

Study on Efficiency Evaluation of Safety Investment of Coal-Mining Enterprises Based on Audit Data

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Abstract. There are many reasons that can induce production accidents in the production process of coal-mining enterprises. The primary premise of normal production in coal industry is safety. In order to ensure coal mine safety production and prevent production accidents, a large number of resources must be efficiently invested in coal production companies. Based on the principles of safety and efficiency, this paper systematically explores the inherent necessity of introducing audit data into the safety resource efficiency evaluation system. At the same time, the characteristics of the recommended DEA method for estimating the effectiveness of safety investment are introduced. The recommended DEA could be used to every one of coal-mining enterprises that may have production accidents, as well as to estimate and reflect the efficiency of the safety investment in coal production companies. Based on function of the system of evaluation, the type of audit data and the main framework for evaluating efficiency of safety investment in coal-mining enterprises is proposed in the application of DEA method. The purpose of this study is to find a system to effectively manage safety resources based on audit data.

Introduction

In the entire production process of coal mining enterprises, if the safety equipment invested is insufficient, various production accidents will be formed directly or indirectly. For example, if the underground ventilation equipment and safety monitoring equipment in the coal mine production are insufficiently invested, the accumulation of various harmful gases in the production environment will exceed a certain limit, which will not only lead to the deterioration of the underground ecological environment, but also may cause a malignant gas explosion and bring about a large number of personal injury or death. Not only that, if the investment in the roof support equipment in coal mine production is insufficient, it will lead to the exacerbation of the underground support state and may cause the malignant roof collapse accident and cause serious personal injury. Coal mining enterprises have been included in the highly dangerous production industry by the Chinese government. The current trend is that many sciences and technologies work together to solve the safety problems in the production of coal mining companies. Life safety is the foundation of the sustainable development of human society, and the representative representation of the progress of civilization [1]. Therefore, this article will briefly discuss such system for assessment of efficiency based on auditing data of safety resources.

Requirement of Building Evaluation System

Necessities for Sustainable Development of Coal Mining Industry

The core connotation of sustainable development lies in meeting the current developments of various types without compromising the potential for development in a long term period [2]. In this special growth model, healthy economic growth, rational use of resources, excellent safety

environment, comprehensive social progress and overall development of individuals are all important factors in measuring sustainable enlargement, and should special reflect the value of people in social progress. Like everything, safety is the most fundamental assurance for coal mines then to gain more economic profit. So, investment of safety funds is the most vital deal then creating profits, in addition, safety environment is the essential condition for healthy production of coal mining enterprises.

New Field in Utilization of Auditing Information

To ensure the normal operation of coal mine production activities and the steady operation of financial accounting system is an important principle of audit work. With the rapid development of science and technology and the continuous enhancement of social and economic strength, the scope of audit work is gradually expanded. Audit information, like accounting information, plays an important and active role in more and more management fields. Audit data of safety input resources not only makes a great contribution to the production safety of coal enterprises themselves, but also provides an important basis for the macro decision-making of relevant government departments and the correct supervision of the government safety regulatory agencies. On the other hand, the application of audit data in the construction of efficiency evaluation system will become a new field of audit research.

Enlargement of Safety Investment

Under the environment of network economy, people have strong dependence on the excellent safety environment, and there is an urgent need for investment in safety. Personal injuries and huge economic losses caused by various accidents have made people pay more attention to the significance of safety. Similarly, coal mining enterprises that not increase their safety investment or not use efficiency will greatly increase the likelihood of production accidents. Once a production accident occurs, it will not only affect the normal production of coal mining enterprises, but also cause serious personal injury and health damage to coal miners. It is necessary to establish a long-term accident prevention mechanism in coal mining enterprises, establish a financial management and economic evaluation system for resource inputs, and safeguard the interests of coal mining enterprises, employees and the public. The funds invested are special resources to improve the production conditions of coal mining enterprises for safety purpose. Such funds shall be used in accordance with the normal production costs of coal mining enterprises and shall be used in accordance with safety requirements. Therefore, such resources should be supervised by the audit work whether they are accrued or used.

Conditions for Provision of Audit Data for Evaluation System

Improved Audit Report

The objective of the current audit is not only to perform the functions of ordinary audit work, but also to provide practical and usable audit data to the resource efficiency assessment system in order to maximize the quality and efficiency of the use of safety resources. The goal of establishing a safety resource economic benefit evaluation system also puts forward higher requirements for the form and content of the audit report. Improved audit reports on safety resources should be truthful, accurate, timely, convenient, applicable and practical. It must not only reflect the actual safety situation of coal enterprises, but also achieve the effects of prevention and prediction. This new and improved audit report should not only provide internal audit information[3][4], but also provide relevant external information; it should provide not only internal financial audit information, but also relevant internal control information[3][4]; not only currency information but also non-currency information. In short, the new audit report is the “work result” of the improved audit work. The monotonous model of past audit reports should be changed, and detailed safety resource information should be disclosed in the improved audit report to meet the needs of economic benefit assessment.

Perfecting Principles of Audit

These auditing information utilized by this assessment system is the current operational data of safety resources in the coal mining enterprise. These subsequent rules would be reminded when auditing statements involving safety are disclosed. First, the relevant auditing principles issued by the state should stipulate the quantity and content of the auditing information related to the safety input resources that should be disclosed in the audit report. Second, the perfect special audit mechanism of safety resources of coal mines must be constructed as soon as possible. Third, the actual safety effects should be compared with the audit information of safety resources. In addition, the operation status and efficiency of coal mine safety resources could be presented by specific "safety auditing report".

Outline of the Proposed DEA Method

Framework of Method

Based on the instability of economic profit, the rationality of safety resource supply of coal mining enterprises must be analyzed on the basis of high reliability of safety resource information. Data envelopment analysis (DEA) method in operational research can be used to study the influence of various factors on the rationality of safety resource supply, so as to further evaluate the return on investment brought by safety investment of coal mining enterprises. Decision unit (DMU) is the basic unit of DEA [5]. In DEA, a series of input factors related to safety resources must be taken as input factors of resource efficiency evaluation, and a series of decision-making output factors are determined correspondingly. There is no obvious correlation between input factors and output factors. Data envelopment analysis (DEA) compares the relative efficiency of decision units (DMUs) by using the mathematical programming model used. Because it evaluates DMUs from the best efficiency point of view, its conclusion is very true. The required data for the input factors of resource efficiency evaluation in DEA method derived from the warily chosen relevant data in audit work.

DEA Model

In the DEA model, z^t , v_i^t and u_j^t are used to represent the decision efficiency of DEA unit's output respectively, the input factor's weighted value variable assigned by the audit data of safety input resources and the decision output's weighted value variable (suppose to t). These three decision variables can be computed by the mathematical programming model C^2R proposed in this paper, see model (4). N numbers of decision-making units in the mathematical programming model (4) are utilized to assess the specific safety resources. For each decision-making unit, existence is I input factors and j output factors of audit data. In accordance with recent auditing theory and the requirement in estimating risks, the major input factors of model (4) must include the entire quantity of SE (safety costs accrued in one period), the entire quantity of SA (safety assets), TA (entire assets) and etc.. The major output factors of model (4) must be the entire quantity of AL (accident losses in coal-mining production), RRA (safety rate of return), ER (equity ratio) and etc., which related with the sustainable development of one coal mine. The assignment of variables SE , CA , FA , TA and AL must be gained by examining or consulting audit data. SA is the total of CA (safety current assets) and FA (safety fixed assets), but SA , RRA and ER can be computed by formulas of (1), (2) and (3) below.

$$SA = \sum CA + \sum FA \quad (1)$$

$$RRA = I_o / (TA_b + TA_e) / 2 \quad (2)$$

$$ER = OE_e / TA_e \quad (3)$$

In the formulas of (1), (2) and (3):

$\sum CA$: Safety current assets

$\sum FA$: Safety fixed assets

TA_b : Entire quantity of assets at beginning of period

TA_e : Entire quantity of assets at end of period

I_o : Income before interest expense and income tax

OE_e : Owner's Equity of balance

In the next model of (4), x^n_i, y^n_j are the No.i input and No.j output in No. n unit, v^t_i and u^t_j are the weights of the No.i input factor of estimating the safety resources and No.j output computed by the model (4)

$$\left\{ \begin{array}{l} \mathbf{max} \ z^t = \sum_{j=1}^J u^t_j y^t_j \\ \mathbf{s.t.} \quad \sum_{i=1}^I v^t_i y^t_i = \mathbf{1}; \\ \quad \quad \sum_{j=1}^J u^t_j y^t_j - \sum_{i=1}^I v^t_i x^n_i \leq \mathbf{0}; \\ n = 1, \dots, t, \dots, N; u^t_j \geq e; v^t_i \geq e; i = 1, \dots, I; j = 1, \dots, J.. \end{array} \right. \quad (4)$$

This e is infinitesimal and the code estimated must guarantee positive weight of all units of inputs and outputs. This model (4) represents thus a specification situation that no of a unit of safety resources estimated would more than 100% or more than 1.0 ratios when coefficient of the similar set of inputs and outputs is utilized to compare with all other units. If the different t would be add into this model (4), the $z^t(0 < z^t \leq 1)$ or efficiency of a DMU would be determined, $z^t=1$ represents that this DMU for estimating the safety resources of this coal mine is effective and also represents lower risks, $z^t < 1$ represents that the DMU is inefficiency for this safety resources in this coal-mining company also represents more risks. With the model (4) of C^2R , the availability of safety resources would be estimated on the base of input and output factors in this coal mine, meanwhile the scope of in-inefficiency for the safety resources input into one coal mine would be determined.

Summary

If enough safety resources can be successfully put into the coal production enterprises, it will form a good safety production environment. This kind of investment is very vital for the stable operation of the coal companies. At the same time, if the investment efficiency is improved, it can also largely reduce the various losses caused by productive accidents. The goal of this study is to offer a latest route for the study of safety resource investment profit, and assist relevant units to make proper safety production decision according to the relevant research results.

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