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A knowledge-based decision support system for measuring the performance of government real estate investment

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Abstract

This paper describes a knowledge-based decision support system for measuring the performance of government real estate investment using DEA models. We propose an evaluation framework for real estate investment, including a database, a model base, and a knowledge base, to create a tool that a government can use to deal with decision-making problems via the Internet. This decision support system converts numerical data into information that can be used to evaluate possible real estate investments. Particularly, rules in the rule base are explained in more detail for illustrating the process of reasoning and KDSSGREI adapts quickly and accurately to infer and generate suggestions or actions. Data envelopment analysis (DEA) is used to perform efficiency analysis in this paper. Finally, we apply China's case to obtain strategies for reforming real estate investment.

Keywords: Real estate investment; Decision support system; Data envelopment analysis; Performance evaluation

1. Introduction

Statistics from the Ministry of Construction show that from 1980 to 2003, China's real estate industry maintained rapid growth of newly built houses in rural and urban areas, reaching 20.3 billion square meters, a two-fold increase compared with the previous 30 years. The Chinese government sees the real estate industry as a new driver of economic growth, and has taken various measures to support it. Mainland China has 31 provinces, including autonomous regions and municipalities. So far, total investment in real estate has hit 80 billion RMB (10 billion US dollars), in China, accounting for 25% of the social fixed asset investment. Thus, when analyzing provincial real investment performance, we seek to answer the following questions: Does the government invest too much? Which province performs better in terms of productivity? What suggestions can we give to inefficient provinces to improve their efficiency?

Various researches have focused on the issues of location choice and real estate, including those of Archer (1981), Gerlowski, Fung, and Deborah (1994), Meen and Andrew (2004), and Painter and Gabriel (2003). But no similar studies on productivity with decision support systems have been done. Past studies have shown that location advantages and agglomeration economies positively affect the location choice of real estate investment. Location expresses the spatial distribution and accumulative behavior of firms. The productivity and technological level in a region may be important criteria for making location choice decisions (Zhao & Zhu, 2000). It is important for a province to know its relative performance and then make good decisions on reducing or expanding its investments. Because of the complexity and importance of measuring the performance of government real estate investment, decision support systems are frequently used as tools to support decision-making. Thus, in this study, a knowledge-based decision support system was developed to provide useful decision-making information, and we applied it to China. In this paper, the model used to perform efficiency analysis and productivity is data envelopment analysis (DEA). The results of this research can help the government studied here understand the relative operating performance of 31 provinces in China.

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

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units, or on the best performers operating on the frontier. Since DEA was developed by Charnes, Cooper, and Rhodes (1978), it has been widely applied to such industries as finance (Miller & Noulas, 1996; Mukherjee, Subhash, & Stephen, 2001), universities or educational programs (Banker, Charnes, & Cooper, 2004; Caballero, Galache, Gomez, Molina, & Torrico, 2004), medical care (Fickler & Wirtschafter, 1993), information technology (Lee & Barua, 1999), airlines (Tone, 1993), and the tourism industry (Barros & Alves, 2004), etc.

The decision support system can be used as a strategic planning tool to evaluate efficiency and performance-based decision-making information. The objective of the decision support system is to help decision makers make good decisions when dealing with complex situations and information. Al-Najjar and Alsyouf (2003) developed an efficient maintenance approach using multiple criteria decision-making. Their method leads to less planned replacement and reduces failures to approximately zero. Park and Han (2002) adopted case-based reasoning (CBR) and an analytic hierarchy process (AHP) to enhance a decision support system. Pal and Palmer (2000) developed a hybrid decision support system for the business acquisition process. Wen, Wang, and Wang (2005a,b) presented a new framework for knowledge-based intelligent decision support systems for national defense budget planning. Kuo and Xue (1998) presented a decision support system for sales forecasting through a fuzzy neural network. Shin and Lee (2002) used a genetic algorithm to predict whether a company would or would not go bankrupt. They found that using the genetic algorithm is better than using ANN. Wen, Wang, and Wang (2005a,b) also used a hybrid knowledge-based decision support system to support enterprise mergers and acquisitions. Their hybrid system integrates a database, case base, rule base, and model base into a tool managers oar use to deal with decision-making problems via the Internet.

The rest of the paper is organized as follows. Section 2 presents a brief review of the DEA theorem. In Section 3, the architecture of knowledge-based decision support system for measuring the performance of government real estate investment is addressed and explained. Section 4 presents the system implementation and results of empirical analysis, including system implementation, efficiency analysis, reference set analysis, return to scale analysis, and inefficiency analysis. Finally, some important conclusions and future works are given in Section 5.

2. Using data envelopment analysis to evaluate performance

This section introduces data envelopment analysis (DEA). Farrell (1957) introduced a framework for efficiency evaluation and measurement, which was subsequently studied by Banker et al. (2004) and Charnes et al. (1978),

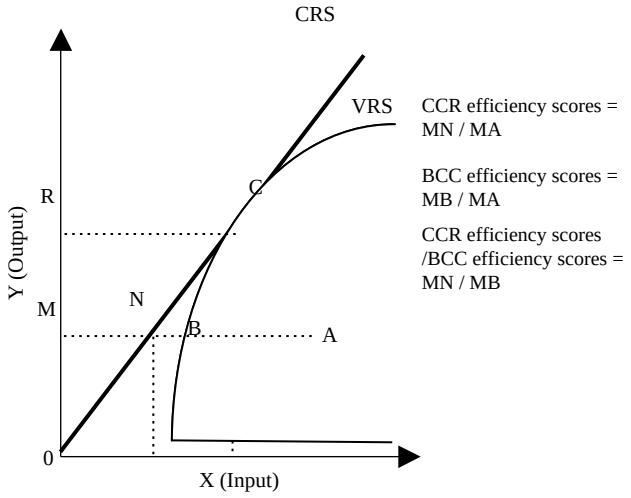

Fig. 1. Envelopment surfaces.

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. It can measure input or output efficiency under the assumption of various types of constant returns to scale (CRS) and variable returns to scale (VRS).

Fig. 1 shows the relationship between the CCR model and BCC model using a single input-single output scenario. The constant returns to scale envelopment surface (the CCR model) must pass through the origin and is, therefore, less restrictive than the envelopment surface of the BCC model. The BCC model reduces the size of the feasible production region by enveloping the data more tightly, and as expected, the number of efficient DMUs declared efficient increases as do the overall efficiency scores. It should be noted that constant returns to scale may exist in a data set if the frontier formed using the BCC model follows the same frontier formed by the CCR model. DEA is a non-parametric linear programming technique used to compare input and output data of production units, or decision marking units (DMUs), with input and output data of other similar DMUs. It is a technique used to measure and evaluate the relative performance of production units. DEA is commonly used to evaluate the efficiency of a number of producers. A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the 'best' producers.

The development of DEA methodology stems from the usual measure of productivity, a ratio of outputs to inputs. The formulation of a relative efficiency measure, or the ratio of weighted outputs to weighted inputs, was introduced to account for the existence of multiple inputs and multiple outputs. Charnes (1994) summarized that DEA calculations