A Study on the Efficiency of Education Financial Expenditure in China

Li Sui

School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, 233030 P. R. China

sui2007nuaa@163.com

Abstract

DEA is a method to estimate the front-edge side of efficient production according to in-out value and estimate integrated effect about many-target. It also can judge suite degree of devoted scale of each DMU and point out how to regulate its devoted scale. The paper uses Data Envelopment analysis (DEA) model to estimate the efficiency of financial expenditure on education from 2010 to 2016 in China. The result shows that the efficiency of allocation of expenditure on education is increasing. But both pure efficiency and scale-efficiency need to be rectified. Finally, the paper gave some advice.

Keywords

Data Envelopment Analysis, decision-making unit, efficiency of financial expenditure on education.

1. Introduction

With the prosperity in economy and society, supporting to education from government financial expenditure and numerous financing channel, the scale of various levels of education institutions enlarged. Although the ratio of government financial expenditure takes on the downside, which still are the important sources of funds to many education institution, especially primary and junior education. Thus the evaluation on the efficiency of education financial expenditure will help promote the allocation efficiency of expenditure and bring financial expenditure into full play. The model will choose the data envelopment analysis(DEA).

Data Envelopment Analysis（DEA）is non parametric method that is widely used quantitative analysis, which bases on the operational research. In detail, DEA uses the relative efficiency among decision making Unit(DMU) and evaluates them. Analyzing synthetically in-out datum and giving quantitative index about synthetic efficiency of each DMU, hereby, each DMU is ranked and confirms efficient(namely high relative efficiency) DMU. It also points out the reason why DMU is inefficient and work out the degree of inefficiency, which supplies the management information to charge department. DEA also can judge the devoted scale of each DMU whether is suitable or not, and present the way about how to regulate the devoted scale. In addition, DEA makes single input-output DMU popularize many input-output DMU and weight are not supposed in advance, which avoid subjective factors and simplify the arithmetic. The paper will use Data Envelopment analysis (DEA) model to estimate the efficiency of financial expenditure allocation of education from 2010 to 2016 in China.

2. Brief introduction about DEA

The basic DEA model (shorted form CCR) put forward by Charnes, Cooper and Rhodes is fixed scale-reward. Using fixed scale-reward model to measure efficiency, the postulate is each decision-making unit being in the best production scale, otherwise, calculated value will cover scale infection. To measure pure technology efficiency, Banker, Charnes, Cooper advanced changing scale-reward model(shorted form BCC) . Under the postulate of changing scale-returns, the possibility muster of production is

$$\left\{ (X,Y): X \geq \sum_{i=1}^{n} \lambda_i X_i,\ \ Y \leq \sum_{i=1}^{n} \lambda_i Y_i, \sum_{i=1}^{n} \lambda_i = 1, \lambda_i \geq 0, 1 \leq i \leq n \right\}$$

Pure technology efficiency model built on the Tv(added slack variable—SA,SB and momentum ε)is:

$$D_t^v = \begin{cases} \min[\theta_v - \varepsilon(e_1^T SA + e_2^T SB)] \\ s.t \sum_{i=1}^{n} \lambda_i X_i + SA = \theta_c X_0 \\ \sum_{i=1}^{n} \lambda_i Y_i - SB = Y_0 \\ \sum_{i=1}^{n} \lambda_i = 1 \end{cases} \quad (1)$$

$\Lambda_i \geq 0$, i=0, 1, 2, …, n, SA≥0, SB≥0

So： when the result is θ_v^*,λ^*,SA^*,SB^*, there are following conclusion:

(1) If θ_v^*=1, and SA=SB=0, so DMU_0 is efficient;

(2) If θ_v^*=1, so DMU_0 is efficient shortly;

(3) If θ_v^*<1, so DMU_0 is non-effective.

Judging from the former, the value measured based fixed scale-returns model, including the scale efficiency and pure technology efficiency. And changing scale-returns model calculates the pure technology efficiency of production unit. Tne relation of technology efficiency (θ_c) ,pure technology efficiency (θ_v) and scale efficiency(θs) is $\theta_c = \theta_v \times \theta_s$.

Running CRS, VRS separately can gain θ_c and θ_v, then, we can calculate the scale efficiency. If $\theta_c=\theta_v$,the scale efficiency of production unit is 1,that is, the production is in the fittest scale; if not, the scale efficiency will be loss. The causations leading to scale efficiency loss are unduly bigness or unduly smallness in scale. But if θ_s<1,we can not make out the industries are in the section of increasing scale-returns or decreasing scale-returns, the effect of analyzing scale efficiency is weakened. Therefore, Coelli brought forward the model--Non-increase Returns to Scale (shorted form NIRS) to judge which section the decision-making units will be in. The restriction of VRS is changed to $\sum_{i=1}^{n} \lambda_i \leq 1$ that is the NIRS model.

If production is in the non-effective. scale(θ_s<1), we can distinguish which scale-returns phase that units are in:

(1) If $\theta s=\theta n$, the units are in the decreasing returns to scale, unduly bigness in industry scale leads to inefficacy, and reducing scale can improve efficiency.

(2) If $\theta s\neq\theta n$, the units are in the increasing returns to scale, unduly smallness in Industry scale leads to inefficacy, and widening scale can improve efficiency.

3. Research on the efficiency of financial expenditure allocation of education in China

The efficiency of financial expenditure is the transform efficiency of input-output. In detail, the government allocated limited public resources to education, purposing to supply various educational product, how the effectiveness of the allocation? The problem involves the input and output of education, which reflecting the degree of contribution of devoted resources to the output, efficiency of financial expenditure collocation i.e. From long-term, the efficiency of financial expenditure will influence the quality and quantity of education.

The paper refer interrelated theories and production about the efficiency of resources collocation, combining effective method—data envelopment analysis (DEA) to study the allocation efficiency of financial expenditure of various levels of education from 2010 to 2016.

3.1 Choosing data

The paper chose index containing various levels of education institutions. Concretely, the output index include the gross student enrollment rates at various levels of education institutions which concern higher education, senior education, junior education and pre-school education; the input index include the budgetary expenditure on education of per student. To choose these index based on 3 reasons: firstly, the gross student enrollment rates is the important index to measure the scale and level of education and also the main goal of judging performance of financial expenditure on education; secondly, financial expenditure on education mainly comes from budgetary expenditure, so the budgetary expenditure on education of per student examines the government how to guarantee various levels of education; thirdly, the gross student enrollment rates is decided by regional economy development, population base and the degree of expenditure on education.

3.2 Study on the efficiency of financial expenditure on education in China

The paper will analyze the efficiency and scale of financial expenditure on various levels of education from 2010 to 2016 in China. we adjusts the datum using price index, and the datum show on table 1.

Table 1 Input-output datum about financial expenditure on various levels of education from 2010 to 2016 China

Year	out-put datum				in-put datum			
	net enrolment rate for school-age children in primary school (%)	the gross junior student enrollment rates(%)	the gross senior student enrollment rates(%)	the gross higher education enrollment rates(%)	budgetary expenditure on education of per primary student	budgetary expenditure on education of per junior student	budgetary expenditure on education of per senior student	budgetary expenditure on education of per higher student
2010	99.7	100.1	82.5	26.5	4012.51	5213.91	4509.54	9589.73
2011	99.79	100.1	84.0	26.9	4966.04	6541.86	5999.60	13877.53
2012	99.85	102.1	85.0	30.0	6128.99	8137.00	7775.94	16367.21
2013	99.71	104.1	86.0	34.5	6901.77	9258.37	8448.14	15591.72
2014	99.81	103.5	86.5	37.5	7681.02	10359.33	9024.96	16102.72
2015	99.88	104.0	87.0	40.0	8838.44	12105.08	10820.96	18143.57
2016	99.92	104.0	87.5	42.7	9557.89	13415.99	12315.21	18747.65

Note: Data source from forms statistics of education and forms statistics of expenditure on education of education department in China

Decomposing the efficiency of financial expenditure on education into pure efficiency and scale efficiency, pure efficiency reflects the input-output lever of financial expenditure on education under the present condition, which embodies syntheses ability. Under the same condition, higher pure efficiency brings higher output. Scale efficiency reflects the lever of macro-management, which is on the side of scale-economy.

As the whole, the efficiency of financial expenditure allocation on various levels of education is high relatively from 2010 to 2016, the mean was 0.833, and the mean of pure efficiency is 1, higher than the mean of scale efficiency which was 0.833. There were only one year—2010,when both pure efficiency and scale efficiency of financial expenditure on various levels of education reached efficient simultaneously. From pure efficiency, all research years were efficient. Since 2010, the expenditure on education have increased quickly. At the same time, output from various education have enhanced greatly, such as the gross senior student enrollment rates and the gross higher education enrollment rates. Pure efficiency has always operated entirely. From scale efficiency, the year when scale efficiency appearing effective were the same with the year when the pure efficiency was effective, which showed the scale of expenditure on education has great impact on the efficiency of the use of expenditure on various education. The year of 2012 and 2015, scale efficiency is low, under the effective efficiency, the whole efficiency of various education has been affected. From 2011 to 2016, scale efficiency has been affected by reducing the benefit of investment in scale of

expenditure on education. At present, China's colleges and universities have such problems as scattered distribution and repeated schooling. There are such problems in primary and secondary schools. This situation causes unreasonable allocation of teaching resources, and there is a great waste of education input.

Table 2 The efficiency of input and decomposition of manufacturing

Sequence	Year	General Efficiency	Pure Efficiency	Scale Efficiency	Scale -returns
1	2010	1.000	1.000	1.000	-
2	2011	0.823	1.000	0.823	drs
3	2012	0.741	1.000	0.741	drs
4	2013	0.801	1.000	0.801	drs
5	2014	0.843	1.000	0.843	drs
6	2015	0.798	1.000	0.798	drs
7	2016	0.824	1.000	0.824	drs
平均		0.833	1.000	0.833	0.833

4. Conclusion

Judging from the mean of these years, pure efficiency was higher than scale efficiency. In addition, the years when efficiency of expenditure was of a sort happened non-economic scale. There is room to improve the efficiency of financial expenditure on education. Improving the efficiency of various levels of education should pay great attention to management and expenditure allocation. Building people-oriented management system and following the principle of "Knowledge organization" to increase the efficiency of management; Quantifying allocation on expenditure on education and using economic levers to promote efficiency of financial expenditure.

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Author in brief:

Li Sui, Lecturer, mainly engaged in statistical theory and application, quantitative and technical economics**.** E-mail:sui2007nuaa@163.com.