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Research Article

SBM Model Based Productivity Evaluation

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Keywords

DEA,
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Banking system,
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Abstract

Evaluating the bank productivity over 2015-2019 with Data Envelopment Analysis (DEA) for 30 banks from eight developing countries is the main target of this study and in this correspondence, we have compared the productivities with Malmquist Productivity Index (MPI) which is very useful for managers for expanding their evaluation. The additive models are often named Slack Based Measure (SBM), and this group of models measures efficiency via slack variables. We evaluate the SBM Variable Return to Scale (SBM-VRS) and Constant Return to Scale (SBM-CRS). The results indicate that the SBM (VRS) model has the most productive effect during all periods compare with other suggested models in MPI. Meanwhile, SBM-CRS is in the second place. Input-oriented has been taken into account for the suggested models. The dataset has been acquired from BankFocus-Bureau van Dijk database.

1. Introduction

Despite the unprecedented growth in the banking industry in developing countries, research on the performance and efficiency of this industry is almost challenging. Svitalkova [1] shows that non-parametric methods are more acceptable than parametric ones for ranking decision-making units (DMUs). Based on Wanke et al. [2], DEA is a critical non-parametric method presently applied for efficiency and productivity evaluation. This method, technologically advanced by Charnes et al. [3], is founded by a scientific way of measuring efficiency. DEA classifies the most efficient DMUs and specifies what inefficient units must do to become efficient. To clarify more, DEA shows the best observe to be recognized from an efficiency frontier [4]. Berger and Humphrey [5], in an outstanding study, surveyed 130 pieces of training that examined 21 multiple countries to evaluate bank efficiency base on parametric and non-parametric approaches, which shows the importance of education on efficiency evaluation in bank sectors. The main purposes are to recapitulate and intially analysis experiential evaluations of financial organization

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efficiency and try to attain at a consent view. They find that the numerous efficiency approaches do not essentially yield constant outcomes and propose some methods that these ways might be improved to bring about results that are more accurate and useful [6-23].

The banking industry plays a critical role in the budget and, consequently, the difficulties associated with bank performance are the focus of our literature. Most papers are inspired by aforementioned concerns, encouraged by the recent financial crisis. As such, it aims to incorporate risk into the bank efficiency and to provide a snapshot of the efficiency outline of the banking industry and, accordingly, to evaluate the banking crisis. It is perceived that various DEA models are commonly utilized in different studies to compare, rank, and evaluate energy efficiency.

Finding the superior model provide valuable information for bank managers to select the best model. Meanwhile, comparing various bank's companies from different developing countries is one of the novelties of our research, which considers large laboratories at the same time. Thus, it can be beneficial for managers to have superior evaluating, remove unrelated data, and more effective processes.

2. Methods

The objective of this study is to compare companies' efficiency effectively. Using a comparative DEA with MPI is established to determine the features of banks in terms of some DMUs with four suggested models. Finally, the entire progression can be divided into four steps, as follows:

2.1. SBM-CRS Model

The additive models are commonly called Slack Based Measure (SBM). This model shows the input extra, and the output lack simultaneously with inward at a point on the efficient frontier. In scientific relationships the SBM-CRS model is given as:

$$MinZ = \sum_{i=1}^{m} S_i^- + \sum_{i=1}^{s} S_r^+ \tag{1}$$

$St.$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = x_i \qquad ,i = 1, \dots \dots, m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_r \qquad ,r = 1, \dots \dots, s$$

$$\lambda_j, S_r^+, \ S_i^- \geq 0 \qquad ,j = 1, \dots, n$$

The key SBM goal is to attain the highest value of the input and output slacks in the assumed DMUs. DEA calculates the efficiency of each observation based on the frontier that shows all the descriptions. Inefficient DMUs can be value-added (changed to the efficient frontier line) with anticipated instruction for growth, which are the facts along the frontier. The distance to the efficiency frontier distributes an amount of efficiency.

2.2. SBM-VRS Model

After adding the following constrain to the SBM-CRS

$$\sum_{j=1}^{n} \lambda_j = 1$$

We can convert CRS to VRS model. This is exactly like the converting CCR to BCC model. In technical relations the SBM-VRS model is given as:

$$MinZ = \sum_{i=1}^{m} S_i^- + \sum_{i=1}^{s} S_r^+$$

$$St. \tag{2}$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = x_i \qquad , i = 1, \dots\dots, m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_r \qquad , r = 1, \dots\dots, s$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j, S_r^+, \; S_i^- \geq 0 \qquad , j = 1, \dots, n$$

3. Inputs and Outputs Description

3.1. Linear Model in SBM-CRS

$$MinZ = -\sum_{i=1}^{m} S_i^- - \sum_{c=1}^{C} S_c^- - \sum_{r=1}^{s} S_o^- - \sum_{h=1}^{H} S_r^+ - \sum_{h=1}^{H} S_h^+$$

$$St. \tag{3}$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + S_i^- = X_i \qquad , i = 1, \dots, m$$

$$\sum_{j=1}^{n} \lambda_j n_{cj} + S_c^- = n_c \qquad , C = 1, \dots, c$$

$$\sum_{j=1}^{n} \lambda_j q_{oj} + S_o^- = q_o \qquad , O = 1, \dots, o$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_r \qquad , r = 1, \dots, s$$

$$\sum_{j=1}^{n} \lambda_j m_{hj} - S_h^+ = m_h \qquad , h = 1, \dots, H$$

$$\lambda_j, S_i^-, S_c^-, S_o^-, S_r^+, S_h^+ \geq 0, j = 1, \dots, n$$

3.2. Dual Model in SBM-CRS

$$Max\ Y = \sum_{r=1}^{s} u_r y_{rj} + \sum_{h=1}^{H} e_h m_{hj} - \sum_{i=1}^{m} v_i x_{ij} - \sum_{c=1}^{C} f_c n_{cj} - \sum_{o=1}^{O} k_o q_{oj} + w$$

$$St. \tag{4}$$

$$\sum_{r=1}^{s} u_r y_{rj} + \sum_{h=1}^{H} e_h m_{hj} - \sum_{i=1}^{m} v_i x_{ij} - \sum_{c=1}^{C} f_c n_{cj} - \sum_{o=1}^{O} k_o q_{oj} + w \leq 0$$

$$\sum_{r=1}^{s} u_r \geq 1$$

$$\sum_{h=1}^{H} e_h \geq 1$$

$$\sum_{i=1}^{m} v_i \geq 1$$

$$\sum_{c=1}^{C} f_c \geq 1$$

$$\sum_{o=1}^{O} k_o \geq 1$$

$$u_r,\, e_h,\, v_i, f_c, k_o \geq 0$$

3.3. Linear Model in SBM-VRS

$$MinZ = -\sum_{i=1}^{m} S_i^{-} - \sum_{c=1}^{C} S_c^{-} - \sum_{r=1}^{s} S_o^{-} - \sum_{h=1}^{H} S_r^{+} - \sum_{h=1}^{H} S_h^{+}$$

$$St. \qquad (5)$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + S_i^{-} = X_i \qquad ,i = 1, \dots, m$$

$$\sum_{j=1}^{n} \lambda_j n_{cj} + S_c^{-} = n_c \qquad ,C = 1, \dots, c$$

$$\sum_{j=1}^{n} \lambda_j q_{oj} + S_o^{-} = q_o \qquad ,O = 1, \dots, o$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^{+} = y_r \qquad ,r = 1, \dots, s$$

$$\sum_{j=1}^{n} \lambda_j m_{hj} - S_h^{+} = m_h \qquad ,h = 1, \dots, H$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j, S_i^{-}, S_c^{-}, S_o^{-}, S_r^{+}, S_h^{+} \geq 0, j = 1, \dots, n$$

3.4. Dual Model in SBM-VRS

$$Max\ Y = \sum_{r=1}^{s} u_r y_{rj} + \sum_{h=1}^{H} e_h m_{hj} - \sum_{i=1}^{m} v_i x_{ij} - \sum_{c=1}^{C} f_c n_{cj} - \sum_{o=1}^{O} k_o q_{oj} + w$$

$$St. \qquad (6)$$

$$\sum_{r=1}^{s} u_r y_{rj} + \sum_{h=1}^{H} e_h m_{hj} - \sum_{i=1}^{m} v_i x_{ij} - \sum_{c=1}^{C} f_c n_{cj} - \sum_{o=1}^{O} k_o q_{oj} + w \leq 0$$

$$\sum_{r=1}^{s} u_r \geq 1$$

$$\sum_{h=1}^{H} e_h \geq 1$$

$$\sum_{i=1}^{m} v_i \geq 1$$

$$\sum_{c=1}^{C} f_c \geq 1$$

$$\sum_{o=1}^{O} k_o \geq 1$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$u_r,\ e_h, v_i, f_c, k_o \geq 0$$

4. Discussion in the MPI Model

4.1. Discussion in MPI-SMB-CRS Model

The average MPI-SBM-CRS for all banks over 2015-2019 is given in Table 1 and Figure 1.

Table1. Productivity measurement results based on MPI-SBM-CRS for 30 banks over 2015-2019

Banks	MPI	Rank	Banks	MPI	Rank
1	0.95	21	16	0.49	30
2	1.16	16	17	1.95	1
3	0.89	23	18	0.91	22
4	1.35	12	19	1.73	7
5	0.81	25	20	1.93	2
6	1.64	8	21	1.05	18
7	1.30	13	22	0.67	28
8	0.96	20	23	1.10	17
9	1.89	4	24	1.17	15
10	0.79	26	25	1.45	11
11	1.25	14	26	0.85	24
12	1.58	9	27	1.82	5
13	1.49	10	28	1.78	6
14	1.04	19	29	1.92	3
15	0.69	27	30	0.59	29

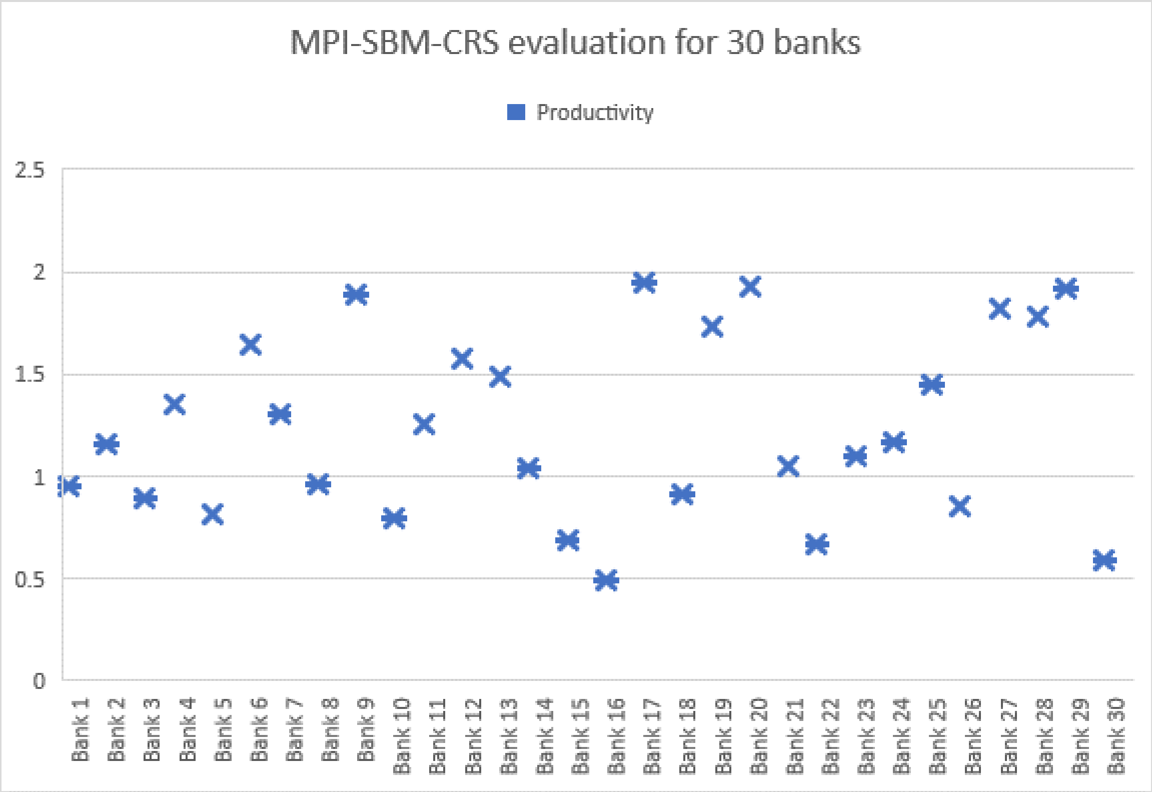

Figure 1. Average productivity for MPI-SBM-CRS over 5-year periods for 30 DMUs

4.2 Discussion in MPI-SBM-VRS Model

The average MPI-SBM-VRS for all banks over 2015-2019 is given in Table 2 and Figure 2.

Table 2. Productivity measurement results based on MPI-SBM-VRS for 30 banks over 2015-2019

Banks	MPI	Rank	Banks	MPI	Rank
1	0.96	21	16	0.50	30
2	1.17	16	17	1.96	1
3	0.90	23	18	0.92	22
4	1.36	12	19	1.76	7
5	0.82	25	20	1.94	2
6	1.65	8	21	1.06	18
7	1.32	13	22	0.69	28
8	0.97	20	23	1.11	17
9	1.91	4	24	1.18	15
10	0.80	26	25	1.48	10
11	1.26	14	26	0.86	24
12	1.60	9	27	1.83	5
13	1.50	10	28	1.79	6
14	1.05	19	29	1.93	3
15	0.70	27	30	0.61	29

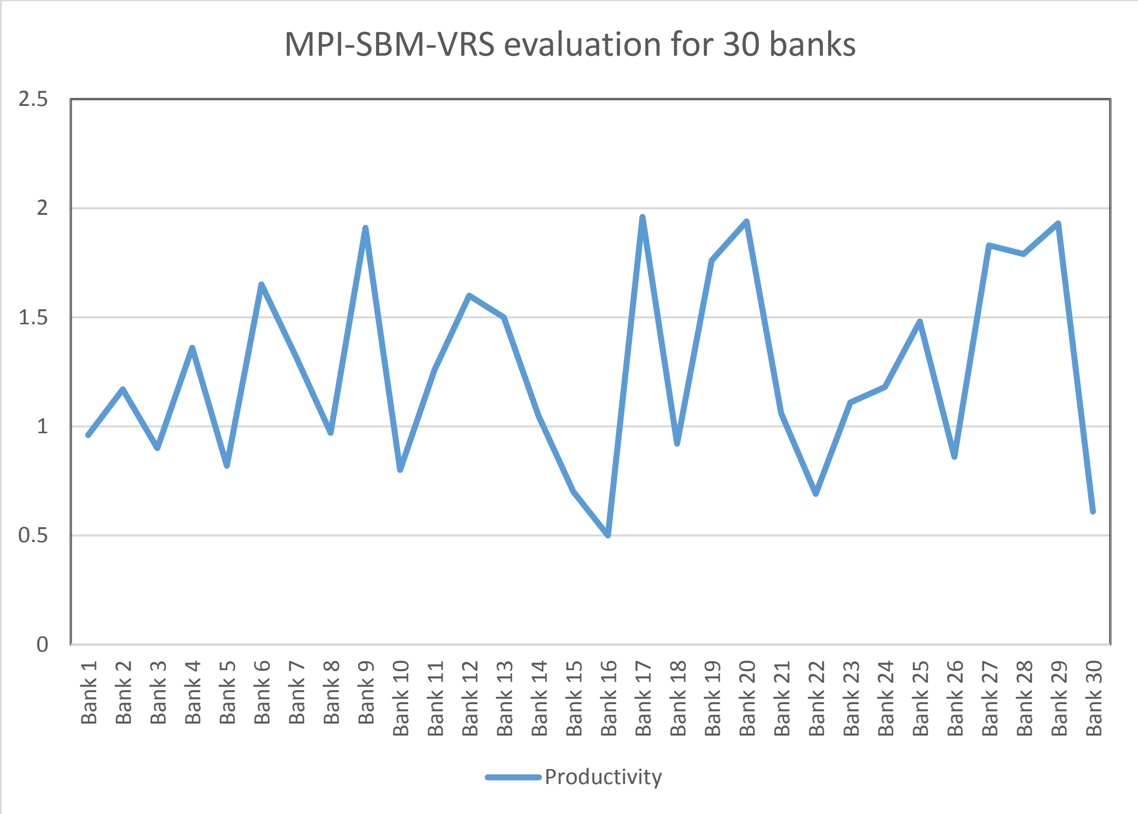

Figure 2. Average productivity for MPI-SBM-VRS over 5-year periods for 30 DMUs

4.3. Results

It can be concluded from (Table 1 and Figure 1) and (Table 2 and Figure 2):

- SBM-VRS, SBM-CRS models have the same ranking for all DMUs
- SBM-VRS model has the first and the highest average efficiency score over 5-years period for 30 DMUs
- SBM-CRS model has the second average efficiency score over 5-years period for 30 DMUs

So SBM-VRS model is the best fit model for our evaluation.

Based on the SBM-CRS model in table 1 and Fig 1:

- The 17th bank has the 1st or the highest MPI with a productivity score of 1.95.
- The 20th and 29th banks are in the 2nd and 3rd places with productivity scores of 1.93 and 1.92, respectively.
- The 16th bank has the 30th and the lowest MPI with a productivity score of 0.49.
- The 22nd and 30th banks are in the 28th and 29th places with productivity scores of 0.67 and 0.59, respectively.

Based on the SBM-VRS model in table 2 and Fig 2:

- The 17th bank has the 1st or the highest MPI with a productivity score of 1.96.
- The 20th and 29th banks are in the 2nd and 3rd places with productivity scores of 1.94 and 1.93, respectively.
- The 16th bank has the 30th and the lowest MPI with a productivity score of 0.50.
- The 22nd and 30th banks are in the 28th and 29th places with productivity scores of 0.69 and 0.61, respectively.

Although the difference between efficiency scores among the six suggested models is negligible, the SBM-VRS model has the highest rank. SBM-CRS, is in the 2nd. Finally, the following relation is applicable for all DMUs in all MPIs and all years:

SBM-VRS> SBM-CRS (7)

5. Conclusion

Productive companies are the best reference for increasing the productivity of unproductive banks. The SBM-VRS model has a more positive impact on efficiency score compare with other suggested models. One of the advantages of the SBM model compare with other suggested methods is decreasing the value of inputs and increasing the number of outputs simultaneously. The proposed approach, geometric average, results, and predictions derived from the period and productivities in MPI can help the practitioner to compare the efficiency of uncertain cases and instruct accordingly. In the future, applying window analysis and comparing final productivities result with MPI will be valuable. Since the proposed window analysis method is based on a moving average, it is useful for finding per efficiency trends over time Meanwhile, using fuzzy and random data for MPI will be interesting as a final comparison. So, the results and predictions can be helpful for managers who benefit from this approach to achieve a higher relative productivity score. For the future study, we will extend the research by utilizing some optimization and machine learning approaches [24-32].

Conflict of Interest Statement

The authors declare no conflict of interest.

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