SBM SBM

2010~2014 0.5292

0.6350

SBM

100026

210046

1987 30

[1]

2016

582 136 17.86% 15.76%

3006 28.01% 30092

22.58% 13401 14.94%

2017SJB0243 2016LZ36

[1]

2011 1

Rice M P “ ”

[1] Sung

“ ” “ ” 7

[2] Chan K F and Lau T

9 [3]

5

[4] —

2 ‴Ḥ ɑ `

[1] DEA

[2]

DEA

1 DEA “ ”

2

3

SBM

SBM

DEA SBM

SBM

m DUM_j (j=1,...,m) $N(n \quad \{1,\dots,N\})$ n r_n s_n

j n x_j^n y_j^n SBM

n $v(v \quad \{1,\dots,N\})$

Tone “ ” $z_j^{(n \to v)}$ $(n \to v)$ L [3]

1. SBM

Tone “ ” SBM

SBM SBM

[3] SBM

$$\theta_o = \min_{\lambda^n, s^{n-}, s^{n+}} \sum_{n=1}^{N} w^n \left[1 - \frac{1}{r_n}\left(\sum_{p=1}^{r_n} \frac{s_{po}^{n-}}{x_{po}^{n}}\right)\right] \Bigg/ \sum_{n=1}^{N} w^n \left[1 + \frac{1}{s_n}\left(\sum_{q=1}^{s_n} \frac{s_{qo}^{n-}}{y_{qo}^{n}}\right)\right]$$

$$\text{s.t.:} \sum_{j=1}^{m} x_j^n \lambda_j^n + s^{n-} = x_o^n \quad (n = 1, \dots, N)$$

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[1] DEA —— 14
2012 1

[2] DEA
2013 4

[3] Tone, K., Tsutsui, M., “ Network DEA: a slacks-based measure approach ” *European Journal of Operational Research*, 2009, 197(1), pp.243-252.

$$\sum_{j=1}^{m} y_j^n \lambda_j^n + s^{n+} = y_o^n \quad (n = 1, \ldots, N) \qquad 1$$

$$\sum_{j=1}^{m} z_j^{(n \to v)} \lambda_j^n = \sum_{j=1}^{m} z_j^{(n \to v)} \lambda_j^v = z_o^{(n \to v)}, \left((n \to v) \quad L \right)$$

$$s^{n-} \geq 0, s^{n+} \geq 0, \lambda_j^n \geq 0, \sum\nolimits_{n=1}^{N} w^n = 1, \sum\nolimits_{j=1}^{m} \lambda_j^n = 1 (\lambda_j^n \geq 0, \quad j, \text{n})$$

[1]

$$\sum_{j=1}^{m} \lambda_j^n = 1 (\quad j, \text{n}) \qquad 2$$

S T Liu [2] SBM

n

$$\theta_o^n = 1 - \frac{1}{r_n} \left(\sum\nolimits_{p=1}^{r_n} \frac{s_{po}^{n-}}{x_{po}^n} \right) \Bigg/ 1 + \frac{1}{s_n} \left(\sum\nolimits_{q=1}^{s_n} \frac{s_{qo}^{n-}}{y_{qo}^n} \right) \qquad 3$$

$\lambda^n \quad R_+^n \left(n \quad \{1, \ldots, N\} \right)$ $s^{n-} \quad R_r^n \quad s^{n+} \quad R_s^n$ n

2. SBM

Fried et al.

DEA [3] DEA SBM

SBM SBM

$$IOS_{jt} = f_i(EV_{ji}, \alpha_i, \varepsilon_{ji}), \ j = 1, \ldots, m \qquad 4$$

$$I\hat{O}S_{jt} = f_i(EV_{ji}, \hat{\alpha}_i, \varepsilon_{ji}), \ j = 1, \ldots, m \qquad 5$$

$$x_{ji}^{adj} = x_{ji} + \left[\max j \left\{ I\hat{O}S_{jt} \right\} - I\hat{O}S_{jt} \right], \ j = 1, \ldots, m \qquad 6$$

SBM

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[1] Tone, K.,“ Variations on the theme of slacks-based measure of efficiency in DEA ” *European Journal of Operational* Research, 2010, 200(3), pp.901-907.

[2] Liu, S. T.,“ Chuang M. Fuzzy efficiency measures in fuzzy DEA/AR with application to university libraries ” *Expert Systems with Applications*, 2009, 36(2), pp.1105-1113.

[3] Fried, H. O., Schmidt, S. S., Yaisawarng, S.,“ Incorporating the operating environment into a nonparametric measure of technical efficiency ” *Journal of Productivity Analysis*, 1999, 12(3) pp.249-267.

IOS_{ji} j i EV_{ji} j
i α_i $I\hat{O}S_{jt}$ j
i x_{ji}^{adj} j i

3.

13 SBM 2010—
2014 SBM
7

$BIEE_{it} = BIE_{it}/BIME_{it}$ 7
$BIEE_{it}$ i t BIE_{it} i
t $BIME_{it}$ i t

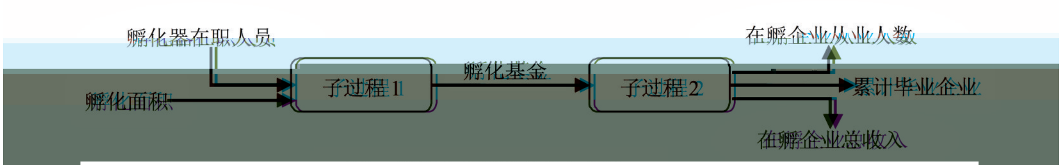
1.

1 BI_L BI_S
BI_F

2010 2012

2 BI_CE BI_IEI BI_IEL

3 1
2



1

1
4 GDP IS IFS ST

GDP

2.

13

2010—2014

65 2011—2015

2011—2015

2011—2015

1

BI_L		1978.00	140.00	645.00	499.08
BI_S		495.00	26.00	143.72	120.64
BI_F		68671.00	3557.45	15772.41	18625.96
BI_GE		1364.00	23.00	390.03	408.99
BI_IEI		592.39	7.12	87.78	148.30
BI_IEL		170711.00	6272.00	35506.77	37187.44
GDP		11118.01	1064.09	3602.05	2497.47
IS	%	53.40	36.95	41.05	3.97
IFS		6615.00	567.10	1924.56	1518.97
ST		4404.00	31.00	884.26	1159.28

2010

1

3.

2 2010—2014

					−		+		
			1	2	BI_L	BI_S	BI_GE	BI_IEI	BI_IEL
	0.6146	4	0.6146	1.0000	1026.5334	122.5372	0.0000	0.0000	0.0000
	1.0000	1	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.6289	3	0.8113	0.7754	217.9268	12.5154	27.2306	1231.6707	49.7511
	0.4584	9	0.6514	0.7025	707.8731	203.5317	128.4762	22669.0634	123.7127
	0.7443	2	0.7443	1.0000	746.9242	217.2572	0.0000	0.0000	0.0000
	0.4869	7	0.5833	0.8378	1131.2488	176.3407	182.2945	7171.2927	12.8882
	0.3537	12	0.9650	0.3652	29.4198	1.2882	285.9157	21340.5251	36.9224
	0.4696	8	0.8490	0.5490	60.9044	31.1742	112.7513	7311.7065	4.4625
	0.3877	11	0.9146	0.4295	93.0100	9.7981	707.1670	36094.7707	90.0491
	0.5419	5	0.9765	0.5562	21.8827	0.5511	246.7916	13397.1108	22.0740
	0.4993	6	0.6982	0.7186	290.2167	63.8798	207.0399	7237.6071	22.6789
	0.4070	10	1.0000	0.4070	0.0000	0.0000	532.8922	45286.1296	95.1230
	0.2875	13	1.0000	0.2875	0.0000	0.0000	397.7155	27077.3492	7.0521
	0.5292		0.8314	0.6637					

2010—2014

2 13 2010—2014

2010—2014

0.5292 47.08%

13

2

1 0.8314 2 0.6637

1

1 1

2

2 2

2

2010~2014

1026.5334 122.5372

4.

3 3 2010—2014

T 1%

0.6146
1.0000
0.6289
0.4584
0.7443
0.

4 - 7

3 2010—2014

0.8377 0.6350

1.0000

I II

III IV

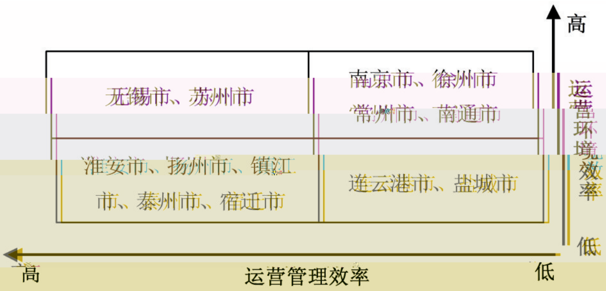
I

II

III

IV

“ —— ”



2

2010—2014

$$\ln BIE = c + \alpha_1 \ln GDP + \alpha_2 \ln IS + \alpha_3 \ln IFS + \alpha_4 \ln ST + \varepsilon \qquad 8$$

c $\alpha_i (i = 1, ..., 4)$ ε 4

4 $\ln GDP$ $\ln IFS$

$\ln ST$ 5% 1% 10%

$\ln IS$ 2010—2014

1%

0.0433% 0.4598% 0.1498% 4

4

		T	
c	4.1800	1.2151	0.2327
$\ln GDP$	0.0433**	2.4860	0.018
$\ln IS$	-2.5814	-0.3018	0.7646
$\ln IFS$	0.4598***	2.7822	0.0087
$\ln ST$	0.1498*	2.2268	0.0566
Adj-R^2	0.2220		
F	2.4252*		

* ** *** 10% 5% 1% P

SBM 2010—2014

SBM “ —— ”

1

2010—2014 0.5292

1 2

2 2010—2014

0.6350

“ —— ”

3

1%

0.0433% 0.4598% 0.1498%

1

13

2 10

15%

3