

Content

Introduction	1
Chapter 1. Efficiency and Productivity - general issues	7
1.1. Efficiency and productivity - general concepts. Technical productive efficiency	7
1.2. Inputs and outputs in the production process	9
1.3. Specific concepts used to measure efficiency.....	10
1.4. Border production function	15
1.4.1. Production boundary obtained by enveloping	15
1.4.2. Effective frontier achieved by enveloping	16
1.5. Methods of measuring a company performance (decision units) - methods and techniques for assessing technical productive efficiency	17
1.5.1. Measuring the efficiency of a firm's business (decision-making units)	17
1.5.2. Methods of measuring a company's performance (decision units)	18
1.5.3. Methods and techniques for assessing productive technical efficiency at the level of a firm (decision units)	20
1.6. Indicative method as a nonparametric method of efficiency analysis	21
1.7. Productivity Measurement at Firm Level (Decision Unit) using the Malmquist indices	22
1.7.1. General features	22
1.7.2. Malmquist indices in the Output Approach	22
1.7.3. Malmquist indices in the input-oriented approach	28
Chapter 2. Econometric Techniques for Efficiency Analysis. Frontier of stochastic production	29
2.1. Defining the production process	29
2.2. Production technologies at the level of a firm (decision units)	30
2.3. The optimal technological scale. The elasticity of the scale at the level of a firm (decision units)	32
2.4. Deterministic Production Border	35
2.4.1. Formulation of the deterministic general model	35
2.4.2. Steps of solving the deterministic model	36
2.5. Stochastic production frontier	36
2.5.1. Formulation of the general stochastic model	36
2.5.2. Stages of Stochastic Model Solving	37
Chapter 3. Non-parametric techniques for measuring the technical efficiency productive (Data Envelopment Analysis - DEA)	39
3.1. General aspects of Data Envelopment Analysis - DEA	41
3.2. Role of enveloping surfaces (winding) in determining the border of efficiency	41
3.3. DEA, CRS versus VRS model - general issues	43

3.4. Managerial efficiency using DEA	47
3.5. Efficiency at scale at firm level (decision unit)	49
3.6. Formulation of the Basic Model, Data Envelopment Analysis - DEA	51
3.7. Scale efficiency in Data Envelopment Analysis - DEA models	53
Chapter 4. The theoretical methodological framework based on research on the DEA technique	56
4.1. Standard specification of DEA models, nonlinear form, with data explicit / exactly	56
4.2. DEA deterministic model, case VRS vs. CRS, linear form, with explicit / accurate data	59
4.2.1. DEA deterministic model, linear VRS form - general presentation	59
4.2.2. DEA deterministic model, VRS case, linear, oriented form to inputs	64
4.2.3. DEA deterministic model, VRS case, linear, oriented form to outputs	65
4.2.4. DEA deterministic model, linear form, CRS case	66
4.3. DEA deterministic model with interval data	68
4.3.1. General Aspects	68
4.3.2. Presentation of DEA deterministic model with data in form of interval	69
4.3.3. Illustrative example of DEA model with interval data	71
4.4. Stochastic model DEA, case of VRS vs. CRS	73
4.4.1. Introduction to the DEA Stochastic	73
4.4.2. Stochastic model DEA, VRS case, output oriented	75
4.4.3. DEA stochastic model oriented to inputs	76
4.4.3.1. Model hypotheses	76
4.4.3.2. Formulation of the DEA stochastic model, oriented towards inputs	77
4.4.3.3. DEA stochastic model analysis, input oriented	78
4.4.3.4. The algorithm corresponding to the DEA stochastic model, oriented to inputs	80
4.4.3.5. Illustrative Example	82
4.4.4. Conclusions and future approaches	86
4.5. The fuzzy DEA (FDEA) model, the CCR vs. BCC case	87
4.5.1. General Aspects	87
4.5.2. DEA models and fuzzy sets theory	88
4.5.3. DEA models and fuzzy weights	92
4.5.4. Steps to solving CCR model with fuzzy weights	97
4.5.5. Illustrative example of the DEA fuzzy model (FDEA)	99
4.5.6. Preliminary conclusions	102
4.6. Dynamic modeling using the DEA technique	102
4.6.1. General Aspects	102
4.6.2. Formulation of DEA dynamic model, a efficiency	103
4.6.3. Dynamic DEA modeling of efficiency analysis environment	108

Chapter 5. Practical methodological framework based on research on the DEA technique	111
5.1. The practical foundations of the application of the DEA technique. Stages of application a DEA model	111
5.2. Technological scheme of proposed practical research	112
5.3. Selection of input and output variables	114
5.4. Troubleshooting in Input Data	116
5.5. Assessing the influence of disturbing factors	117
5.6. Formulation of the DEA model	117
5.7. Detecting extreme (aberrant) values	118
5.8. Using Software in Estimating Efficiency and Productivity	118
5.8.1. Using DEAP2.1 in Nonparametric Approach	119
5.8.2. Using FRONTIER4.1 in the Parametric Approach	120
Chapter 6. Empirical Data Envelopment Analysis - DEA, with practical emphasis on the role of nonparametric technique in measuring performance at institution / organization / company	121
6.1. General considerations	121
6.2. Objectives, fields of application and working hypotheses	121
6.3. Use of nonparametric Data Envelopment Analysis - DEA, to measure productive technical efficiency at the level of one lot of companies / subunits in the banking system	122
6.3.1. Empirical analysis based on DEA CRS models	123
6.3.2. Empirical analysis based on DEA models of VRS type	125
6.3.2.1. Empirical analysis based on the DEA model of the VRS type, oriented towards inputs	125
6.3.2.2. Empirical analysis based on the DEA model of the VRS type, output-oriented	127
6.4. Use of nonparametric Data Envelopment Analysis - DEA, to measure productive technical efficiency and productivity	

lot of companies credited through the banking system	129
6.4.1. Description of data	129
6.4.2. Nonparametric approach, specific to DEA models	130
6.4.2.1. DEA CRS models, oriented to inputs or outputs	130
6.4.2.2. DEA VRS models, oriented to inputs or outputs	133
6.4.3. Malmquist Productivity Analysis	139
6.4.4. Parametric approach, SFA stochastic boundary	141
6.4.4.1. Production function Cobb - Douglas	142
6.4.4.2. Translog production function	144
6.5. Using Data Envelopment Analysis techniques - DEA, in the version Variable Return Variable - VRS, to measure unit efficiency of higher education in Romania	147
6.5.1. General considerations	148
6.5.2. Specific methodology used	149
6.5.3. Results and Discussion - Analysis of Educational Efficiency	150
6.5.4. Preliminary conclusions	154
6.6. Using Data Envelopment Analysis techniques - DEA, in the version constant return to scale - CRS, to measure unit efficiency of higher education in Romania	154
6.6.1. General considerations	154
6.6.2. Specific methodology used	155
6.6.3. Results and Discussion - Analysis of Educational Efficiency	156
6.6.4. Preliminary conclusions	160
Conclusions, implications and recommendations	161
Bibliography	174
Annexes	181

Annex A1. Entry data for inputs and outputs at the level of 27

decision units for the years 2016 and 2017	181
Annex A2. Inputs and outputs, at the level of the 27 decision units, for year 2017	183
Annex A3. CRS efficiency scores in input orientation for year 2016	184
Annex A4. CRS and VRS performance scores, with output orientation, for the year 2017	185
Annex A5. Efficiency of DEA targeted, corresponding to year 2017	186
Annex A6. Reference firms and output weights at the level of 2017	187
Annex A7. Matrix with input data for inputs and outputs, at the level of the 27 decision-making units for the years 2016 and 2017	189
Annex A8. Efficiency relative to 2016 technology in output orientation	190
Annex A9. Efficiency relative to 2017 technology in output orientation	191
Annex A10. OLS, COLS, and MLE estimates for Cobb-Douglas in 2016	192
Annex A11. OLS, COLS, and MLE estimates for Cobb-Douglas in 2017	193
Annex A12. Efficiency scores for the Cobb-Douglas model in 2016 and 2017 respectively	194
Annex A13. OLS, COLS, and MLE estimates for the translog function in year 2017	195
Annex A14. Efficiency scores for SFA CD, SFA TL and DEA, corresponding to year 2017.....	197
Annex A15. Comparisons between the DEA and SFA Cobb-Douglas models, corresponding to 2017	198
Annex A16. Data on the activity of 49 state universities from Romania	199

keywords : efficiency, productivity, data envelopment analysis, CRS model, VRS model.

METHODS OF MEASURING EFFICIENCY WITH APPLICATIONS IN ECONOMY

The paper is structured in 6 chapters, namely:

Chapter 1 Efficiency and Productivity - General Issues, show essential issues regarding efficiency and productivity - general concepts, productive technical efficiency, inputs and outputs in the production process, specific concepts used in measuring efficiency, production border function, methods (decision makers) - methods and techniques for evaluating productive technical efficiency, index method, as a nonparametric method of efficiency analysis, measuring productivity at firm level (decision-making unit) using the Malmquist indexes.

Chapter 2 Econometric Techniques for Efficiency Analysis. The stochastic production frontier presents important aspects in defining the production process, production technologies at the level of a firm (decision units), the optimal technological scale, the elasticity of the scale at the level of a firm (decision units), the deterministic production boundary, the frontier of stochastic production.

Chapter 3 Non-parametric Techniques for Data Envelopment Analysis (DEA), presents aspects related to Data Envelopment Analysis (DEA), the role of enveloping surfaces (winding) in determining the efficiency boundary, DEA model, CRS versus VRS - general aspects, managerial efficiency using DEA technique, scale-level efficiency at the firm level (unit of decision), formulation of the basic model, Data Envelopment Analysis - DEA, scale efficiency in Data Envelopment Analysis - DEA .

Chapter 4 The DEA-based theoretical methodological framework presents important issues regarding the standard specification of DEA models, nonlinear form, explicit / exact data, DEA deterministic model, VRS vs. CRS case, linear form, explicit data, DEA deterministic model with interval data, DEA stochasis model, VRS versus CRS case, DEA fuzzy model (FDEA), CCR versus BCC case, dynamic modeling using DEA technique.

Chapter 5 The practical methodological research framework, based on the DEA technique, presents essential aspects related to the selection of input and output variables, the correction of errors in the input data, the evaluation of the influence of the disturbing factors, the

DEA model formulation, the detection of extreme values (aberrant) of software products in estimating efficiency and productivity.

Chapter 6 Empirical Analysis Data Envelopment Analysis - DEA, with practical emphasis on the role of nonparametric technique in measuring performance at institution / organization / firm level, presents important aspects in terms of objectives, areas of application and working hypotheses, use of nonparametric technique Date Envelopment Analysis - DEA, for the measurement of productive technical efficiency, at the level of a group of companies in the banking system, the use of Data Envelopment Analysis (DEA) techniques in Variable Return Variable (VRS) for measuring the efficiency of Romanian higher education institutions , the use of Data Envelopment Analysis (DEA) techniques in CRS, to measure the efficiency of Romanian higher education institutions.

The paper concludes with Conclusions, implications and recommendations, Bibliographic references and Appendices.