Quest Journals
Journal of Research in Business and Management
Volume 11 ~ Issue 11 (2023) pp: 115-118
ISSN(Online):2347-3002
www.questjournals.org

Research Paper

Solution to the problem of fuzzy factor pricing and factor allocation

Chu Fang
College of Economics and Management, Zhaoqing University, Zhaoqing City, Guangdong, China

Abstract: *In today's fiercely competitive world, reducing production costs is an important factor for manufacturers to survive. Therefore, one of the problems faced by decision-makers is how to minimize production costs at a specific output, which can traditionally be solved through mathematical programming models to achieve optimal resource allocation. However, in some practical situations, due to the lack of historical references, the prices of production factors often exhibit uncertainty, making traditional analysis methods difficult to use. After Bellman and Zadeh proposed the concept of fuzzy theory, many scholars applied mathematical programming problems to fuzzy environments. However, in existing fuzzy mathematical programming models, many scholars obtain clear numerical values in their research, resulting in the loss of characteristics of fuzzy data. In addition, some models have overly complex solving methods, which reduces their applicability.This study aims to establish a universal and easily solvable factor allocation model to solve the problem of minimizing production costs and provide substantive assistance to decision-makers. When the price of production factors is a fuzzy value, the total production cost is also a fuzzy value. This study attempts to use the Yager sorting method to sort the fuzzy factor coefficients in the cost function. Firstly, they are converted into clear values, and then solved using traditional mathematical programming models. This solution method was also compared with the commonly used centroid method in fuzzy decision-making, and the differences in the results obtained by the other three commonly used fuzzy numerical ranking methods were analyzed. The results show that when the factor prices are symmetric fuzzy values, the results obtained by the centroid method and the Yager sorting method are the same; When the factor prices are asymmetric fuzzy values, the results of the Yager sorting method are better than those of the centroid method. Therefore, the Yager sorting method is the optimal solution for this type of problem. This study applies the concept of solving factor allocation problems to transportation problems where the unit transportation cost is a fuzzy numerical value. The results also indicate that using the Yager sorting method to solve this problem can achieve lower total transportation costs.*

R*eceived 15 Nov., 2023;* ***R****evised 28 Nov., 2023;* ***A****ccepted 30 Nov., 2023*

P*ublished with open access at* ***www.questjournals.org***

I. Introduction

The production cost of enterprise manufacturers is not only influenced by production technology, but also by the combination of production factor inputs, which is an important key factor. Different combinations of factors will result in different production costs. Under these conditions, in order for enterprise manufacturers to achieve the lowest production cost, they need to face how to make the most appropriate allocation of scarce production costs around them, in order to achieve maximum output and promote the lowest total cost. In other words, the decision problem for managers is to determine the optimal quantity of various resources at a specific production level in order to minimize the total cost. In order to solve such resource allocation problems, homework research is one of the most commonly used tools in decision-making, and mathematical planning is the most widely used tool among them. Mathematical planning models can be applied not only to production decisions of enterprise manufacturers, but also to water resource management, forest thinning, engineering design, and investment decisions. The advantages of using mathematical programming models have led many scholars to develop useful mathematical models and their corresponding solving methods. In addition, there are various efficient commercial software solutions that can be utilized, which is its biggest advantage.

II. Research Model

Fuzzy sorting method is mainly a method considered when fuzzy numbers present different possible values of membership functions, which makes it difficult to highlight the final value to determine which scheme is preferred. In 1970, more than ten methods or theorems were proposed. Freeing (1979) classified fuzzy sorting methods based on their usage, including extended maxima, implication logic, preference relationships, and direct comparison(Direct comparison) and linguistic methods.

Later, Tseng et al. (1988) classified fuzzy sorting methods into four categories based on their applications: Hamming distance, fuzzy boundaries, centroid index, and likelihood advantage. Zeng et al.'s method mainly combines the advantages of Freeing (1979), Lee, and Li (1988) to develop a set of different types of fuzzy sorting methods. In addition, Tseng et al.'s method also provides some fuzzy permutations constructed for various criteria in different situations to construct better sorting results.

This method mainly calculates the priority index values in fuzzy sets, that is, the dominance between fuzzy numbers. When the preference index of a fuzzy set is higher, its ranking is also higher. The determination of the preference index of a set is determined by the position of the fuzzy set tip, and since it is based on the shape of the fuzzy set and its position on the coordinate axis, illogical results may occur. The relevant fuzzy sorting methods are summarized as follows:

In this study, when factor prices become fuzzy values due to the lack of historical data or subjective judgments of decision-makers, the centroid method (Yager, 1980a) and Yager fuzzy numerical ranking method (Yager 1981) are used to solve the problem of factor allocation under fuzzy factor prices; And the results of the two different solving methods were compared and analyzed using the fuzzy numerical sorting method proposed by Tsukamoto et al. (1983), the fuzzy numerical sorting method proposed by Chen (1985), and the fuzzy mathematical sorting method proposed by Tseng and Klein (1989).

III. Empirical Research

Among various production functions, the Cobb Douglas production function is the most commonly used. Its production function has many unique properties, such as diminishing marginal returns on labor, diminishing marginal returns on capital, and different characteristics of returns to scale.The production function of Cobb Douglas can be expressed as:

$$Q = AL^{\alpha}K^{\beta}$$

In the formula, Q represents the output of goods, L represents the input of labor, K represents the input of capital, and variables α and β It is a parameter between 0 and 1, and A is a positive technical coefficient related to production technology. When α æ β< At 1 o'clock, it indicates that the manufacturer is in the stage of increasing returns to scale; When α æ β= At 1 o'clock, it indicates that the manufacturer is in a fixed stage of scale regression; When ασβ< At 1 o'clock, it indicates that the manufacturer is in a phase of diminishing returns to scale.

Assuming that w and r are the prices of labor and capital, respectively, the cost function of the total expenditure incurred by a company in hiring two production factors is represented by equation:

$$C = wL + rK$$

Therefore, the decision-making problem faced by enterprise manufacturers is how to determine the optimal combination of production factor usage (L, K) at a specific output level Q, in order to minimize production costs C. Therefore, the resource allocation problem of enterprise manufacturers can be transformed into the following mathematical programming problem, as shown in pattern.

$$Min \quad C = wL + rK \; subject \quad to \quad AL^{\alpha}K^{\beta} = Q$$
$$L \geq 0, K \geq 0$$

They are known constants α and β, therefore they are nonlinear programming problems with equal sign constraints. For these problems, Constrained Variable Metrics (CVM) or general reduced gradient methods can be used

Generalized Reduced Gradient (GRG) can be effectively solved

(Reklaitis et al., 1983; Rao, 1996). In traditional economics, solving methods are based on the tangent point between the equal production curve in equation (3.1) and the equal cost line in equation (3.2) is used to determine the optimal allocation of two production factors by the enterprise manufacturer.

In this example, assuming that the prices of labor and capital are expressed as w=90 and r=60, respectively, the coefficients in the production function are A=3 α= 0.5 β= 0.5 and Q=120. The factor configuration issues that manufacturers need to face are:

$$Min \quad C = wL + rK \text{ subject } \quad to \qquad AL^{\alpha}K^{\beta} = Q$$

$$L \geq 2, K \geq 1$$

		End point						Supply quantity
		1	2	..	*j*	..	*n*	
Starting point	1	c_{11} x_{11}	c_{12} x_{12}	..	c_{1j} x_{1j}	..	c_{1n} x_{1n}	s_1
	2	c_{21} x_{21}	c_{22} x_{22}	..	c_{2j} x_{2j}	..	c_{2n} x_{2n}	s_2
	:	:	:	:	:	:	:	:
	i	c_{i1} x_{i1}	c_{i2} x_{i2}	..	c_{ij} x_{ij}		c_{in} x_{in}	s_i
	:	:	:	:	:	:	:	:
	m	c_{m1} x_{m1}	c_{m2} x_{m2}	..	c_{mj} x_{mj}	..	c_{mn} x_{mn}	s_m
Demand		d_1	d_2	..	d_j	..	d_n	

IV. Result

This study uses two methods, the centroid method and the Yager sorting method, to solve mathematical programming problems with fuzzy objective function values. When labor prices and capital prices are symmetric fuzzy values, the optimal cost value obtained by the Yager sorting method is the same as the result obtained by the center of gravity method. Moreover, when the fuzzy values of these two factor prices are clear values, their most likely values wm and rm are the same as the optimal factor allocation, and the corresponding fuzzy values of the total cost are also the same. In addition, when the fuzzy values of labor prices (capital prices) in the model are converted to a single explicit value, the results obtained by the centroid method and the Yager sorting method are the same as those obtained by traditional optimization methods, representing the robustness of these two methods.

The focus of this chapter is to discuss the solution program for transportation problems with fuzzy unit transportation cost coefficients. This study uses the Yager sorting method to directly rank unit transportation costs with fuzzy characteristics. Under the condition of minimizing the sorting index value, the minimum total transportation cost and optimal transportation volume were solved. Comparing the results of the centroid method and the Yager sorting method using three fuzzy sorting methods, the results show that the fuzzy value of the total transportation cost solved by the Yager sorting method is smaller than that solved by the centroid method. This confirms that the Yager sorting method is a better solution method.

If the fuzzy values of factor prices are asymmetric, then the fuzzy values of the total production cost obtained through two solving methods are also asymmetric. Comparing the results of the two solving methods with the other three fuzzy numerical sorting methods, the results show that the Yager sorting method seems to achieve better results under the goal of minimizing total production costs.

References

[1]. Kao, C. and S.T. Liu, 2003, A mathematical programming approach to fuzzy efficiency ranking, International Journal of Production Economics **86**, 145-154.

[2]. Kolodziejczyk, W., 1986, Orlovsky’ s concept of decision-making with fuzzy preference relation-further results, Fuzzy Sets and Systems **19**, 11-20.

[3]. Korhonen, P.J., 1986, A hierarchical interactive method for ranking alternatives with multiple qualitative criteria, European Journal of Operational Research, Vol. 24, 265-276.

[4]. Lai, Y.J. and C.L. Hwang, 1981, A new approach to some possibilistic linear programming problem, Fuzzy Sets and Systems **35**,

143-150.

[5]. Lee, E.S. and R.L. Li, 1988, Comparison of fuzzy numbers based on the probability measure of fuzzy event, Computer and Mathematics with Applications, Vol. 15, 887-896.

[6]. Lee, H.T., 2001, Cpk index estimation using fuzzy number, European Journal of Operational Research **129**, 683-688.

[7]. Lin, C.J. and U.P Wen, 2004, A labeling algorithm for the fuzzy assignment problem, Fuzzy Sets and Systems **142**, 373-391.

[8]. Reklaitis, G.V., A. Ravindran, and K.M. Ragsdell, 1983, Engineering Optimization, John Wiley & Sons, New York.

[9]. Rao, S.S., 1996, Engineering Optimization-Theory and Practice, 3rd Ed., John Wiley & Sons, New York.

[10]. Sinha, S., 2003, Fuzzy mathematical programming applied to multi-level programming problems, Computers and Operations Research **30**, 1259-1268.

[11]. Tanaka, H. and K. Asai, 1984, Fuzzy linear programming problems with fuzzy numbers, Fuzzy Sets and Systems **13**, 275-289.

[12]. Tanaka, H., T. Okuda, and K. Asai, 1974, On fuzzy mathematical programming, Journal of Cybernetics **3**, 37-46.

[13]. Tong, R.M. and P.P. Bonissone, 1984, Linguistic solutions to fuzzy decision problems, TIMS/Studies in the Management Science, Vol. 20, 323-334.