Efficiency Analysis of Real Estates Investment and Development in China

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Abstract

In this paper we analyze and measure real estates investment and development efficiency of provinces in China. The methodology used to perform efficiency analysis is Data Envelopment Analysis（DEA）and logistic regression model. We use the DEA models include CCR and Slacks-Based Measure (SBM). The input variables include real estate investment, area of purchase land, area of development land and area of construction and the output variables include sales for commodity house, area of completion and sales of area. We adopt logistic regression model to analyze the effect factors of inefficient provinces. Finally, we provide the reform strategies of real estates investment and development.

Keyword：Real Estates, Performance Evaluation, LISREL Model, Data Envelopment Analysis, SBM, Logit Model

Introduction

Statistics from Ministry of Construction show that from 1980 to 2000, China's real estate industry had kept a rapid growth momentum with newly built houses in rural and urban areas to have reached 20.3 billion square meters, an increase of two folds as compared with the past 30 years. Chinese government has taken real estates industry as a new drive for its economic growth, and has taken various measures to support the industry. So far, total investment in real estate hit 80 billion RMB (10 billion US dollars) in China, accounting for 25 percent of the social fixed asset investment.

In this study, we measure the relative efficiency of real estates investment and development. Two stage methodologies to be used in this research. The methodology used to perform efficiency analysis of the province is Data Envelopment Analysis（DEA）and logistic regression model. Farrell[5]introduced a framework for efficiency evaluation and measurement, which was subsequently studied by Charnes, Cooper, and Rhodes [2], Banker, Charnes, and Cooper [1]etc. The development of linear programming approach is known as data envelopment analysis（DEA）. The DEA model assumes that the random error is zero so that all unexplained variations can be treated as reflecting inefficiencies. The linear programming approach is flexible. DEA is a mathematical programming approach developed to measure the relative efficiency of units in an observed group of similar units. DEA provides a relative efficiency measure for each unit based on a set of similar units or on best performers operating on the frontier.

Methodology and Data

Slacks-Based Measure（SBM Model）

DEA is a linear programming-based technique that converts multiple input and output measures into a single comprehensive measure of productivity efficiency (Epstein and Henderson, [4]). One of its most important features is its

ability to handle multidimensional inputs and outputs, unlike traditional performance indicators that generally use one input-one output measures.

Tone [9]has proposed a slacks-based measure（SBM）,which is non-radial and deals with input/output slacks directly. The SBM returns an efficiency measure between 0 and 1, and gives unity if and only if the DMU concerned is on the frontiers of the production possibility set with no input/output slacks.

In order to estimate the efficiency of a DMU（x_0, y_0）,we formulate the following fractional program in λ, s^-,and s^+:

$$\text{Min} \quad \rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{i0}}{1 + \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{r0}}$$

$$\text{s.t.} \quad x_0 = X\lambda + s^-$$

$$y_0 = Y\lambda + s^-$$

$$\lambda \geq 0, s^- \geq 0, s^+ \geq 0.$$

In this model, we assume that $X \geq 0$. If x_{i0}=0, then we delete the term s_i^- / s_{i0} in the objective function. If $y_{io} \leq 0$, then we replace it with a very small positive number so that the term s_r^+ / y_{r0} plays the role of a penalty.

Data and Input-Output Variables

The goal of this model is to evaluate real estates investment and development performance of China in order to provide an additional measure on how efficient invest and develop in China. There are 4 inputs and 3 outputs for this model. Mainland China has 31 provinces, included autonomous regions and municipalities. Thirty-one provinces were subjected to empirical analysis in this study. Data from the China statistics database, statistics data were used to determine the relative efficiency of the provinces in China.

In this research, the four inputs in the operational performance model are real estate investment（x_1）, area of purchase land（x_2）, area of development land（x_3）and area of construction（x_4）. Identifying output for product activities in general, and the provinces in particular, present difficulties for cost measurement but also for production performance. The three outputs are sales for commodity house（y_1）, area of completion（y_2）and sales of area（y_3）in our research.

Analysis and Results

Lisrel Analysis

The relationship between inputs and outputs should meet the requirement of 'Isotonicity', which the inputs increase; the outputs should not be decrease. Therefore, we use the LISREL model to investigate the causal effects and the associations. The LISREL model specifies the causal relationships among the latent variables, describes the causal effects, and assigns the explained and unexplained variance（Jöreskog & Sörbom, [6], [7]）.The full model comprised of the structural model, which comprised of two latent variables and seven manifest variables, and the measurement model, which specified the relationships between latent variables and

manifest variables. The results of parameter estimates are reported in Figure 1. The investment performance had a significant positive influence (P<.01) on the resource input (γ=198.67; t VALUE=5.94; p<0.001). The results of parameter estimates are reported in Table 1.

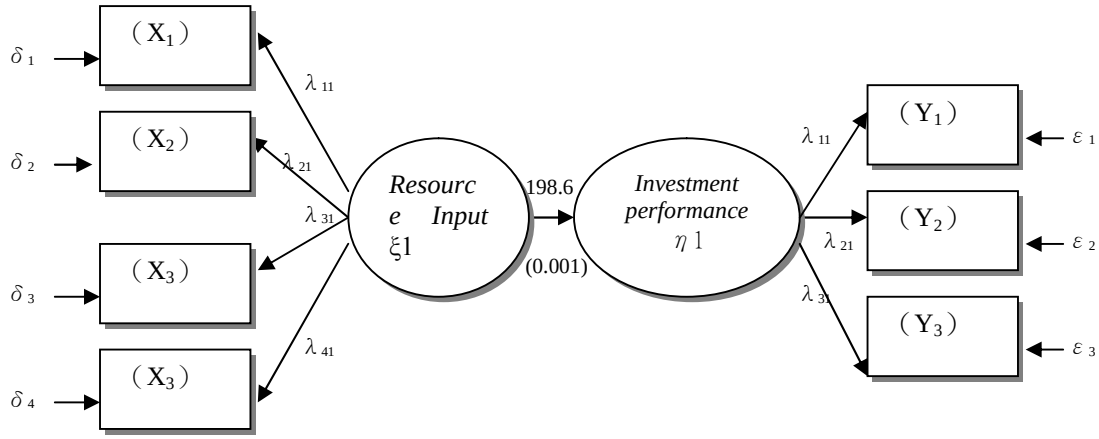

Figure 1：LISREL Model

Table 1 parameter estimates for structural equations

	Parameter estimates	Standard Error	T-statistics
Resource Input→Investment performance（γ_{11}）	198.679***	33.447	5.94

Note：”*”p<0.1 ”**”p<0.05 ”***”p<0.01

Efficiency Results

DEA provides a comprehensive evaluation of overall performance. The results for CCR and SBM models are shown in Table 2. The efficiency score analysis shows that 9 provinces are relatively efficient in CCR model, and its efficiency score are equal to 1. The estimated overall technical efficiency scores for the sample of provinces in China vary from 0.665 to 1, with an average of 0.898. Of the 31 provinces investigated in this study, 9 （29%）are found to be overall technical efficiency. The SBM results show that of the 31 provinces, 9 （29%）are efficient. These results were the same with CCR model. The most frequent reference province was found to be Heilongjiang.

Table 2 Reference Set and Slack Variables of SBM Model

DMU	CCR	SBM Model				Input Variables			
		SBM	Reference Set	Frequency	Rank	REI	APL	ADL	AC
1Beijing	0.976	0.697	8,9,29	0	16	-238.09	-800.02	-544.37	0
2Tianjing	0.846	0.670	8,9	0	18	-20.73	-204.66	-357.44	-486.67
3Hebei	0.666	0.425	5,8	0	30	-79.25	-634.97	-966.07	-621.03
4Shanxi	0.872	0.754	5,29	0	11	-7.67	-60.29	-110.07	-110.04
5Inner Mogolia	1	1	5	11	1	0	0	0	0
6Liaoning	0.844	0.732	8,9,29	0	13	-60.19	-172.90	-663.56	-517.36
7Jilin	1	1	7	0	1	0	0	0	0
8Heilongjiang	1	1	8	17	1	0	0	0	0
9Shanghai	1	1	9	9	1	0	0	0	0

10Jiangsu	0.933	0.743	8,9,29	0	12	-32.16	-839.32	-832.43	-467.93
11Zhejiang	0.736	0.572	8,9,29	0	26	-180.53	-2199.16	-802.15	-2297.91
12Anhui	1	1	12	0	1	0	0	0	0
13Fujian	0.993	0.758	9,29,30	0	10	0	-617.14	-265.69	-860.08
14Jiangxi	0.781	0.515	8	0	29	-11.53	-866.45	-266.04	-533.83
15Shandong	0.785	0.609	5,8,29	0	23	-80.05	-1308.16	-689.88	-1130.21
16Henan	0.884	0.701	5,8,29	0	15	-14.05	-283.82	-178.21	-710.97
17Hubei	0.886	0.603	5,8	0	24	-18.00	-1168.71	-552.72	-405.62
18Hunan	0.785	0.571	5,8	0	27	-31.31	-610.56	-496.11	-469.73
19Guangdong	0.931	0.690	5,9	0	17	-373.11	-89.94	-963.28	-3081.52
20Guangxi	0.964	0.559	8,9	0	28	-2.60	-298.65	-287.18	-511.20
21Hainan	1	1	21	0	1	0	0	0	0
22Chongqing	0.836	0.652	5,8,29	0	19	-33.93	-582.05	-294.71	-1615.49
23Sichuan	1	1	23	0	1	0	0	0	0
24Guizhou	0.880	0.634	8	0	20	-0.25	-207.07	-117.33	-794.75
25Yunnan	0.846	0.593	8,9,29	0	25	-16.55	-399.88	-244.57	-138.55
26Shaanxi	0.782	0.716	5,8,29	0	14	-26.09	-167.20	-68.00	-566.01
27Gansu	0.843	0.618	5,8	0	22	-3.91	-108.08	-98.07	-203.05
28Qinghai	0.886	0.620	5	0	21	-1.91	-51.64	-59.98	-81.75
29Ningxja	1	1	29	11	1	0	0	0	0
30Xinjiang	1	1	30	1	1	0	0	0	0
31Tibet	0.665	0.421	5,8	0	31	-3.91	-18.08	-78.07	-182.05

Note: 1. CCR: CCR efficiency scores, SBM: SBM efficiency scores

2. REI : real estate investment

APL : area of purchase land

ADL : area of development land

AC : area of construction

Slack Analysis

The next step of interest is estimating how much the outputs could be increased or inefficiency provinces could conserve the inputs. These mean additional decreases in inputs could enable a province to invest and develop as well as efficient provinces, and increases in output could be achieved through lower levels of inputs. Table 2 shows the results of slack analysis for 31 provinces. More detailed insights can be found from slack analysis at the individual provinces level. In this study, it was found that all the inefficient provinces could improve their performance by decreasing their inputs. For example, Beijing should be able to become efficient if real estate investment is decreased 238.09, area of purchase land is decreased 800.37（RMB ten thousand）,and area of development land is decreased 544.37 of their existing level. The results show the existence of a great amount of slack for this province and the need for it to utilize its resources more efficiently.

Logit Model Analysis

Logistic regression is a statistical technique used to classify observations, by means of a set of independent variables, into two or more mutually exclusive categories. This technique is appropriate, when the dependent variables are categorical（e.g. efficiency-inefficiency）and therefore non-metric, while the independent variables are metric. We can describe the logit model as follows. Let $Y = Y_1, Y_2, ..., Y_n$ be the N observations of the dependent variables which represent the outcome of the bidding process; it can be assigned as one or zero as follows:

$Y_i = 1,$ if area i is inefficient;

$Y_i = 0,$ if area i is efficient.

Table 3 shows the results of the regression predicting the effect factors for inefficient province. The variable ADL（*area of development land*） is statistically significant at the 0.05 level. The results show that ADL variable exhibits significant positive relationship between the effect factor and inefficiency province examined in this study.

Table 3 Logistic Regression Analysis Result

logit（Y）＝-0.82-0.001REL-0.002APL+0.012ADL

Chi-square＝13.537 df＝4 Sig.＝0.009

-2*log（Likelihood）：23.815 Cox & Snell R Square: 0.354

	Inefficient Area（Y=1）			
	B	S.E.	Wald	P-level
Constant	-.820	.876	.878	.349
REL	-.001	.008	.006	.939
APL	-.002	.003	.656	.418
ADL	.012	.006	3.835	.050**
AC	.000	.001	.082	.774

Note：1. Significant at the 0.01 level. ** Significant at the 0.05 level. ***Significant at the 0.1 level.*

2. REI: real estate investment（x_1）

APL: area of purchase land（x_2）

ADL: area of development land（x_3）

AC: area of construction （x_4）

Conclusions

In this study, we used nonparametric DEA methods to analyze the technical efficiency of provinces in China and used the logistic regression method to investigate inefficient provinces. The main findings can be summarized as follows. The CCR and SBM efficiency score analysis results show that 9 provinces are relatively efficient. All inefficient provinces can improve their performance by decreasing their inputs. Efficient reform strategies（down input） have been proposed for the inefficient provinces. When the inefficient provinces exhibit decreasing return-to-scale, it is likely that the program can improve their performance by decreasing their inputs. For inefficient provinces, the most significant way of reforms has been decrease area of development land strategy.

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