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Research Article

Bank performance evaluation using dynamic DEA: A slacks-based measure approach

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Abstract

Data envelopment analysis (DEA) has been applied in many studies in the banking industry but deficiency of empirical studies in Iranian banking sector that incorporate time factor into the efficiency, have still remained. Previous studies measured the efficiency of bank branches in a single period within cross-sectional data. They did not considered effect of interconnecting activities (links) between two consecutive terms. The main contribution of this paper is to evaluate the efficiency of an Iranian bank using dynamic SBM model in DEA during three consecutive terms considering net profit as a good link and loan losses as a bad link. In order to realize most important variables (inputs-outputs), relative to our case, we made a checklist and distributed them among headmen of branches and arranged an interview with the CEO of bank. Dynamic SBM efficiency is compared with its static efficiency to check the validity of described model. In addition, input-bad link excesses and output-good link shortfalls (slacks) are analyzed and further suggestions to the management are provided.

Keywords: Efficiency, Data envelopment analysis, Dynamic slacks-based measure.

1 Introduction

Performance evaluation of bank branches is a major concern for both, the managers and the shareholders, since it has a strong effect on the performance of economy. Strong banking system will result in developed economy and society. One of the most important issues in bank performance evaluation is measuring the operational and technical efficiency. There are two major methods for evaluating the efficiency of organizations: parametric methods which estimate production frontier set like financial proportions analysis, regression analysis approach, SFA (Stochastic Frontier Approach), DFA (Distribution Free Approach), TFA (Tick Frontier Approach), and non-parametric methods like data envelopment analysis (DEA). DEA does not require the predetermined weights to be attached to each input and output and it also does not require prescribing the functional forms that are needed in statistical regression approaches.

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Measuring the efficiency of bank branches, using new mathematical DEA techniques, have received a great deal of attention in recent years, Emrouznejad et al. (2008) evaluated the researches in efficiency and productivity and provided a comprehensive bibliography of the first 30 years of scholarly literature in DEA. In traditional DEA models, efficiency is measured in single period using cross-sectional data. Such measuring could not be a comprehensive approach for performance evaluation in long-term point of view. As a result, overall efficiency evaluation of firms over time is not provided.

Recently, many DEA researchers analyzed the dynamic structure of production in models where actions taken in one period can affect the efficiency of firms in future periods. Bogetoft et al.(2008), Chen (2009), Fare and Grosskopf (1996), Kao (2008), Nemoto and Goto (1999), Sueyoshi and Sekitani (2005), Park and Park (2009) and Chang et al.(2009) contributed in this field. Classical DEA models do not account for the effect of carry-over activities (links) between two consecutive terms. For each term, these models have inputs and outputs, but the connecting activities between terms are neglected (Tone and Tsutsui, 2010). The dynamic DEA model proposed by Fare and Grosskopf (1996) was the first action for dealing with these interconnecting activities. Then Tone and Tsutsui (2010) developed Fare and Grosskopf model into a slacks-based measure (SBM) framework.

This paper describes a particular methodology called dynamic SBM model in DEA and evaluates the efficiency of an Iranian bank during three consecutive terms. Each branch in each term expends money on labor salaries and operating expense as inputs to produce loans as output. In each term some loans become non-performing, because of unable borrowers to make full or even partial payment. We call non-performing loans (loan losses) as undesirable or bad link that carried to the next term and affect the efficiency of future terms. Contrary to loan losses, net profit is considered as desirable or good link. According to Fukuyama and Weber (2010), we treat loan losses and net profit as bad and good links instead of as input and output, because banks cannot incur loan losses or make profit until inputs are used to begin making loans. Using dynamic model in this paper, we can implement the long term performance evaluation, in addition, incorporating non-oriented SBM model enables us to identify inefficiencies in both inputs and outputs concurrently.

The remainder of this paper is organized as follows: In section 2 we describe a literature review of DEA, SBM DEA and dynamic DEA. Methodology, objective functions and efficiency of dynamic SBM model are presented in section 3. We demonstrate an empirical use of the dynamic SBM model into a case study (an Iranian bank) and solve both dynamic and static models in section 4. Conclusion will be in the last section.

2 Literature review

Data envelopment analysis (DEA) is a non-parametric linear programming technique that measures the relative efficiency of a group of decision making units (DMUs) which receive multiple inputs to produce multiple outputs and has been applied by various research communities across a wide range of industries. DEA, first proposed by Charnes, Cooper and Rhodes in 1978, based on earlier work initiated by Farrell (1957), and developed by Banker in 1984, is a new mathematic technique developed in operations research and management science over the last three decades for measuring productive efficiency. DEA evaluates the efficiency of relative DMUs in comparison with each other. The most basic models of DEA are CCR, BCC, Additive and SBM. CCR and BCC models are radial and aim to minimize inputs while keeping outputs at least the given output levels, we call it *input-oriented* model or attempt to maximize outputs without requiring more of any of the observed input values, called *output-oriented*. The combination of both orientations in a single model is called additive model. Additive models treat the slacks (the input excesses and output shortfalls) directly in objective function, but it doesn’t have the ability to measure the depth of inefficiency by a scalar similar to θ^* in CCR-type models. The slacks-based measure of efficiency proposed by Tone (2001) made up this deficiency. Additive and SBM models are non-radial and can deal with inputs and outputs individually (Cooper, Seiford and Tone, 2000).

In comparison with techniques of evaluating organizational efficiency, DEA proposed by Charnes et al. is a better way to organize and analyze data since it allows efficiency to change over time and requires no prior assumption on the specification of the efficient frontier. Thus, DEA is an excellent approach for the efficiency analysis in banking industry in literature. Aly, et al. (1990) used the Charnes–Cooper–Rhodes (CCR) model to evaluate the technical efficiency, scale efficiency, and allocative efficiency of 322 independent USA banks in 1986. The number of full-time staff, fixed asset, capital and loanable fund were chosen as input variables; real estate loan, commercial and industrial loan, consumer loan, miscellaneous loan, and current deposit were output variables. Athanassopoulos et al. (2000) examined 47 branches of the Commercial Bank of Greece and the DEA results were used to implement the proposed changes in the bank performance measurement system. Wang, Huang, and Lai (2005) studied four state-owned banks and 12 private banks (totally 16 commercial banks) in mainland China in 2004 and chose capital and asset as input items and net income, return on total assets (ROA), return on equity (ROE) as output terms respectively. Wu et al. (2006) integrated the DEA and neural networks (NNs) to examine the relative branch's efficiency of a big Canadian bank. Their results are compared with the normal DEA results. Tyrone, Chi et al. (2009) took 117 branches of a certain bank in Taiwan in 2006 as the research subject and introduced data envelopment analysis (DEA) to evaluate the operating performances of business units of this bank to provide the reference for a bank's managers in determining operation strategies. Avkiran (2009) applied non-oriented network slacks-based measure in domestic commercial banks of United Arab Emirates (UAE) for the first time. He used non-oriented, non-radial SBM modeling in order to enhance the relevance of efficiency studies to the world of business. Fukuyama and Weber (2010) introduced a slacks-based measure for a two-stage system with bad outputs and applied the model to Japanese banks. Their two-stage network SBM model allowed for inputs and outputs to be scaled in non-radial directions to a frontier technology and accounts for any input excesses or output shortfalls.

Although great flexibility and extendibility exist, most of DEA studies have dealt primary with cross sectional data and measured relative efficiencies in a single period (Park and Park, 2009). Exceptions are Malmquist-type indexes of productivity (Fare and Grosskopf, 1996). Sengupta (1995) presented a dynamic DEA model by introducing the shadow values of quasi-fixed inputs and their optimal paths into an analytic linear programming problem. Fare and Grosskopf (1996) formulated several kinds of intertemporal substitution among inputs, outputs and intermediate outputs using a network theory by which more realistic production processes across periods can be described (Nemoto and Goto, 1999). Nemoto and Goto (1999) extended DEA to a dynamic framework. Their dynamic DEA not only provided a measure of efficiency, but also had the ability to be used as a non-parametric alternative to the economic modeling of the intertemporal behavior of a firm. They incorporated two different types of inputs (variable inputs and quasi-fixed inputs) into a framework of dynamic DEA. Unique feature of quasi-fixed inputs is that those are considered as outputs in the current period, while being treated as inputs at the next period. Sueyoshi and Sekitani (2005) developed a method of how to incorporate the concept of return to scale (RTS) into the dynamic DEA. Regarding Fare and Grosskopf model, Tone and Tsutsui (2010) developed a slacks-based measure (SBM) model for measuring the dynamic efficiency of relative DMUs over several terms. They accounted the effect of interconnecting activities (carry-over activities) between two consecutive terms and categorized them into four types: good, bad, free and fixed carry-over activities.

3 Proposed model

We consider n DMUs $(j=1,2,\dots,n)$ over T terms $(t=1,2,\dots,T)$. At each term DMUs have their respective inputs and outputs along with the carry-overs (links) from previous term to this term. We assume that we have a panel data between term1 to T. So we look at the DMUs as a continuum between term 1 and the term T. We symbolize the two category links as z^{good} and z^{bad}. Good carry over activities (links) must be treated as outputs because the excess is desirable. In contrast with good links, bad links must be considered as inputs because the excess is accounted as inefficiency. We used SBM model introduced by Tone (2001) and DSBM model proposed by Tone and Tsutsui (2010) for evaluating the overall efficiency over three consecutive terms. Figure 1, illustrates the dynamic structure of bank production process and links over T terms.

Where the ($x_{1jt}, x_{2jt}, \ldots, x_{mjt}$), ($y_{1jt}, y_{2jt}, \ldots, y_{sjt}$), ($z_{1jt}^{bad}, z_{2jt}^{bad}, \ldots, z_{nbadjt}^{bad}$) and ($z_{1jt}^{good}, z_{2jt}^{good}, \ldots, z_{ngoodjt}^{good}$) are the input, output, bad link and good link vectors of DMU_j in term *t*, respectively.

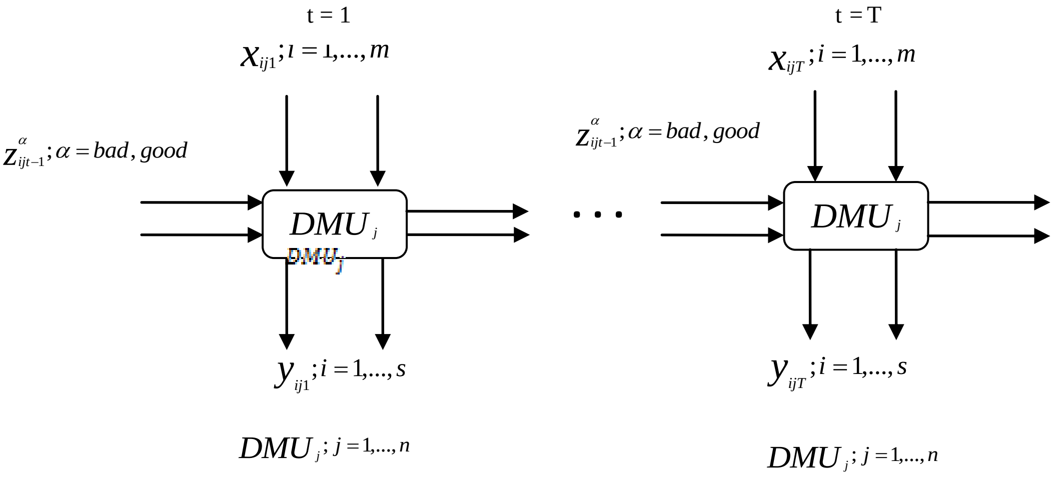

Fig 1. Dynamic structure of bank production process

$$\rho_0 = Min\left(\frac{1}{T}\sum_{t=1}^{T} w^t\left[1-\frac{1}{m+nbad}\left(\sum_{i=1}^{m}\frac{s_{it}^-}{x_{i0t}}+\sum_{i=1}^{nbad}\frac{s_{it}^{bad}}{z_{i0t}^{bad}}\right)\right]\right)\cdot\left(\frac{1}{T}\sum_{t=1}^{T} w^t\left[1+\frac{1}{s+ngood}\left(\sum_{i=1}^{s}\frac{s_{it}^+}{y_{i0t}}+\sum_{i=0}^{ngood}\frac{s_{it}^{good}}{z_{i0t}^{good}}\right)\right]\right)^{-1}$$

S.t.

$$\sum_{j=1}^{n}\lambda_j^t x_{ijt} + s_{it}^- = x_{i0t}, i=1,\ldots,m; t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t y_{ijt} - s_{it}^+ = y_{i0t}, i=1,\ldots,s; t=1,\ldots,T \qquad (1)$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{good} - s_{it}^{good} = z_{i0t}^{good}, i=1,\ldots,ngood; t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{bad} + s_{it}^{bad} = z_{i0t}^{bad}, i=1,\ldots,nbad; t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{\alpha} = \sum_{j=1}^{n}\lambda_j^{t+1} z_{ijt}^{\alpha}, t=1,\ldots,T-1$$

$$s_{it}^-, s_{it}^+, s_{it}^{good}, s_{it}^{bad}, \lambda_j^t, \lambda_j^{t+1} \geq 0$$

Where w^t, is weight to term t and must satisfy the condition as:

$$\sum_{t=1}^{T} w^t = T$$

The constraint ($\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{\alpha}=\sum_{j=1}^{n}\lambda_j^{t+1} z_{ijt}^{\alpha}$) is critical for dynamic model and guarantees the continuity of link flows and Symbol α stands for good and bad link. According to Cooper et al. (2007) the fractional DSBM model can be transformed into the linear programming by introducing a positive scalar variable k as follows:

$$\tau = Min(\frac{1}{T}\sum_{t=1}^{T} w^t \left[k - \frac{1}{m+nbad}\left(\sum_{i=1}^{m}\frac{ks_{it}^{-}}{x_{i0t}} + \sum_{i=1}^{nbad}\frac{ks_{it}^{bad}}{z_{i0t}^{bad}} \right) \right])$$

S.t.

$$\frac{1}{T}\sum_{t=1}^{T} w^t \left[k + \frac{1}{s+ngood}\left(\sum_{i=1}^{s}\frac{ks_{it}^{+}}{y_{i0t}} + \sum_{i=1}^{ngood}\frac{ks_{it}^{good}}{z_{i0t}^{good}} \right) \right] = 1$$

$$\sum_{j=1}^{n}\lambda_j^t x_{ijt} + s_{it}^{-} = x_{i0t},\ i=1,\ldots,m;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t y_{ijt} - s_{it}^{+} = y_{i0t},\ i=1,\ldots,s;\ t=1,\ldots,T \qquad (2)$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{good} - s_{it}^{good} = z_{i0t}^{good},\ i=1,\ldots,ngood;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{bad} + s_{it}^{bad} = z_{i0t}^{bad},\ i=1,\ldots,nbad;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\lambda_j^t z_{ijt}^{\alpha} = \sum_{j=1}^{n}\lambda_j^{t+1} z_{ijt}^{\alpha},\ t=1,\ldots,T-1$$

$$s_{it}^{-}, s_{it}^{+}, s_{it}^{good}, s_{it}^{bad}, \lambda_j^t, \lambda_j^{t+1} \geq 0$$

Now let us define:

$$S_{it}^{-} = ks_{it}^{-}, S_{it}^{+} = ks_{it}^{+}, S_{it}^{good} = k\, s_{it}^{good}, S_{it}^{bad} = k\, s_{it}^{bad}, \Lambda_j^t = k\,\lambda_j^t, \Lambda_j^{t+1} = k\,\lambda_j^{t+1}$$

Then we have:

$$\tau = Min(\frac{1}{T}\sum_{t=1}^{T} w^t \left[k - \frac{1}{m+nbad}\left(\sum_{i=1}^{m}\frac{S_{it}^{-}}{x_{i0t}} + \sum_{i=1}^{nbad}\frac{S_{it}^{bad}}{z_{i0t}^{bad}} \right) \right])$$

S.t.

$$\frac{1}{T}\sum_{t=1}^{T} w^t \left[k + \frac{1}{s+ngood}\left(\sum_{i=1}^{s}\frac{S_{it}^{+}}{y_{i0t}} + \sum_{i=1}^{ngood}\frac{S_{it}^{good}}{z_{i0t}^{good}} \right) \right] = 1$$

$$\sum_{j=1}^{n}\Lambda_j^t x_{ijt} + S_{it}^{-} = x_{i0t},\ i=1,\ldots,m;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\Lambda_j^t y_{ijt} - S_{it}^{+} = y_{i0t},\ i=1,\ldots,s;\ t=1,\ldots,T \qquad (3)$$

$$\sum_{j=1}^{n}\Lambda_j^t z_{ijt}^{good} - S_{it}^{good} = z_{i0t}^{good},\ i=1,\ldots,ngood;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\Lambda_j^t z_{ijt}^{bad} + S_{it}^{bad} = z_{i0t}^{bad},\ i=1,\ldots,nbad;\ t=1,\ldots,T$$

$$\sum_{j=1}^{n}\Lambda_j^t z_{ijt}^{\alpha} = \sum_{j=1}^{n}\Lambda_j^{t+1} z_{ijt}^{\alpha},\ t=1,\ldots,T-1$$

$S_{it}^{-}, S_{it}^{+}, S_{it}^{good}, S_{it}^{bad}, \Lambda_j^{t}, \Lambda_j^{t+1} \geq 0$

Let an optimal solution be ({ Λ_j^{t*} }, { Λ_j^{t+1*} }, { S_{it}^{+*} }, { S_{it}^{-*} }, { S_{it}^{good*} }, { S_{it}^{bad*} },{k*}). We define optimal solution of DSBM model as follows:

$$\lambda_j^{t*} = \frac{\Lambda_j^{t*}}{k^*}, \lambda_j^{t+1*} = \frac{\Lambda_j^{t+1*}}{k^*}, s_{it}^{-*} = \frac{S_{it}^{-*}}{k^*}, s_{it}^{+*} = \frac{S_{it}^{+*}}{k^*}, s_{it}^{good*} = \frac{S_{it}^{good*}}{k^*}, s_{it}^{bad*} = \frac{S_{it}^{bad*}}{k^*}$$

4 Empirical Study

Based on proposed model which was described in previous section, we apply the dynamic SBM model to evaluate the efficiency of 10 branches of an Iranian bank over three consecutive terms. In order to select significant variables that have more relationship with efficiency of considered bank, we provided a checklist consisting important variables (inputs and outputs) in banking industry that utilized in researches before. Variables that we used in checklist distributed among headmen of branches are illustrated in Table 1. Also we arranged an interview with the CEO of bank, and she added new variable that had serious effect on efficiency of branches; it was loan losses. According to the development of bank during three previous terms, she assigned different weights to each term as follows: .6 for 1st term, .9 for 2nd term and .5 for 3rd term.

According to the result of checklists, we selected the variables that had gained more score. Each branch at each term has two inputs: average monthly salaries (x_1), operating expense (x_2) and one output: total value of loans (y_1), along with two carry-over activities: net profit as a good link (z_1) and loan losses as a bad link (z_2), carried from previous term to this term.

Table 1: Checklist's variables

Variables (inputs and outputs)	**Author (s)**
Total value of deposits	Camanho and Dyson (2008)
Current deposit	Lin, Lee, and Chiu (2009)
Net profit	Al-Faraj, Alidi, and Bu-Bshai (1993)
Balance of current accounts	Al-Faraj, Alidi, and Bu-Bshait (1993)
No, of staffs	Cook, Hababou, and Tuenter (2000)
Average monthly salaries	Al-Faraj, Alidi, and Bu-Bshait (1993)
Operating expense	Cook, Seiford, and Zhu (2004)
Number of accounts	Oral and Yolalan (1990)
Total value of loans	Camanho and Dyson (2008)
Interest and fee income	Begõa, Carlos, and Cecilio (2007)
Earning operating revenue	Lin, Lee, and Chiu (2009)
Interest revenue	Lin, Lee, and Chiu (2009)
Space	Sherman and Gold (1985)
Expenditure on decoration	Al-Faraj, Alidi, and Bu-Bshait(1993)
Number of full-time staff	Aly et al. (1990)
Return on asset (ROA)	Wang, Huang and Lai (2005)
Return on equity (ROE)	Wang, Huang and Lai (2005)

The evaluation index system of bank branch performance evaluation is shown in Table 2.

Table 2: Evaluation index system.

factors	Name of index	Unit of index
Input	Average monthly salaries	100'000'000 Riyal
	Operating expense	10'000'000 Riyal
Output	Total loans	1'000'000'000 Riyal
Good link	Net profit	100'000'000 Riyal
Bad link	Loan losses	100'000'000 Riyal

The data are given in following Table 3.

Table 3: Inputs-output and links data.

DMUs	**Average monthly salaries**			**Operating expense**			**Total loans**			**Net profit**			**Loan losses**		
	T1	**T2**	**T3**	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
DMU1	2.828	2.705	3.775	27.55	35.25	50.43	40.01	49.85	54.38	57.95	58.85	66.64	12.41	7.88	7.4
DMU2	5.667	5.825	7.657	84.5	122	105.5	282.9	297.6	322.5	94.18	87.29	111.6	41.34	34.95	28.64
DMU3	6.23	6.32	8.899	183.6	159.5	170.8	184.5	191.4	188.4	103.7	120.5	121.6	28.44	22.71	21.41
DMU4	5.577	5.532	7.552	122.7	94.48	94.97	195.9	200.5	202.2	58.98	58.42	58.25	22.8	25.68	26.69
DMU5	3.864	4.526	5.72	57.19	38.43	40.27	106.2	102.9	98.36	32.41	42.5	48.91	8.51	6.25	8.93
DMU6	4.696	4.601	6.196	72.07	2.64	3.41	175.5	176.1	190.7	60.7	58.88	47.68	10.35	11.89	10.22
DMU7	3.582	3.108	4.221	21.83	21.3	29.76	21.56	24.38	28.28	18.68	19.17	19.42	1.91	1.24	2.02
DMU8	5.395	5.522	7.139	63.85	56.14	49	133	147.1	156.8	76.77	99.79	100.9	30.49	21.06	18.07
DMU9	7.761	7.522	10.746	27.93	34.4	31.14	872.9	815.4	803.3	314.7	312.8	31.21	80.96	119.5	115.5
DMU10	3.748	3.593	5.138	59.99	96.5	60.43	113.7	121.6	122.9	72.64	84.51	81.45	7.33	3.28	13.53

The overall efficiency score is calculated based on the model (3). We used non-oriented dynamic SBM model to measure inefficiencies in both inputs and outputs concurrently. The results of dynamic model are summarized in Table 4. For making comparisons between dynamic and static model and clarify favorable features of dynamic model, we solved the problem in static situation that linkage between consecutive terms was neglected. We treated net profit as output and loan losses as input in each separate term. Overall efficiency of static model is calculated as an average of term efficiencies during three terms and illustrated in Table 5. There are considerable differences between dynamic and static model in the rank of overall efficiency. Results show that being inefficient in a single term can be covered by other terms. This is the unique feature of dynamic model that evaluates the efficiency from the long term view point by taking into account the links between consecutive terms.

Table 4: Dynamic efficiency evaluation and reference units.

	Overall dynamic efficiency	Reference units in term 1	Reference units in term 2	Reference units in term 3
DMU1	0.7591	9,10	1	1
DMU2	1	2	2	2
DMU3	0.6298	9,10	6,9,10	1,6
DMU4	0.4312	9,10	6,9	6,9
DMU5	0.685	6,9,10	6,10	1,6,10
DMU6	1	6	6	6
DMU7	0.8983	6,10	7	7
DMU8	0.7173	9	1,6,9	1,6,9
DMU9	1	9	9	9
DMU10	1	10	10	10

Table 5: Static efficiency evaluation

	Overall static efficiency	Term 1 efficiency	Term 2 efficiency	Term 3 efficiency
DMU1	0.232	0.3938	0.1667	0.1345
DMU2	0.664	0.392	0.6006	1
DMU3	0.563	0.3644	0.6284	0.6957
DMU4	0.422	0.3521	0.4549	0.4578
DMU5	0.602	0.5173	0.6863	0.6024
DMU6	1.000	1	1	1
DMU7	0.717	0.555	0.5971	1
DMU8	0.606	0.2833	0.6331	0.9024
DMU9	1.000	1	1	1
DMU10	1.000	1	1	1

In comparison with the static model, we found that DMU2 becomes efficient over three terms because inefficiency in 1st and 2nd terms eliminated in 3rd term. Efficiency score in dynamic model is relatively greater than that of static model; this means that branches are on a stream line to be more efficient during terms. In other words evaluating efficiency in a long term point of view provides us more comprehensive results.

On the basis of SBM feature to identify slacks, and in respect to inefficient DMUs, slack variable analysis realizes the status of input resource excess and output shortfall and improves the extent of corresponding attribute value (see Table 6). The results of table 6 provide the bank management with a direction for resource reallocation.

Take DMU4 with worst overall efficiency for example. The improvable spaces of this DMU's inputs, output, bad and good links at the first term are (3.4, 109), (2.5), (4.7) and (16.4), respectively. At the second term, efficiency will improve for DMU4 where the operating expense has to decrease by 87.2 units and total loans has to increase by .07 units. At the third term net profit as a good link must increase by 13.2 units.

5 Conclusion

This paper is the first empirical study in Iranian banking industry that incorporates time factor into the efficiency of branches using dynamic slacks-based measure model in DEA. We described the Dynamic

SBM model proposed by Tone and Tsutsui (2010) and applied to 10 branches of an Iranian bank for evaluating the efficiency over three consecutive terms. In order to select the most important variables, we introduced a checklist consisting most common variables in bank efficiency evaluation to headmen of branches and also we arranged an interview with the CEO of bank. Both dynamic and static models solved and results compared with each other to show that dynamic model can provide more comprehensive approach for evaluating the efficiency over terms, and inefficiency in a single term can be covered by other terms. Reference units at each term for every inefficient branch identified, slacks analyzed and further suggestions provided for the management.

Table 6: Inefficiency slacks from dynamic SBM model.

DMUs	Slacks												
	Term 1					Term2				Term3			
	s_{11}^-	s_{21}^-	s_{11}^+	s_{11}^{bad}	s_{11}^{good}	s_{22}^-	s_{12}^+	s_{12}^{good}	s_{12}^{bad}	s_{13}^+	s_{23}^-	s_{13}^{bad}	s_{13}^{good}
DMU1	.9	10	101	0	0	0	0	0	0	0	0	0	0
DMU2	0	0	0	0	0	0	0	0	0	0	0	0	0
DMU3	1.5	125	61	8.5	13.1	104	92.1	.81	0	45.6	111	2	0
DMU4	3.4	109	2.5	4.7	16.4	87.2	.07	0	0	0	0	0	13.2
DMU5	.9	12.9	0	1.5	18.5	4.4	14.5	11.7	0	22.4	17	0	0
DMU6	0	0	0	0	0	0	0	0	0	0	0	0	0
DMU7	2.5	6.2	8.1	0	0	0	0	0	0	0	0	0	0
DMU8	3.1	55.6	15.5	6.7	15.5	15	24.9	0	1.4	32.6	.2	0	.14
DMU9	0	0	0	0	0	0	0	0	0	0	0	0	0
DMU10	0	0	0	0	0	0	0	0	0	0	0	0	0

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