMUs) when the production process presents a structure of multiple inputs and outputs.It has applications in diverse areas including finance and banking, education, and healthcare.

Data envelopment analysis (DEA) is used in performance evaluation and benchmarking under the context of multiple performance measures. DEA uses mathematical programming techniques and models to evaluate the performance of peer units (e.g., bank branches, hospitals and schools) in terms of multiple inputs used and multiple outputs produced. DEA examines the resources available to each unit and monitors the “conversion” of these resources (inputs) into the desired outputs. In particular, DEA is an excellent tool for improving the productivity of service businesses (Sherman and Zhu, 2006).

Objectives:

- To investigate the theory behind schemes, procedures and algorithms used in performing a DEA study.
- To understand the advantages, disadvantages and limitations of DEA method.
- Exploring the various applications of DEA & understanding some of them
- Exploring the various features of commercially available DEA softwares.
- To understand the algorithms & implement them on a user friendly platfor

Basic Definitions

1) **Input:** Set of input factors like labour and capital available to be processed to produce the output.

2) **Output:** Set of output like manufactured cars or cloths line which are the resultant of a process of machinery.

3) **Process:** Those activities, actions, and operations that involve the production and sale of goods and services. This includes the extraction of raw materials and natural resources. This framework element serves as a broad placeholder for all economic processes.

4) **Decision-Making Unit (DMU):** In DEA, the organization under study is called a Decision-Making Unit. Generically a DMU is regarded as the entity responsible for converting inputs into outputs and whose performances are to be evaluated. For example, in managerial applications, DMUs may include banks, department stores and supermarkets, and extend to car makers, hospitals, schools, public libraries and so forth.

DEA ENVELOPMENT MODELS:

The Dea models may be input oriented or output oriented.

Input Oriented:

In the input oriented model the inputs are minimized while the outputs are kept at the current levels

Output Oriented:

In the Output oriented model the outputs are maximized keeping the inputs at the current levels.

Table 1-1. CCR DEA Model

Input-oriented	
Envelopment model	Multiplier model
$\min \theta - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$	$\max z = \sum_{r=1}^{s} \mu_r y_{ro}$
subject to	subject to
$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta x_{io} \quad i = 1,2,\ldots,m;$	$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} \nu_i x_{ij} \leq 0$
$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{ro} \quad r = 1,2,\ldots,s;$	$\sum_{i=1}^{m} \nu_i x_{io} = 1$
$\lambda_j \geq 0 \quad j = 1,2,\ldots,n.$	$\mu_r, \nu_i \geq \varepsilon > 0$
Output-oriented	
Envelopment model	Multiplier model
$\max \phi + \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$	$\min q = \sum_{i=1}^{m} \nu_i x_{io}$
subject to	subject to
$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{io} \quad i = 1,2,\ldots,m;$	$\sum_{i=1}^{m} \nu_i x_{ij} - \sum_{r=1}^{s} \mu_r y_{rj} \geq 0$
$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = \phi y_{ro} \quad r = 1,2,\ldots,s;$	$\sum_{r=1}^{s} \mu_r y_{ro} = 1$
$\lambda_j \geq 0 \quad j = 1,2,\ldots,n.$	$\mu_r, \nu_i \geq \varepsilon > 0$

Figure 1 : Comparing Input & output Oriented models

Sub-Type:

1.Constant Returns To Scale (CRS): The DMU’s are assumed to have constant returns to scale. This model is also known are CCR model.

The basic equations remain the same as in figure1 with $\sum\lambda >= 0$

2.Variable Returns To Scale (VRS):_ The DMU’s are assumed to have variable returns to scale. This model is also known as BCC model.

The basic equations remain the same as in figure1 but with $\sum\lambda = 1$.

3. The Increasing Returns-to-Scale (IRS) Model or the Non Decreasing Returns to scale (NDRS) Model:

The DMU’s are assumed to have increasing returns to scale.

The basic equations remain the same as in figure1 but with $\sum\lambda >= 1$.

4. The Decreasing Returns-to-Scale (DRS) Model or the Non Increasing Returns to scale (NIRS) Model:

The DMU’s are assumed to have decreasing returns to scale.

The basic equations remain the same as in figure1 but with $\sum\lambda <= 1$.

SOFTWARE:

Using The Software:

The software works on Microsoft Office –Excel 2003 and above.

The software requires the SOLVER- ADD IN of excel to be installed & be enabled.

The data to be analyzed is to be copy pasted to sheet-1 of the file dea_beta.xlam

The format of table is <DMU Name>,<All INPUTS>,<ALL OUTPUTS>.

Then click on Run Dea button & choose the appropriate model after entering the number of DMU's , inputs & outputs.

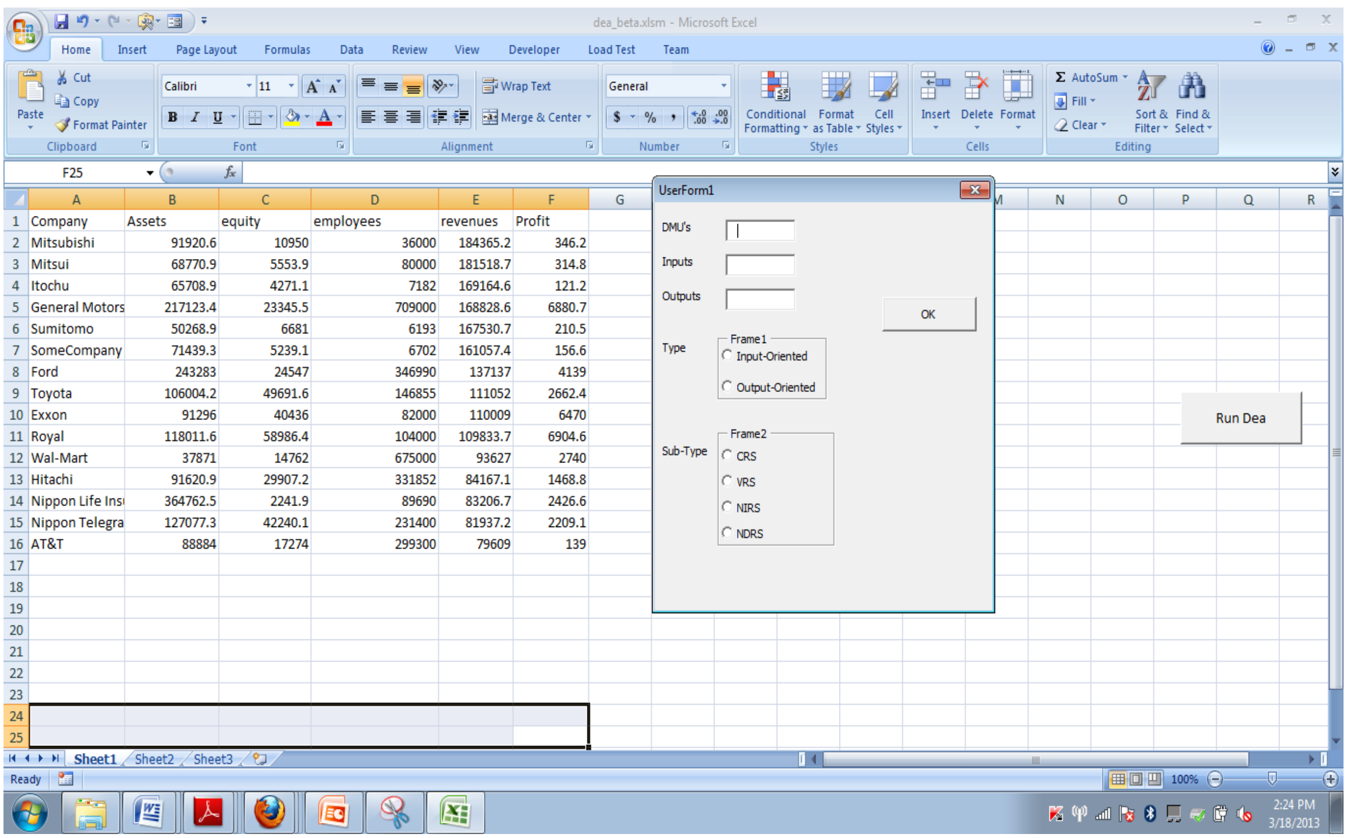
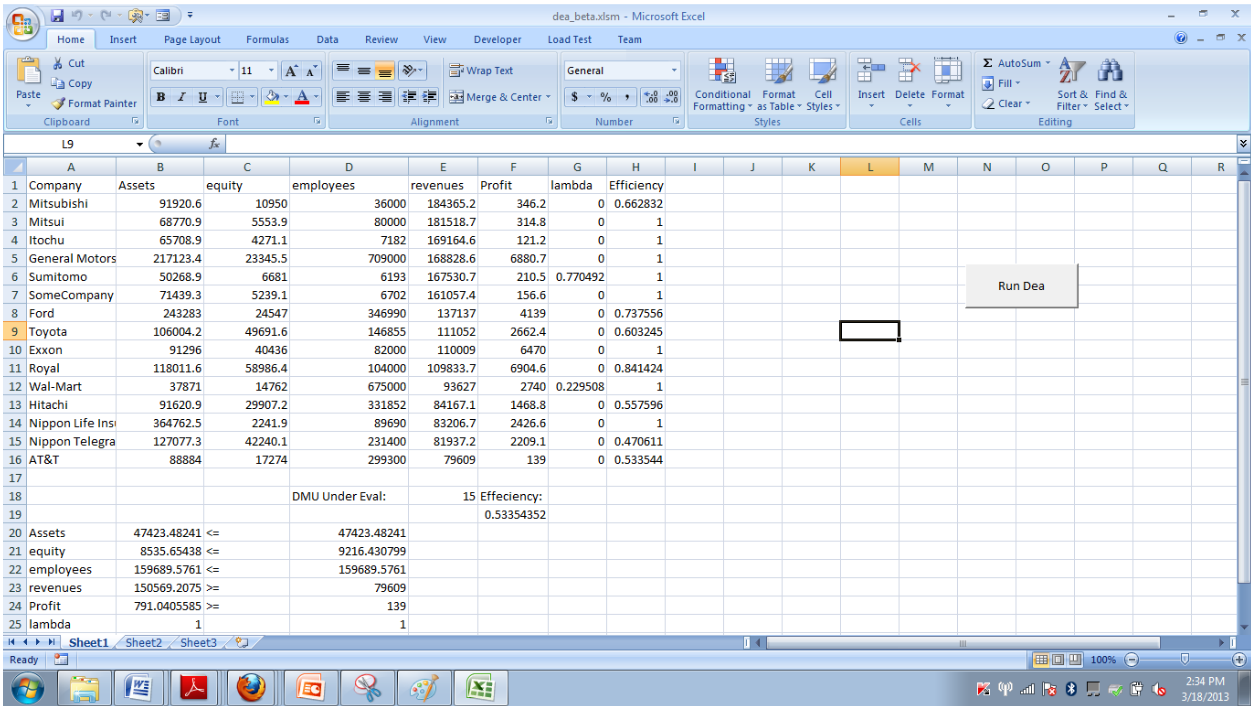


Figure 2: Input format of software

After entering the right & appropriate values in the user form Click OK.

The software macro will run the Solver in the backend for each DMU after generating the appropriate set of equations.

The following result is for Input Oriented –CRS.

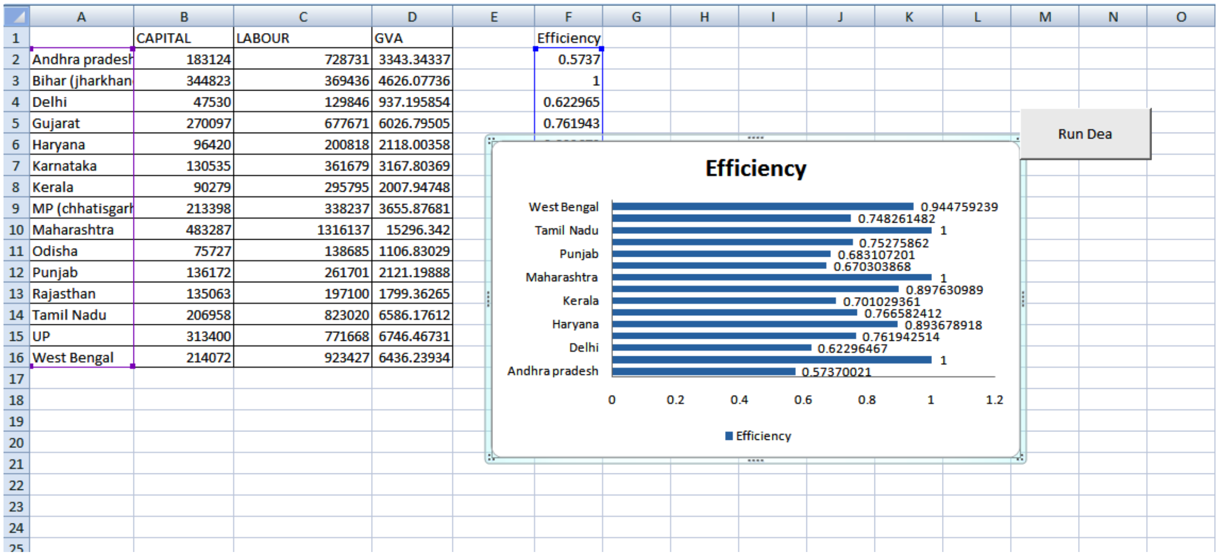


	A	B	C	D	E	F	G	H
1	Company	Assets	equity	employees	revenues	Profit	lambda	Efficiency
2	Mitsubishi	91920.6	10950	36000	184365.2	346.2	0	0.662832
3	Mitsui	68770.9	5553.9	80000	181518.7	314.8	0	1
4	Itochu	65708.9	4271.1	7182	169164.6	121.2	0	1
5	General Motors	217123.4	23345.5	709000	168828.6	6880.7	0	1
6	Sumitomo	50268.9	6681	6193	167530.7	210.5	0.770492	1
7	SomeCompany	71439.3	5239.1	6702	161057.4	156.6	0	1
8	Ford	243283	24547	346990	137137	4139	0	0.737556
9	Toyota	106004.2	49691.6	146855	111052	2662.4	0	0.603245
10	Exxon	91296	40436	82000	110009	6470	0	1
11	Royal	118011.6	58986.4	104000	109833.7	6904.6	0	0.841424
12	Wal-Mart	37871	14762	675000	93627	2740	0.229508	1
13	Hitachi	91620.9	29907.2	331852	84167.1	1468.8	0	0.557596
14	Nippon Life Insu	364762.5	2241.9	89690	83206.7	2426.6	0	1
15	Nippon Telegra	127077.3	42240.1	231400	81937.2	2209.1	0	0.470611
16	AT&T	88884	17274	299300	79609	139	0	0.533544
17								
18				DMU Under Eval:	15	Effeciency:		
19						0.53354352		
20	Assets	47423.48241	<=	47423.48241				
21	equity	8535.65438	<=	9216.430799				
22	employees	159689.5761	<=	159689.5761				
23	revenues	150569.2075	>=	79609				
24	Profit	791.0405585	>=	139				
25	lambda	1		1				

Figure 3 : Input Oriented CRS

Incorporation of Graphs in the Analysis Software

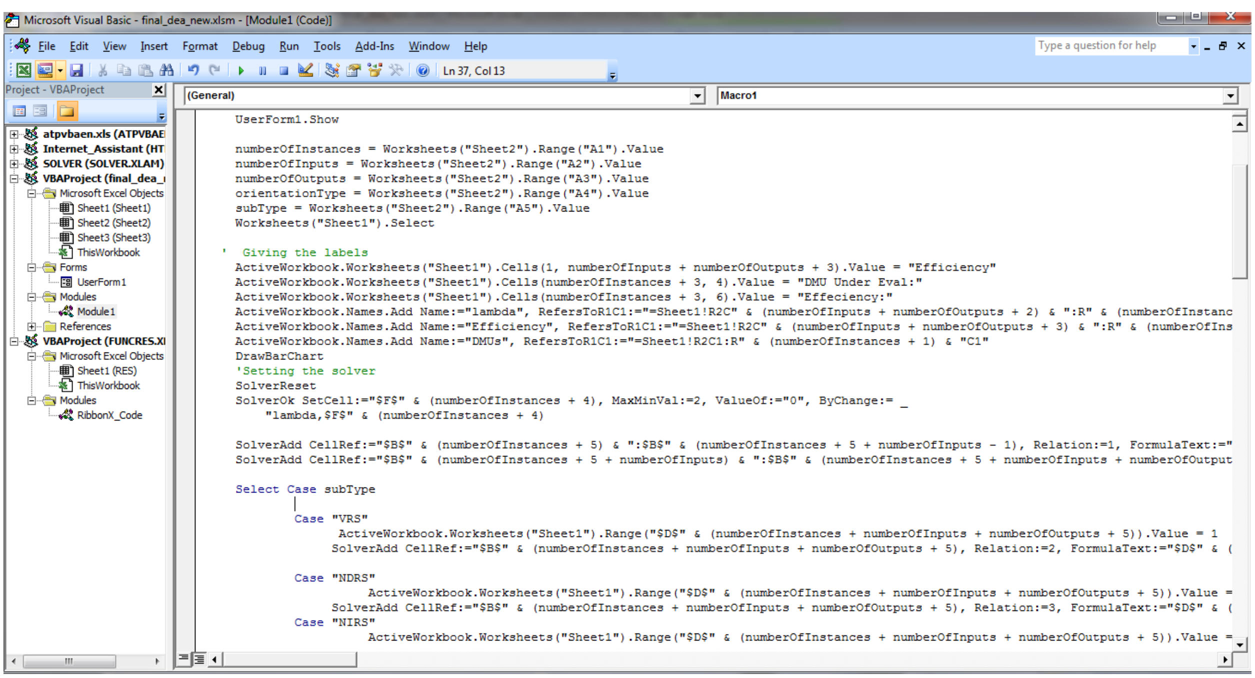
Automated Excel generated Graphs of Efficiency will also appear along with the results



	CAPITAL	LABOUR	GVA		Efficiency
Andhra pradesh	183124	728731	3343.34337		0.5737
Bihar (jharkhan	344823	369436	4626.07736		1
Delhi	47530	129846	937.195854		0.622965
Gujarat	270097	677671	6026.79505		0.761943
Haryana	96420	200818	2118.00358		
Karnataka	130535	361679	3167.80369		
Kerala	90279	295795	2007.94748		
MP (chhatisgarh	213398	338237	3655.87681		
Maharashtra	483287	1316137	15296.342		
Odisha	75727	138685	1106.83029		
Punjab	136172	261701	2121.19888		
Rajasthan	135063	197100	1799.36265		
Tamil Nadu	206958	823020	6586.17612		
UP	313400	771668	6746.46731		
West Bengal	214072	923427	6436.23934		

Figure 4 : Efficiency Graphs

Snapshot of The Excel Macro-VBA code Running behind the scene



```
UserForm1.Show

numberOfInstances = Worksheets("Sheet2").Range("A1").Value
numberOfInputs = Worksheets("Sheet2").Range("A2").Value
numberOfOutputs = Worksheets("Sheet2").Range("A3").Value
orientationType = Worksheets("Sheet2").Range("A4").Value
subType = Worksheets("Sheet2").Range("A5").Value
Worksheets("Sheet1").Select

'  Giving the labels
ActiveWorkbook.Worksheets("Sheet1").Cells(1, numberOfInputs + numberOfOutputs + 3).Value = "Efficiency"
ActiveWorkbook.Worksheets("Sheet1").Cells(numberOfInstances + 3, 4).Value = "DMU Under Eval:"
ActiveWorkbook.Worksheets("Sheet1").Cells(numberOfInstances + 3, 6).Value = "Effeciency:"
ActiveWorkbook.Names.Add Name:="lambda", RefersToR1C1:="=Sheet1!R2C" & (numberOfInputs + numberOfOutputs + 2) & ":R" & (numberOfInstanc
ActiveWorkbook.Names.Add Name:="Efficiency", RefersToR1C1:="=Sheet1!R2C" & (numberOfInputs + numberOfOutputs + 3) & ":R" & (numberOfIns
ActiveWorkbook.Names.Add Name:="DMUs", RefersToR1C1:="=Sheet1!R2C1:R" & (numberOfInstances + 1) & "C1"
DrawBarChart
'Setting the solver
SolverReset
SolverOk SetCell:="$F$" & (numberOfInstances + 4), MaxMinVal:=2, ValueOf:="0", ByChange:= _
    "lambda,$F$" & (numberOfInstances + 4)

SolverAdd CellRef:="$B$" & (numberOfInstances + 5) & ":$B$" & (numberOfInstances + 5 + numberOfInputs - 1), Relation:=1, FormulaText:="
SolverAdd CellRef:="$B$" & (numberOfInstances + 5 + numberOfInputs) & ":$B$" & (numberOfInstances + 5 + numberOfInputs + numberOfOutput

Select Case subType

        Case "VRS"
              ActiveWorkbook.Worksheets("Sheet1").Range("$D$" & (numberOfInstances + numberOfInputs + numberOfOutputs + 5)).Value = 1
             SolverAdd CellRef:="$B$" & (numberOfInstances + numberOfInputs + numberOfOutputs + 5), Relation:=2, FormulaText:="$D$" & (

        Case "NDRS"
                  ActiveWorkbook.Worksheets("Sheet1").Range("$D$" & (numberOfInstances + numberOfInputs + numberOfOutputs + 5)).Value =
             SolverAdd CellRef:="$B$" & (numberOfInstances + numberOfInputs + numberOfOutputs + 5), Relation:=3, FormulaText:="$D$" & (
        Case "NIRS"
                  ActiveWorkbook.Worksheets("Sheet1").Range("$D$" & (numberOfInstances + numberOfInputs + numberOfOutputs + 5)).Value =
```

Figure 5: Excel VBA Editor