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A Hybrid Model Based on Neural Network and Data Envelopment Analysis Model for Evaluation of Unit Performance

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Abstract

Efficiency and evaluation is one of the main and most important demands of organizations, companies and institutions. As these organizations deal with a large amount of data, therefore, it is necessary to evaluate them on the basis of scientific methods to improve their efficiency. Data envelopment analysis is a suitable method for measuring the efficiency and performance of organizations. This paper has been conducted to evaluate the performance and efficiency of decision making units. First, using the data envelopment analysis, the BCC output oriented model, these units are ranked and the shortcoming of the model in terms of efficacy measurement and separation are determined. Then, to overcome such problems, a combined method of data envelopment analysis; the BCC output oriented model and artificial neural network are used to evaluate the efficiency of these units and finally the results of the two models are compared. Given the efficiency obtained with the BCC output oriented method, it was observed that the amount of efficiency for some units which leads for these units not to be ranked but using the proposed NEURO-DEA method, no two units have the same efficiency and given the obtained efficiency, these units can be evaluated and ranked.

Keywords:
Efficiency
Performance evaluation
Data Envelopment Analysis
Artificial Neural Network (ANNS) BCC Output Oriented model

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INTRODUCTION

Data Envelopment Analysis is one of the most common methods used to measure the efficiency and productivity of decision-making units. Also, over the last decade, it has been widely regarded as a management tool and widely used to evaluate the performance of public and private sectors and organizations such as banks, hospitals and universities. Then, in practice we deal with a very large scale data sets. This method requires large amounts of computer resources for such sets in terms of processing memory and time. In data envelopment analysis, the under study units are divided into two effective and non-effective groups. Effective units are those whose efficiency scores are equal to one. Non-effective units are those whose score is less than one. Efficient units cannot be categorized using classical data envelopment analysis models because their scores equal to one.

Obviously, the ranking of effective units for determining the most efficient units is of much importance. Therefore, in this paper, a combination of data envelopment analysis and neural network is used to solve these problems. Artificial neural networks are large sets of parallel processes able to solve nonlinear problems and even complex relationships by units called neuron. By receiving input patterns, artificial neural networks are able to extract their specifications and assign a specific group to them.Thus, during the training process, they remember the characteristics of the patterns and groups in question by matching a series of weight coefficients. If the training is implemented correctly, they are able to categorize the patterns. Data envelopment analysis is a technique used by mathematical programming model to evaluate the efficiency of decision-making units with multiple inputs and outputs.

Charens, Cooper, Rhodes in 1978 presented a model able to measure the efficiency with multiple inputs -outputs. This model was named "Data Envelopment Analysis". This model was named to the its Inventors names (CCR) (Charnse et al., 1978).

In 1984, Bunker et al. developed the concepts and models of data envelopment analysis and presented BCC model to measure the efficiency without assuming a return to scale constant (Banker et al., 1984). Yu and Lin presented a paper titled "the efficiency of Railway Performance using a multi-agent network data envelopment analysis model" (yu & lin, 2008). In 2000, neural networks were used to estimate the cost functions and in 2004, Santin used neural network to simulate nonlinear production function. Also, he compared the results with more commonly used methods such as random boundaries and data envelopment analysis with different observations and disturbances and showed that neural networks are more stable compared to the above-mentioned methods (Santin et al., 2004).

In this paper, a combined algorithm using neural network and data envelopment analysis; the BCC output oriented model is presented that by training a feed forward neural network, it reduces the processing time and memory to the extent required by the conventional methods in data envelopment analysis. It also reduces the computational volume and improves and facilitates the computation of the efficiency of large datasets. Therefore, this method can be a useful tool in measuring the efficiency of a large data sets. This paper is comprised of three sections. The first section describes the data envelopment analysis and its models. In the second section, the neural network is presented and in the third section, the proposed method and the applied example of the proposed method are presented.

DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) includes techniques and methods to evaluate the efficiency or measuring the efficiency of decision-making units. This technique is in fact the generalization of Farrel's work in devising the first nonparametric method. With the inputs and outputs of the decision-making units and the principles governing them, Farrell introduced a set titled “production possibility set” and a part of the boundary was named as production function. This boundary has been called efficient frontier and the decision-making units on this frontier have been evaluated efficiently (Farrell ,1957). As DEA is a technique to evaluate the relative efficiency of decision-making units, at least one unit is on the frontier and the rest are below it. The name of the data envelopment analysis has been derived from envelopment.

In general, data envelopment analysis models are divided into two input oriented and output oriented groups. Input oriented models without changing the outputs use less inputs to obtain the same output value and output oriented models are units which without changing the input, yield more output. Data envelopment analysis provides facilities for studying the units with multiple inputs and outputs. Data envelopment analysis model is based on linear algebra and its ability is mostly due to linear programming. Linear programming enables data envelopment analysis to use linear programming methods and duality theorem and so solve the linear programming problems and specify the sources and amounts of inefficiency for each input and output.

CCR model

The first model of data envelopment analysis; the CCR model, was introduced by Charles, Cooper and Rhodes in 1978 aimed to measure and compare the relative efficiency of organizational units with multiple inputs and outputs similar to each other. In measuring the relative efficiency of the units, Farrell focused on the weighted sum of units and suggested Eq.1 as follow as a tool for measuring the technical efficiency.

$$\text{Efficiency} = \frac{\textbf{weighted sum of outputs}}{\textbf{weighted sum of inputs}} \quad (1)$$

If the goal is to examine the technical efficiency of n units, each with m inputs and s outputs, the relative efficiency of j^{th} unit (j = 1, 2..., n) is calculated using Eq. 2:

$$\text{Efficiency of Jth} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \quad (2)$$

The variables in (2) are defined as follow:

X_{ij}:The input value of i^{th} for the jth unit (j = 1,2, ..., n)

Y_{rj}:The output value of r^{th} for the jth unit (j = 1, 2,..., n)

U_r: the weight assigned to j^{th} output (j = 1, 2,..., n)

V_i: the weight assigned to j^{th} input (j = 1, 2,…., n)

If the goal is to evaluate the relative efficiency of under study units which are called zero units or decision-making units, this unit consumes inputs (x_{1o} .x_{2o} …..x_{mo})to generate generate outputs(y_{1o} .y_{2o} …..y_{so}).

If the weights assigned to the outputs (or output prices) are shown by (u_1.u_2…..u_s) and the weights assigned to the inputs are shown by(v_1.v_2…..v_m), then $\frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$ should be maximized. This method should also be implemented for other units.

BCC model

By changing CCR model, Bancar, Charnes and Cooper introduced a new model which based on the first letters of their first names, became known as BCC model. This model is a type of data envelopment analysis model that evaluates the relative efficiency of units with variable returns to scale (Banker et al., 1984).

BCC multiplier model

The output oriented BCC multiplier model is as follows:

$$\begin{aligned} &Max\ \ \varphi \\ &s.t. \\ &\quad \sum_{j=1}^{n} \lambda_j X_j \le \varphi X_p \\ &\quad \sum_{j=1}^{n} \lambda_j Y_j \ge \varphi Y_p \\ &\quad \sum_{j=1}^{n} \lambda_j = 1 \\ &\quad \lambda_j \ge 0 \end{aligned} \quad (3)$$

ARTIFICIAL NEURAL NETWORK

Artificial Neural Networks (ANNs) are mathematical models that imitate human brain functions and their ability to extract patterns in observed data does not need assumptions about the relationships between variables. In the neural network, Neuron is the smallest information processing unit and is the basis of the neural network function. The dramatic expansion of the use of neural networks in various fields of science and knowledge reflects the high value of this powerful technique in complex computations and the reason for the continuance of research for their development. With the evolution of the biological recognition of the brain and its related nervous systems and also due to the rapid progress of computer science, neural network technology has evolved over the past years in a remarkable evolution.

Multilayer Perceptron Neural Network

One of the simplest and most efficient layouts proposed to use in modeling real nerves is multilayered perceptron model. This network includes one input layer and one output layer (containing input and output neurons) and one or more hidden layers (including hidden neurons). The number of neurons in input and output layers depends on the type of problem while the number of neurons in the hidden layers is arbitrary and will be computed with the test and error. In this type of network, the connection is only from component i to component i + 1 and does not exist in the opposite direction. The above network is practically created by the integration of three single-layer perceptron networks. One is the output layer and the other two are called intermediate layers. The outputs of the first layer form the input vector of the second layer and the output vector of the second layer forms the third layer inputs and the third layer outputs form the real network response. In other words, the process of signaling in the network is made in a forward path (from left to right from a layer to another layer). Each layer can have a number of different neurons with different conversion functions. That is, models of neurons in layers can be considered differently.

HISTORY OF DATA ENVELOPMENT ANALYSIS AND ARTIFICIAL NEURAL NETWORKS

In that study, it was tried that by improving and accelerating the process of that algorithm, the computational volume is greatly reduced and the efficiency of the large data set is facilitated (Emrouznejad & Shale, 2009).In a paper titled "ranking of bank branches using undesirable and fuzzy Data: An approach based on DEA", a method based on data envelopment analysis was introduced for evaluating and ranking the decision-making units where undesirable measurements existed (Kord rostami et al., 2016). in a paper titled "the efficiency of Eghtesad e Novin Bank branches", with a combination of neural network and data envelopment analysis as two nonparametric methods, they dealt with the efficiency evaluation of Eghtesad e Novin Bank branches (Mehrabian et al., 2011). In a paper titled " an integrated data envelopment analysis-artificial neural network-rough set algorithm for assessment of personnel efficiency " the impact of personnel specifications on total efficiency has been investigated. In this paper, the proposed algorithm assesses the impact of personnel efficiency attributes on total efficiency through data envelopment analysis, artificial neural network and rough set theory (Azadeh et al., 2011).

In a paper titled " application of DEA-ANN for best performance modeling", DEA and ANN are combined to tale advantages of optimization and prediction capabilities inherent in each method. This paper aimed to present a complementary model approach using data envelopment analysis (DEA) and artificial neural network (ANN) as an adaptive decision support tool in promoting best performance benchmarking and performance modeling (Kwon et al., 2009).In a paper titled " bank efficiency evaluation using a neural network - DEA method ", RBFN with the k-means clustering method for the efficiency evaluation of a large set of branches for an iranian bank has been presented it was shown that using tje hybrid learning method, the weights of the neural network are convergent (Aslani et al., 2009). A combined algorithm using the feed forward neural network and data envelopment analysis was presented by (Emroznejad & Shale, 2009) which was highly effective in evaluating the efficiency of large datasets as well as calculations saving. In Fig. 1 the structure of the feed forward neural network and the data envelopment analysis are shown.

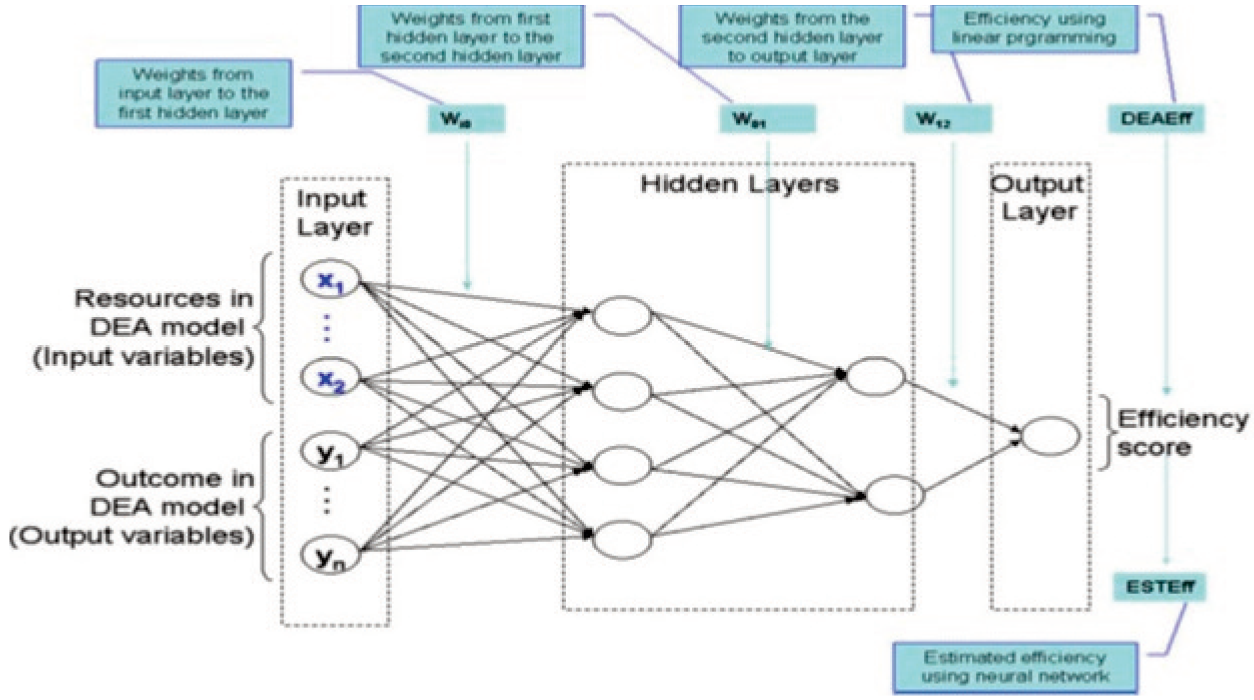

Fig. 1. the structure of feed forward neural network to estimate the efficiency (Emroznejad & Shale, 2009)

As can be seen, the network inputs correspond to those indexes that can be used to measure the efficiency of each unit in DEA and the network outputs correspond to the amount to be predicted (that is, the same amount of efficiency in DEA).

Network inputs simultaneously make the first layer of the network and the weighted outputs from the first layer make the make the second layer. Thus, the weighted outputs of the second layer (the first intermediate layer) make the input layer. Note that the number of intermediate layers is optional, but in practice, usually only one or maximum of three layers are used. In this way, the input of the output layer (the last layer) is composed of the output of the last intermediate layer and after multiplying the related weights and applying the transfer function, the final output of the network is obtained. The multi-layer network shown in Fig. 1 has two intermediate layers and one output layer, which is generally referred to as a three-layer neural network. This network is a feed forward network where no inputs or outputs of any of the layers are returned and is also fully interconnected in a way that in each layer, all the neurons are connected together. In this way, it is shown that a multilayer feed forward neural network with a sufficient number of intermediate layers can accurately measure the efficiency of each unit (Zandi & Toloo, 2013).

PROPOSED METHOD

We in this paper calculate the amount of efficiency for 447 DMU and given such obtained efficiency, we rank and evaluate these DMUs and determine the efficient one. Each of these units has two inputs and three outputs. The inputs include the number of personnel, the profit payable and the outputs include the long- term deposits, the short- term deposits and interest –free deposits. First for each DMU, using the data envelopment analysis, the BCC output oriented model and using the GAMS software, we calculate the amount of efficiency for each unit.in table Appendix, the efficiency is obtained and given the table Appendix and the column of Real Efficiency of BCC, it is observed that in BCC output oriented model, some units have the same efficiency equals to one. therefore, these method of data envelopment analysis can't be used to rank and evaluate the efficiency of units and to solve this problem, a combined method of DEA-ANN; The BCC output oriented model is presented. To obtain the efficiency of the proposed method, the following steps are implemented:

We consider the output of this model (BCC output oriented) along with the input and output of each of these DMus as inputs for the proposed method (Neuro-DEA) and using GAMS, we calculate the output for each unit and these outputs for each unit is proposed as the efficiency for the proposed method. Finally, given the obtained efficiency, these units are ranked and efficient and non-efficient units are determined. The table in appendix presents the experimental (efficiency) results obtained from BCC output oriented method and the proposed method.

The table Appendix and table 1, it is observed that some of the efficiency obtained from the proposed method are more than one. As in NEURO-DEA method and given the amounts of inputs and outputs and artificial network, the efficiency is obtained, so there is no constraint for the efficiency to be less than one and it may be that for some outputs of this model be bigger than one.

In below Section we can observe the steps in the proposed method.

Applied example of the proposed method

In the study of real systems for measuring the efficiency, the first step is to determine the inputs and outputs in a way that reflect the efficiency of the decision-making units. The case study of this research is on 447 decision making units.

In the efficiency analysis of these DMUs, determining the inputs and outputs is of particular importance. In this paper, the input data consists of two inputs and three outputs for each unit. However, according to the opinion of managers and officials of these units, other criteria can be considered as inputs and outputs. The inputs include the number of personnel and the interest payable and the outputs include long-term deposits, short-term deposits and deposits in Qarz al-Hassaneh.

Given the nature of inputs and as is clear, the lower the number of personnel and the lower the interest payable, the more interest for each unit. On the other hand, the more long-term deposits, short-term deposits and deposits of Qarz al-Hassaneh at that time, the more profit and return for that unit.

In other words, the lower the input criteria and the more the outputs criteria, the better it will be. This research involves two approaches that each will be further discussed in details.

The first approach: After normalizing the data and using the GAMS software, we measure the efficiency of 447 units by data envelopment analysis (output-oriented BCC model) and the calculated output is actually the efficiency of these units with the DEA (Output oriented BCC)

The second approach: After measuring the real efficiency using the BCC output oriented Model, using the proposed method, a multi-layer feed forward network is used. The inputs of this model which include the number of personnel and the interest payable and outputs which include long-term deposits, short-term deposits and deposits in Qarz al-Hassaneh along with the output of BCC output oriented model as another input of the proposed method is given to MATLAB software to compute the efficiency of this method. Then we evaluate and rank these units using the efficiency of the proposed method. Table 1 presents the results of the efficiency obtained from the data envelopment analysis; the output oriented BCC model and proposed method.

Table 1: Ranking of 24 top DMU with two methods of DEA and proposed method

Efficiency with DEA	DMU	Row	Efficiency of proposed method	DMU	Row
1	DMU 10	1	1.260042775	DMU 309	1
1	DMU 25	2	1.217216628	DMU 404	2
1	DMU 26	3	1.076523007	DMU 301	3
1	DMU 43	4	1.076499847	DMU 230	4
1	DMU 62	5	1.051696864	DMU 43	5
1	DMU 65	6	1.043601594	DMU 178	6
1	DMU 73	7	1.040619975	DMU 350	7
1	DMU 74	8	1.036208719	DMU 193	8
1	DMU 91	9	1.031000891	DMU 419	9
1	DMU 99	10	1.029908836	DMU 26	10
1	DMU 150	11	1.026438301	DMU 300	11
1	DMU 183	12	1.012009218	DMU 326	12
1	DMU 200	13	0.997660667	DMU 225	13
1	DMU 225	14	0.964907304	DMU 10	14
1	DMU 230	15	0.96355883	DMU 378	15
1	DMU 300	16	0.960008903	DMU 334	16
1	DMU 301	17	0.927091898	DMU 305	17
1	DMU 324	18	0.923879516	DMU 324	18
1	DMU 326	19	0.919300346	DMU 223	19
1	DMU 328	20	0.915391224	DMU 411	20
1	DMU 333	21	0.912271355	DMU 68	21
1	DMU 350	22	0.891956598	DMU 91	22
1	DMU 400	23	0.891187106	DMU 254	23
1	DMU 404	24	0.889119524	DMU 401	24

As is clear from the results, in terms of the efficiency obtained by the DEA method, 24 units have a value equal to one and this is a shortcoming of the BCC model while using the proposed Neuro-DEA method, none of the two units has the same efficiency and can be easily ranked.As can be seen, using the efficiency obtained from the data envelopment analysis; the output oriented BCC model, these units cannot be evaluated and ranked accurately which is one of the weaknesses in data envelopment analysis while using the efficiency value of the proposed Neuro-DEA model, we evaluated and ranked these units and resolved the problems encountered in the data envelopment analysis method. Fig. 2 shows the efficiency of the data envelopment analysis (BCC Output Oriented Model) and the proposed method for all units as shown below.

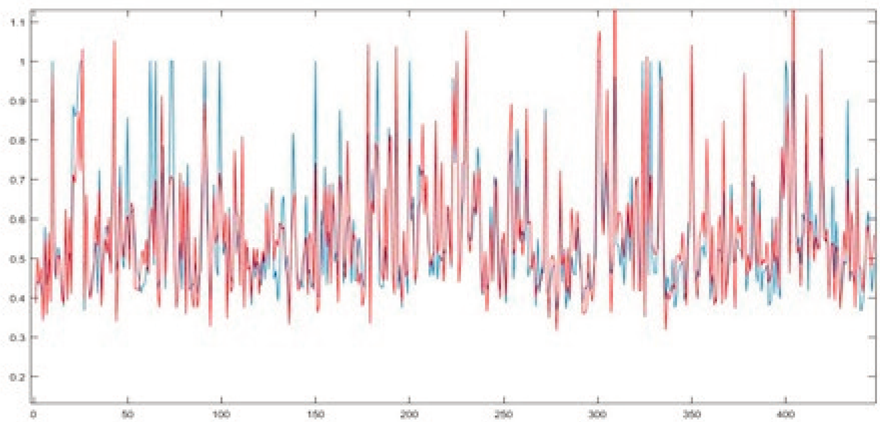

Fig. 2. Efficiency of the BCC output oriented Model and Proposed method

In the Fig. 2 the red part is the efficiency obtained using the proposed method and the blue part is the efficiency of the data envelopment analysis using the BCC output oriented model. As shown above, in the DEA diagram of the BCC model, the efficiency of some units is equal and has a value of one which the branches cannot be ranked by this method but in the proposed method diagram, there is no such problem and no unit has the same efficiency.

CONCLUSION

This paper has been conducted to evaluate the efficiency of decision-making units. First, we obtained a BCC output oriented approach, the efficiency of the units was obtained and the model's weakness was determined in terms of computation and efficiency separation. Then, to overcome these problems, the combined approach of data envelopment analysis, the BCC output oriented model and artificial neural network were used to evaluate the efficiency of these units. In this paper, we compiled the data of 447 decision making units and computed their efficiency using data envelopment analysis, the BCC output oriented model and the proposed model. It was observed that data envelopment analysis has some problems in evaluating the efficiency of units but the efficiency of the proposed method has overcome the problems of data envelopment analysis. In the end, using the results obtained from this proposed method, we ranked these units. By comparing the efficiency of two models of data envelopment analysis and proposed model, it was observed that in the amount of efficiency obtained by the data envelopment analysis method, the number of 24 units has a value equal to one that cannot be ranked by the data envelopment analysis model and in data envelopment analysis model, these units are referred as efficient but using the proposed Neuro-DEA, almost no two units have the same efficiency value and can easily be ranked.

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Appendix: Efficiency Results from Data Envelopment Analysis Model BCC Output Oriented Model and Proposed Method

Branch	Real efficiency of BCC	stimated efficiency of the proposed method	Branch	Real efficiency of BCC	stimated efficiency of the proposed method
DMU 1	0.41846	0.38512564	DMU 225	1	0.997660667
DMU 2	0.439476	0.50021957	DMU 226	0.44162415	0.437503511
DMU 3	0.443363	0.4344881	DMU 227	0.50530108	0.500024818
DMU 4	0.420638	0.47627972	DMU 228	0.63413391	0.74037923
DMU 5	0.383218	0.34129337	DMU 229	0.66235373	0.741590485
DMU 6	0.580132	0.54580551	DMU 230	1	1.076499847
DMU 7	0.432136	0.356499	DMU 231	0.56793153	0.550883763
DMU 8	0.496886	0.56521417	DMU 232	0.54340132	0.515046924
DMU 9	0.414135	0.38793001	DMU 233	0.54793523	0.614811625
DMU 10	1	0.9649073	DMU 234	0.63118862	0.720506399
DMU 11	0.473584	0.54146704	DMU 235	0.6056122	0.608543902
DMU 12	0.445476	0.45182061	DMU 236	0.78050203	0.636602666
DMU 13	0.528155	0.50860271	DMU 237	0.71542299	0.727535258
DMU 14	0.500424	0.49503695	DMU 238	0.42099952	0.477188747
DMU 15	0.429594	0.39648355	DMU 239	0.4053629	0.411518013
DMU 16	0.377576	0.3852145	DMU 240	0.50061247	0.517792837
DMU 17	0.582788	0.62382254	DMU 241	0.42101216	0.364998726
DMU 18	0.428286	0.39262163	DMU 242	0.44461455	0.460844844
DMU 19	0.515519	0.60162725	DMU 243	0.62952622	0.586790144
DMU 20	0.470641	0.40873268	DMU 244	0.45519206	0.439175696
DMU 21	0.887339	0.71153468	DMU 245	0.7071344	0.568107786
DMU 22	0.858125	0.69047514	DMU 246	0.66877625	0.702310617
DMU 23	0.872813	0.75100053	DMU 247	0.43947041	0.522835753
DMU 24	0.964883	0.8718404	DMU 248	0.40854696	0.396190009
DMU 25	1	0.72063421	DMU 249	0.54853583	0.529948225
DMU 26	1	1.02990884	DMU 250	0.48358563	0.566042464
DMU 27	0.366617	0.39490005	DMU 251	0.38621117	0.407461161
DMU 28	0.653935	0.66095157	DMU 252	0.54074117	0.558202576
DMU 29	0.441778	0.4443003	DMU 253	0.73819935	0.812436778
DMU 30	0.401454	0.3965431	DMU 254	0.77444927	0.891187106
DMU 31	0.44715	0.41990118	DMU 255	0.44650112	0.508682292
DMU 32	0.488672	0.48134254	DMU 256	0.52712753	0.528847824
DMU 33	0.540151	0.60670133	DMU 257	0.8274086	0.681292689
DMU 34	0.410146	0.531162	DMU 258	0.72868816	0.545498088
DMU 35	0.723694	0.67449735	DMU 259	0.53865697	0.599752363
DMU 36	0.416921	0.37752745	DMU 260	0.5690911	0.505819943
DMU 37	0.49838	0.48072802	DMU 261	0.54395086	0.572108367
DMU 38	0.57719	0.54865868	DMU 262	0.75127666	0.880048821
DMU 39	0.581508	0.51175352	DMU 263	0.45248301	0.587614087
DMU 40	0.511069	0.60354109	DMU 264	0.48122074	0.593625393
DMU 41	0.47964	0.46087796	DMU 265	0.47833432	0.46823716
DMU 42	0.715836	0.64322751	DMU 266	0.51864247	0.515373104
DMU 43	1	1.05169686	DMU 267	0.37715736	0.401036434
DMU 44	0.467055	0.33864575	DMU 268	0.54997063	0.431352815
DMU 45	0.49778	0.47872818	DMU 269	0.41244529	0.433528748
DMU 46	0.733542	0.67839327	DMU 270	0.47433416	0.44558586
DMU 47	0.501805	0.54134275	DMU 271	0.46031455	0.50120468
DMU 48	0.47351	0.5006293	DMU 272	0.87904944	0.852716559
DMU 49	0.554337	0.59122263	DMU 273	0.41618389	0.448240226
DMU 50	0.85732	0.60685982	DMU 274	0.38433134	0.346625391
DMU 51	0.521235	0.47151086	DMU 275	0.44131067	0.498723387
DMU 52	0.612622	0.6407938	DMU 276	0.47574597	0.507627187
DMU 53	0.625391	0.6231751	DMU 277	0.48432331	0.491413396

DMU 54	0.533365	0.42124153	DMU 278	0.36744032	0.316017129
DMU 55	0.472309	0.42266858	DMU 279	0.41430427	0.404692437
DMU 56	0.446521	0.4174352	DMU 280	0.65329508	0.722502412
DMU 57	0.412416	0.4964739	DMU 281	0.43754878	0.480836511
DMU 58	0.429525	0.52020121	DMU 282	0.5242912	0.510029667
DMU 59	0.434229	0.48214053	DMU 283	0.37108384	0.412551488
DMU 60	0.480083	0.54846887	DMU 284	0.43072933	0.527446233
DMU 61	0.462882	0.45884671	DMU 285	0.39142221	0.397659585
DMU 62	1	0.57572839	DMU 286	0.50460878	0.625374156
DMU 63	0.7009	0.62915817	DMU 287	0.46216223	0.566292023
DMU 64	0.482086	0.50554822	DMU 288	0.45654295	0.517845911
DMU 65	1	0.69739251	DMU 289	0.57772114	0.617635729
DMU 66	0.41867	0.42186823	DMU 290	0.49391329	0.549250686
DMU 67	0.447455	0.37397189	DMU 291	0.46276127	0.475807246
DMU 68	0.671773	0.91227136	DMU 292	0.38576928	0.359099708
DMU 69	0.785168	0.62898549	DMU 293	0.42685655	0.359551503
DMU 70	0.421397	0.45106731	DMU 294	0.42253289	0.370668052
DMU 71	0.609502	0.53853552	DMU 295	0.4635443	0.51315089
DMU 72	0.657944	0.67785333	DMU 296	0.41702175	0.435231343
DMU 73	1	0.70792457	DMU 297	0.42995186	0.390134306
DMU 74	1	0.70123677	DMU 298	0.4840712	0.425612109
DMU 75	0.5016661	0.47626715	DMU 299	0.50915949	0.714663943
DMU 76	0.37277	0.37257911	DMU 300	1	1.026438301
DMU 77	0.430022	0.43529867	DMU 301	1	1.076523007
DMU 78	0.540596	0.71572942	DMU 302	0.69891384	0.621901349
DMU 79	0.418292	0.49637449	DMU 303	0.56913202	0.558750439
DMU 80	0.694244	0.68503079	DMU 304	0.74294935	0.650343964
DMU 81	0.40519	0.35756567	DMU 305	0.69173997	0.927091898
DMU 82	0.739339	0.68088314	DMU 306	0.56007942	0.574149068
DMU 83	0.417099	0.513082	DMU 307	0.46157702	0.361587131
DMU 84	0.433853	0.40802269	DMU 308	0.4784623	0.513429807
DMU 85	0.430485	0.37370284	DMU 309	0.96167666	1.260042775
DMU 86	0.489213	0.55478318	DMU 310	0.53283351	0.558432088
DMU 87	0.407482	0.37365911	DMU 311	0.53301318	0.615050541
DMU 88	0.458649	0.40100762	DMU 312	0.47875909	0.613705544
DMU 89	0.46666	0.57855976	DMU 313	0.55276025	0.579207721
DMU 90	0.655651	0.71584589	DMU 314	0.43216526	0.501277866
DMU 91	1	0.8919566	DMU 315	0.50400139	0.565607665
DMU 92	0.628875	0.74425526	DMU 316	0.62151398	0.641334465
DMU 93	0.537529	0.56883282	DMU 317	0.49187649	0.552383491
DMU 94	0.393087	0.32643073	DMU 318	0.70664998	0.637718273
DMU 95	0.52297	0.53359516	DMU 319	0.4197247	0.417560979
DMU 96	0.686944	0.65869593	DMU 320	0.68932745	0.67519795
DMU 97	0.482562	0.53711196	DMU 321	0.70594358	0.706076559
DMU 98	0.45514	0.56334546	DMU 322	0.53239047	0.416342371
DMU 99	1	0.71524387	DMU 323	0.41730086	0.420639337
DMU 100	0.689209	0.66443872	DMU 324	1	0.923879516
DMU 101	0.508284	0.53465484	DMU 325	0.40181599	0.351179654
DMU 102	0.542752	0.61610589	DMU 326	1	1.012009218
DMU 103	0.408105	0.34727861	DMU 327	0.4551355	0.587867004
DMU 104	0.628337	0.60828324	DMU 328	1	0.710350475
DMU 105	0.453381	0.41356619	DMU 329	0.50851885	0.537679803
DMU 106	0.435456	0.42796055	DMU 330	0.46168242	0.510883981
DMU 107	0.759062	0.77287834	DMU 331	0.46148764	0.511390274
DMU 108	0.510797	0.61479482	DMU 332	0.5908881	0.525701549
DMU 109	0.571926	0.60519383	DMU 333	1	0.676476383
DMU 110	0.443449	0.4298227	DMU 334	0.94255486	0.960008903
DMU 111	0.808888	0.80207448	DMU 335	0.56640051	0.479498401
DMU 112	0.380735	0.37280786	DMU 336	0.39507973	0.316690437

DMU 113	0.516419	0.54683076	DMU 337	0.45346325	0.414817266
DMU 114	0.526914	0.47056827	DMU 338	0.41995743	0.394085528
DMU 115	0.459677	0.48066896	DMU 339	0.41350202	0.411532627
DMU 116	0.380634	0.39794347	DMU 340	0.49714837	0.432710679
DMU 117	0.505949	0.52613608	DMU 341	0.37329841	0.420598371
DMU 118	0.448104	0.47403812	DMU 342	0.40495515	0.507215944
DMU 119	0.492218	0.5252841	DMU 343	0.4639346	0.508414339
DMU 120	0.486174	0.40876828	DMU 344	0.48595321	0.492330622
DMU 121	0.429311	0.47552003	DMU 345	0.49135778	0.565118874
DMU 122	0.515808	0.51905228	DMU 346	0.39190825	0.493759386
DMU 123	0.444684	0.48820631	DMU 347	0.4272808	0.379835598
DMU 124	0.638868	0.61951458	DMU 348	0.58663955	0.528073316
DMU 125	0.471878	0.50726045	DMU 349	0.59577667	0.608574637
DMU 126	0.617183	0.61791541	DMU 350	1	1.040619975
DMU 127	0.679573	0.67288445	DMU 351	0.57816751	0.619607102
DMU 128	0.447224	0.49308053	DMU 352	0.43637974	0.445510876
DMU 129	0.467671	0.54662201	DMU 353	0.46898832	0.396172023
DMU 130	0.391492	0.53016794	DMU 354	0.45273279	0.556659775
DMU 131	0.461928	0.5904498	DMU 355	0.52512633	0.568927385
DMU 132	0.631696	0.5741031	DMU 356	0.53113152	0.616512314
DMU 133	0.656848	0.5798314	DMU 357	0.50143095	0.552911081
DMU 134	0.469522	0.47448427	DMU 358	0.79645053	0.802131631
DMU 135	0.507901	0.45251808	DMU 359	0.61355055	0.598934762
DMU 136	0.360642	0.33170107	DMU 360	0.39384236	0.432927818
DMU 137	0.486444	0.51772862	DMU 361	0.45872031	0.582637318
DMU 138	0.817144	0.6168339	DMU 362	0.40012805	0.380450921
DMU 139	0.66801	0.66660508	DMU 363	0.38881922	0.40061104
DMU 140	0.44799	0.47128913	DMU 364	0.52427548	0.557132951
DMU 141	0.416955	0.41689198	DMU 365	0.52092867	0.60858338
DMU 142	0.448097	0.44240037	DMU 366	0.48886135	0.383614958
DMU 143	0.422354	0.48557294	DMU 367	0.66874108	0.848160838
DMU 144	0.484296	0.51825645	DMU 368	0.42310753	0.394364788
DMU 145	0.658062	0.55376965	DMU 369	0.43482713	0.464966472
DMU 146	0.457294	0.4065368	DMU 370	0.49763065	0.53901779
DMU 147	0.471198	0.56641671	DMU 371	0.68645495	0.64947121
DMU 148	0.423322	0.53483935	DMU 372	0.48950179	0.530082213
DMU 149	0.443137	0.41890524	DMU 373	0.49165698	0.371284251
DMU 150	1	0.74030626	DMU 374	0.54969386	0.606458103
DMU 151	0.401612	0.36115449	DMU 375	0.52267974	0.563598259
DMU 152	0.408177	0.38509747	DMU 376	0.5212995	0.584558166
DMU 153	0.62041	0.57533253	DMU 377	0.4951366	0.499095754
DMU 154	0.455587	0.59781536	DMU 378	0.96966788	0.96355883
DMU 155	0.730983	0.67686343	DMU 379	0.41474133	0.451939159
DMU 156	0.431971	0.52899966	DMU 380	0.46609549	0.509848911
DMU 157	0.567239	0.68790125	DMU 381	0.46809675	0.467209469
DMU 158	0.498748	0.43475773	DMU 382	0.69426416	0.495005686
DMU 159	0.689936	0.66875227	DMU 383	0.67546213	0.710811369
DMU 160	0.488019	0.61936772	DMU 384	0.47301531	0.530056271
DMU 161	0.516841	0.55078397	DMU 385	0.43845742	0.478060485
DMU 162	0.45741	0.38656132	DMU 386	0.6750911	0.615830611
DMU 163	0.875861	0.70873295	DMU 387	0.41442845	0.48129465
DMU 164	0.68364	0.64846566	DMU 388	0.46461047	0.496523872
DMU 165	0.434755	0.49427894	DMU 389	0.46785941	0.487946547
DMU 166	0.500283	0.44951028	DMU 390	0.48285869	0.54107862
DMU 167	0.589153	0.7975902	DMU 391	0.38010078	0.43684687
DMU 168	0.607198	0.62848283	DMU 392	0.38866445	0.459317797
DMU 169	0.436703	0.476454	DMU 393	0.60242925	0.548609047
DMU 170	0.599286	0.56512143	DMU 394	0.40800499	0.490319797
DMU 171	0.444403	0.55102045	DMU 395	0.50626388	0.602793542
DMU 172	0.44171	0.53871725	DMU 396	0.43360069	0.425310567

DMU 173	0.552731	0.43403217	DMU 397	0.39650152	0.63552184
DMU 174	0.519899	0.46304356	DMU 398	0.77971	0.782813552
DMU 175	0.442814	0.37830761	DMU 399	0.64854265	0.648519335
DMU 176	0.426102	0.40286732	DMU 400	1	0.75890584
DMU 177	0.606455	0.57414893	DMU 401	0.95567519	0.889119524
DMU 178	0.81707	1.04360159	DMU 402	0.46087862	0.461780012
DMU 179	0.392414	0.33379952	DMU 403	0.71771133	0.672265907
DMU 180	0.725709	0.64381065	DMU 404	1	1.217216628
DMU 181	0.619261	0.61164953	DMU 405	0.64268988	0.723209963
DMU 182	0.748395	0.79291059	DMU 406	0.5247732	0.513424459
DMU 183	1	0.77108991	DMU 407	0.554322	0.529770222
DMU 184	0.435636	0.57257291	DMU 408	0.48480023	0.428334976
DMU 185	0.425377	0.46980401	DMU 409	0.61283503	0.547710823
DMU 186	0.425734	0.44225751	DMU 410	0.59295835	0.572039618
DMU 187	0.530127	0.67640622	DMU 411	0.79025283	0.915391224
DMU 188	0.443737	0.44522054	DMU 412	0.41707909	0.496229854
DMU 189	0.830597	0.76996677	DMU 413	0.69517403	0.593636524
DMU 190	0.740847	0.81122667	DMU 414	0.57018642	0.586282254
DMU 191	0.463024	0.45787176	DMU 415	0.52088573	0.49071466
DMU 192	0.406573	0.41061637	DMU 416	0.61141049	0.555543385
DMU 193	0.881791	1.03620872	DMU 417	0.52658409	0.521089532
DMU 194	0.420346	0.4643002	DMU 418	0.53699684	0.524891376
DMU 195	0.484454	0.45131486	DMU 419	0.80520566	1.031000891
DMU 196	0.373365	0.38671274	DMU 420	0.69570875	0.556269965
DMU 197	0.554939	0.56979385	DMU 421	0.56724571	0.542434438
DMU 198	0.483743	0.45299662	DMU 422	0.53240624	0.576041198
DMU 199	0.408593	0.46584363	DMU 423	0.41690807	0.397289224
DMU 200	1	0.80238987	DMU 424	0.50364844	0.528325242
DMU 201	0.594859	0.64038848	DMU 425	0.68200132	0.539636222
DMU 202	0.655556	0.57831428	DMU 426	0.44917342	0.393443395
DMU 203	0.43287	0.44104755	DMU 427	0.59362691	0.530979627
DMU 204	0.476981	0.47128132	DMU 428	0.48500217	0.504827968
DMU 205	0.736098	0.6290792	DMU 429	0.38414157	0.371096875
DMU 206	0.706589	0.6469145	DMU 430	0.42382371	0.455233855
DMU 207	0.722143	0.84098131	DMU 431	0.49207287	0.569664423
DMU 208	0.673531	0.61017492	DMU 432	0.48447735	0.513300548
DMU 209	0.66096	0.70974083	DMU 433	0.90110746	0.698532518
DMU 210	0.582753	0.54415228	DMU 434	0.44148164	0.440432521
DMU 211	0.453299	0.47864959	DMU 435	0.46847288	0.616202408
DMU 212	0.496916	0.50267497	DMU 436	0.45119477	0.562023423
DMU 213	0.455958	0.5168522	DMU 437	0.41971556	0.373743062
DMU 214	0.818103	0.84838278	DMU 438	0.72772619	0.708681518
DMU 215	0.445983	0.51014992	DMU 439	0.40952497	0.478010945
DMU 216	0.510065	0.55017037	DMU 440	0.36484207	0.475684463
DMU 217	0.491469	0.74411979	DMU 441	0.3897352	0.413407856
DMU 218	0.511541	0.44121877	DMU 442	0.4533034	0.480375116
DMU 219	0.524535	0.52677304	DMU 443	0.58274471	0.561378862
DMU 220	0.625888	0.63293553	DMU 444	0.6181421	0.586231257
DMU 221	0.545068	0.61630553	DMU 445	0.48475003	0.480713004
DMU 222	0.474583	0.48249827	DMU 446	0.41494114	0.485174715
DMU 223	0.958152	0.91930035	DMU 447	0.48828005	0.559280132
DMU 224	0.739443	0.77429182			