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Comparative Study of Management Accounting Interpolation Method and Profit Deficit Calculation Method

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Abstract: Management accounting is the product of accounting and mathematics integration, interpolation is the management accounting capital time value and long-term investment project profit evaluation of the main calculation method, according to the selection of different test values, interpolation can be divided into interpolation, interpolation; Deficiency of surplus is the content of the seventh volume of The Nine Chapters suanshu in China, and its test values are different, which can be divided into deficiency of surplus (profit and loss), double surplus, double deficit, adequate surplus (surplus and non-surplus and non-deficit), adequate deficit (deficit and non-surplus and non-deficit). Through the analysis of mathematical mechanism, the case of applied anatomy found that: the calculation method of surplus deficiency is completely consistent with the interpolation method, interpolation method from the surplus deficiency, China's ancient mathematics to the development of modern management accounting, made a great contribution; It confirms the natural connection between accounting method and mathematics development, accounting is a dual subject with both social attributes and natural attributes. It provides a basis for improving the calculation methods of textbooks such as Management Accounting and Financial Management.

Keywords: Accounting Method, Interpolation Method, Jiuzhang Suanshu, Yu and the Lack

1. Introduction

Interpolation method is to use function $f(x)$ to insert the function value of several independent variable points in an interval to calculate the dependent variable value of the corresponding model structure, select independent variable and dependent variable value in the function model, and calculate the value of unknown dependent variable and independent variable. In this way, some complex function structure, The equations with the higher powers of the variables are transformed into simple calculations to find the corresponding values of the specific variables. The method of taking known values of x and $f(x)$ at other points in the interval is called interpolation. Select the test value corresponding to the calculated function value on both sides of the target value of the test is called inner interpolation; The test value on the same side of the objective function value is called external interpolation. The closer the calculation result of the test value is to the target value, the closer the test value is to the true value. If this particular function is polynomial, it is called

an interpolating polynomial. Interpolation method uses complex higher power in simple calculation, and is widely used in natural science experiments: physics, chemistry, medicine, economy, management and other industries. In "Management Accounting", "Financial Management", periodicals and other textbooks also has a core position [1, 2, 4].

In 1996, "Finance and Accounting" initiated a discussion [20, 21], especially the discussion on the calculation method of the embedded rate of return (IRR). The research results were fruitful, including the function method, the plane geometry method, the analytical geometry method, and the analytical coordinate and plane geometry similar proportion method. Recently, the author has read the textbooks of Management Accounting and Cost Management Accounting published by university Press, China Renmin University Press and China Machine Press. It seems that the introduction of interpolation method needs to be clear and improved. In particular, the Ministry of Finance issued the "Basic Guidelines for Management Accounting" and "Guidelines for Management Accounting Application" in 2016, which shows that the importance and application promotion of management

accounting are unprecedented, and the application [5-7] tools of management accounting are more profound.

The research objectives of this paper: one is to do new old problems; although the discussion of interpolation has become a thing of the past in accounting circles, there is still room for perfection, pragmatism and innovation. Second, the original source; Does the interpolation come from a foreign country? Is the development of Chinese ancient mathematics connected? [3] Third, the standard application; the introduction of the techniques of relevant textbook knowledge points should refer to the specification of the Chinese nation's intellectual property rights. Fourth, remolding attributes; Highlight the connection between mathematics and accounting, reveal that accounting not only has social attribute, but also has the double attribute of natural attribute, accounting and mathematics of natural discipline connection.

2. Interpolation Calculation Formula
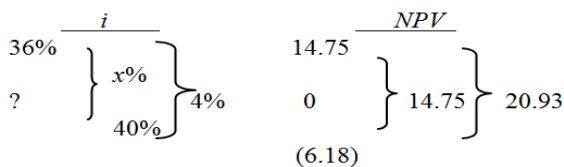
2.1. Li Tianmin's Calculation Method

Figure 1. Computational structure diagram 1.

$$x/4 = 14.75/20.93$$

$$x = (4 \times 14.75)/20.93 = 2.82 \tag{1}$$

IRR=36%+2.82%=38.82%

In Management Accounting, there are mainly applications in "Calculation of time value of money" and "Evaluation of long-term Investment Performance". In Modern Management Accounting (P270) [17], teacher Li Tianmin used the proportion method to solve the problem.

2.2. Calculation Method of Professor Yu Xu-ying

Yu Xu-ying, only the reservation xiao-mei guo, professor of IRR calculation method adopted is (coordinates) analytic geometry and plane geometry similar triangle than process (line with absolute value symbol, the book has been slightly) calculation method, the tassel professor with xiao-mei guo professor knowledge, YuXu-ying xiao-mei guo "management accounting" (new form of textbooks P212) [18, 19], the calculation formula:

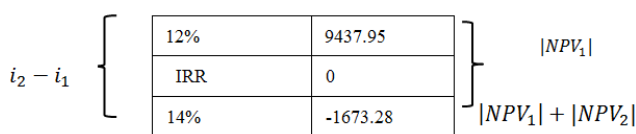$$IRR = i_1 + (i_2 - i_1) \times \frac{|NPV_1|}{|NPV_1| + |NPV_2|} \tag{2}$$

Figure 2. Computational structure diagram 2.

$$IRR = 12\% + 2\% \times \left(\frac{9437.95}{11111.23}\right) = 13.69\%$$

2.3. The Analytical Formula of Curve Is Replaced by a Straight Line

In1996, the author wrote an article and published it in "Management Accounting" [22]. Hededuced a new calculation formula based on the two-point linear method of the functional relationship between discount rate and net present value. The relationship between discount rate and net present value is an inverse proportional curve, but in the micro line segment (with small difference between two test values), straight line can replace curve. The theory that two - point fixed lines replaces at least three - point fixed curves. NPV is the value of f of x, where x is the discount rate. The derivation process of the analytic graph is omitted by using the analytic formula of direct substitution curve. Two-point line fixing formula: the two test values (x_1, N_1) and (x_2, N_2) are as follows:

$$\frac{N - N_1}{x - x_1} = \frac{N_1 - N_2}{x_1 - x_2}$$

$$x = x_1 + \frac{N_1 - N}{N_1 - N_2} \times (x_2 - x_1) \tag{3}$$

When *n*=0, *x* is IRR. This formula does not require an absolute value sign.

2.4. Solving Equations of Higher Order and Trial-and-Error Method

Eugene F. Brigham and Joel F. Houston calculate the IRR high-order equation in Financial Management [24]. P: 269.

$$NPV = CF_0 + \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + \cdots + \frac{CF_N}{(1+IRR)^N} = 0$$

$$0 = \sum_{t=0}^{N} \frac{CF_t}{(1+IRR)^t} \tag{4}$$

$$NPV_S = 0 = -1000 + \frac{500}{(1+IRR)^1} + \frac{400}{(1+IRR)^2} + \frac{300}{(1+IRR)^3} + \frac{100}{(1+IRR)^4}$$

The paper puts forward the method of trial and error, financial calculator and Excel to solve the problem. The trial and error method is to convert the results of two tests into interpolation method. The discount rate that makes the net present value of a project equal to zero is the internal rate of return (IRR) of an investment project, trial and error. We can use trial and error to solve the formula by inserting some discount rate into the equation and seeing if the result is zero; if the NPV is not equal to zero, try a different discount rate. Repeat this process until we find a discount rate that makes the net present value zero. This discount rate is the embedded rate of return. Using trial and error is very time consuming, so calculating IRR is rarely used. In fact, the book denies the science and feasibility of trial and error (interpolation). With Excel tools, as long as the cash flow is pulled into the IRR calculation function module, the answer will be displayed

immediately. The embedded calculation formula replaces the trial and error method, that is, the interpolation method. With Excel computing tools, solving high-order equations, is not a problem; but before computers, it was very difficult to solve higher order equations. The trial-and-error method is another name for interpolation, and it is the best choice for manual calculation in the historical period.

3. The Historical Origin of Interpolation

The development history of ancient mathematics in our country [3] has its origin, of interpolation algorithm. It originated from the Nine Chapters of Arithmetic collected by Zhang Cang and Geng Shouchang in the Western Han Dynasty, and from the labor and wisdom of the ancient Chinese nation. In Wei and Jin Dynasties, Liu Hui completely cracked Jiuzhang Arithmetical [3], and Jiuzhang Arithmetical Notes [8-10] were also translated by Li Chunfeng and Jin Ren in later periods. It has been translated into many foreign languages and is popular internationally. When the author used the multi-solution method to solve the 20 question of Volume 7 [11-13]: Shortfall of earnings in the Nine Chapters of Arithmetic Notes repeatedly illustrated by Professor Chen Zhiwu in academic reports in Shanghai and other places [16], he believed that the interpolation method in today's Management Accounting and Financial Management could be equivalent to the shortfall of earnings (profit and loss) solution.

Surplus deficiency is mainly a number of people to buy goods, according to a certain standard of payment, more than the total value, the amount of surplus; According to another standard payment, less than the total value, the less part is called insufficient, that is, debt, deficit; Divide the sum of profit and loss by the difference between the two payment values to obtain the full allocation criteria, and multiply by the purchase volume to obtain the payment value. In the distribution of materials, the first time according to the calculation standard distribution, the total number of distribution is less than the target value, the target value has a balance, called surplus; The second time according to another test standard allocation, the total allocation is greater than the target value, the target value relative allocation value is not enough, called deficit; Then ADD PROFIT AND LOSS (the absolute value of loss is actually profit and loss reduction, when introducing a negative sign, negative and negative is positive, that is, added. Divide by the difference between the two allocation criteria to arrive at the correct allocation criteria and the complete target total. Can also be used to cross multiply and add the two distribution standards and profit and loss, divided by the difference between the two distribution test standards, the total money, the number of things; then calculate the distribution standard and the number of people. Profit and loss is the distribution or payment of the total number relative to the total number of goals, did not reach the total number of goals, the number of goals relative to the allocation of more, called surplus; Exceeding the target total is called a deficit. The deficit is a negative number, and you add

the absolute value to the surplus. The target number is the standard, is the subtraction in the comparison difference; the number from the test is subtracted.

In addition to the type of profit and loss, there are other forms of combination of profit and loss, such as double profit. The calculation method is: the difference between the cross multiplication of the two molecular distributions and earnings is divided by the difference between the two distributions (the large profit decreases the profit). Double deficit, calculation method: the difference between the cross multiplication of the two allocations and the insufficient number (deficit) divided by the difference between the two allocations (big deficit reduces deficit). The calculation method is as follows: the first allocation target has surplus, the second allocation is just right, and the second allocation standard is obtained. Insufficiency is adequate, namely the first allocation is deficient, the second allocation is just, the second allocation standard was obtained, and the total amount is also obtained. Surplus less than five forms of calculation methods are obtained.

The mathematical mechanism is expressed by the following formula:

When the total quantity and a factor quantity are required to be solved, assume that the required two variables are set as y and x respectively, and the equation is: $y=ax+b$, and the two test variables can be functional expressions.

$$b_1 = f(x_1), \qquad b_2 = f(x_2)$$

We have two tests with values of

$$\begin{cases} y = a_1 x + f(x_1) \\ y = a_2 x + f(x_2) \end{cases}$$

$$Solution$$

$$\begin{cases} x = \dfrac{f(x_2) - f(x_1)}{a_1 - a_2} \\ y = \dfrac{a_1 f(x_2) - a_1 f(x_1)}{a_1 - a_2} + f(x_1) \end{cases} \tag{5}$$

Or

$$\begin{cases} x = \dfrac{f(x_2) - f(x_1)}{a_1 - a_2} \\ y = \dfrac{a_2 f(x_2) - a_2 f(x_1)}{a_1 - a_2} + f(x_2) \end{cases} \tag{6}$$

This is consistent with the solution of surplus and deficiency in Liu Hui's "Nine Chapters Arithmetical Notes", in which the positive numbers are subtracted from the negative numbers by cross multiplication, and the negative and negative numbers are plus, and the denominator is the difference between two distributions. It can be seen from the above that the only difference between Liu Hui's technique of surplus and deficiency and modern formula is the notation of addition and subtraction and the expression of positive and negative numbers. Our current "Management Accounting", "Financial management" in the interpolation method and profit and deficiency has the same origin.

4. Comparison Between Interpolation Method and Surplus and Deficiency Questions

4.1. Management Accounting IRR Calculation and Inadequacy

Table 1. *Discount rate 18%, NPV test.*

Age	0	1	2	3	4	5
The cash flows	-392500	130000	130000	130000	130000	121000
Convert into cash a rate	18%					
Clean current value	-392500	110169.5	93363.9759	79122.01	67052.55377	52890.22
∑ NPV	10098.25					

Table 2. *Discount rate 20%, NPV test.*

Age	0	1	2	3	4	5
The cash flows	-392500	130000	130000	130000	130000	121000
Convert into cash a rate	20%					
Clean current value	-392500	108333.3	90277.7778	75231.48	62692.90123	48627.19
∑ NPV	-7337.32					

Note: Data from [25]: P401.

Calculate IRR results from two test values:

Figure 3. *NPV was tested twice.*

Conformity surplus and deficiency calculation:

IRR = (-C7 * D8 + C8*D7)/(D7- D8) = 19.16%

Calculate by analytical formula:

$$IRR=C7 + ((D7-0)/(D7-D8)) * (C8 - C7) = 19.16\%$$

The calculation formula of surplus and deficiency is in complete agreement with the results obtained by the modern analytical formula method. Our ancestors have long used the test method to solve the higher order equation method, the surplus and deficiency method is the source of interpolation. In this case, the IRR is calculated, and the target net present value is 0. The net present value obtained by the two tests is greater than 0 and less than 0 respectively, so it belongs to the surplus and deficiency type.

4.2. IRR Calculation and Adequacy of Management Accounting by Ray H. Rison

Table 3. *Calculation table of present value coefficients of Ray H. Garrison.*

Age	Now	1-10
The beginning starts an investment	-16950	
The year cost economizes a sum		3000
Total cash discharge	-16950	3000
Convert into cash coefficient	1	5.650
Cash discharge current value	-16950	16950
Clean current value	0	

Note: Data from [26]: P408.

Here we know that NPV=0, present value coefficient is 5.650, period n=10, check the present coefficient table of ordinary annuity, the corresponding discount rate i=12%=IRR. This method, calculation formula and process are all in the present value of annuity coefficient table. We call the IRR value obtained in the last step as the table lookup method. In the interference deficiency method, when the discount rate of 12% is used for testing, the ∑NPV=0 can be obtained. In the interference deficiency method, it is called "interference adequacy", and the answer can be obtained in one test, which is a special case. The answer can be obtained in the interpolation method and the interference deficiency method at one time, and the definition of interference deficiency is more detailed than that of interpolation method.

4.3. Guo Xiaomei's Management Accounting IRR Calculation and Profit Deficit

Take Guo Xiaomei "Management Accounting" [P203] cash Flow as an example:

Table 4. *Net present Value test Table.*

Year	The discount rate	0	1	2	3	4	5	∑NPV
	NCF	(200000)	49600	49600	49600	49600	103600	
12%NPV	12%	(200000)	44285.71	39540.82	35304.30	31521.70	58785.42	9437.95
13%NPV	13%	(200000)	43893.81	38844.08	34375.29	30420.61	56229.93	3763.71
13.69%NPV	13.69%	(200000)	43628.29	38375.56	33755.24	29691.20	54549.70	0.00
14%NPV	14%	(200000)	43508.77	38165.59	33478.59	29367.18	53806.59	-1673.28
15%NPV	15%	(200000)	43130.43	37504.73	32612.81	28358.96	51507.51	-6885.56

13% and 14% were selected to meet the under-profit question twice, and the under-profit calculation formula was used to cross the product and divide the sum of profit and loss:

$$IRR=(14\%×3793.71+13\%×1673.28)÷(3763.71+1673.28)≈13.69\%$$

The results are consistent with those of equations (1) and (2).

Interpolation method in the selection of discount rate 13%, 14%, the sum of net present value distribution in the target net present value of 0 on both sides, belonging to the interpolation, to direct generation curve analytical formula method calculation (with the proportion method, analytic geometry and plane geometry method of the equivalent of the answer, completely equal, this is omitted.) According to Equation (3), the calculation is as follows:

$$IRR=13\%+(3763.71-0)×(14\%-13\%)÷[3763.71-(-1673.28)]≈13.69\%$$

If the first discount rate is 13.69% and the NPV sum is 0, there is no need for a second test, so the 13.69% test is called sufficient.

Table 5. *Comparison table between interpolation combined interpolation method and surplus and deficiency type.*

The discount rate	∑NPV	Combination of two tests	IRR	Type of surplus and deficit	Type of interpolation
12%	9437.95	12%With13%	13.6633%	Double surplus	Peripheral interpolation
13%	3763.71	12%With13.69%	13.6922%	Surplus with sufficient	Appropriate interpolation
13.69%	0	14%With13.69%	13.6922%	Kui with sufficient	Appropriate interpolation
14%	-1673.28	14%With15%	13.6790%	Double Kui	Peripheral interpolation
15%	-6885.56	13%With14%	13.6922%	Surplus less than	Internal interpolation

The more the test value is connected to the net present value of the target, the higher the precision of the calculated result is. The more the test value deviates from the target NPV, the lower the accuracy.

4.4. The Nine Chapters of Arithmetic Is Inadequate

Choose Liu Hui "Nine chapters of Arithmetic Notes" 20 titled example "Today some people hold money in Shu, the interest rate is 30%. First fourteen thousand, then thirteen thousand, then twelve thousand, then eleven thousand, then ten thousand. A total of five years even, all the benefits. Ask Ben to hold money and profit each geometry" (Yale economics professor Chen Zhiwu's favorite case) [14].

In order to facilitate calculation and calculation, the following calculation tables are set by using the Excel calculation tool:

Table 6. *Use tables instead of Excel charts.*

1	A	B	C	D	E	F
2	Period	1	2	3	4	5
4	Interest rate	30%	30%	30%	30%	30%
5	Current interest	9600	8280	6864	5323.2	3620.16
6	Principal plus interest	41600	35880	29744	23067.2	15687.36
7	Payment	-14000	-13000	-12000	-11000	-10000
8	Surplus or inadequate					5687.36

Where D2 is the initial variable, D4=D2*D3, D5=D2+D4; E2=D5+D6, E4=E2*E3, E5=E2+E4; F2=E5+E6, F4=F2*F3, F5=F2+F4; G2=F5+F6, G4=G2*G3, G5=G2+G4; H2=G5+G6, H4=H2*H3, H5=H2+H4, H7=H5+H6; The initial value of D2 is 32,000 yuan, which is 5,687.36 yuan more than the repayment principal and interest of 60,000 yuan. Just change the value of cell D2 and H7.

Table 7. *Interpolation combination and surplus and deficiency category division table.*

Order	Test values	Profit and loss	Combination test	borrowing	Profit and loss situation	Type of Interpolation
1	40000	35390.8	1 With2	30468 8/35	Double surplus	Peripheral interpolation
2	31000	1947.43	2 With3	30468 8/35	Surplus with sufficient	Appropriate interpolation
3	30468.23	0.0052	4 With3	30468 8/35	Kui with sufficient	Appropriate interpolation
4	30000	-1738.5	4With5	30468 8/35	Double Kui	Peripheral interpolation
5	28000	-9164.36	1With4	30468 8/35	Surplus less than	Internal interpolation

Where 0.0052≈0, the three tests in the table are sufficient, that is, the answer has been found. The answer of principal is calculated by the formula of surplus and deficiency method and interpolation method respectively, and the answer is the same. The formula and process of embedding calculation are omitted.

In fact, there is no need for three interpolation tests in some textbooks. Two external interpolation tests (both greater than or less than the target NPV) can be used to calculate the value of IRR, but there is a precision error. In Table 3, the calculated principal is slightly larger for the combined test values of 1 and 2.

5. Concluding Remarks

Examples of surplus and deficiency are common in mathematics of primary and secondary schools. Interpolation method is widely used in accounting textbooks of universities, but most books have no special introduction of knowledge and techniques, which seems to have forgotten their ancestors. There are many contents in Nine Chapters of Arithmetic [15], such as the application of calculation methods in cost management accounting, such as "square fields", "corn", "declining fractions", "Shaoguang", "commercial power", "uniformly lost", "equation", etc., which are not studied in this paper. The Nine Chapters of Arithmetic written in the Western Han Dynasty is more than 1,600 years older than the Sum of Arithmetic, Geometry, Ratio and Proportion written by Luca Pacelli of Italy. Nine Chapters on Arithmetic and Nine Chapters on Arithmetic [16] made great contributions to accounting techniques and methods. Unfortunately, it is separated into mathematics, management, economics, operations research and accounting. The above conclusions and suggestions are as follows:

5.1. Surplus Insufficiency Is the Original Source of Interpolation

Nine Chapters of Arithmetic originated from the social practice of Chinese ancient working people, from the collection of Zhang Cang and Geng Shouchang, and its solution came from Liu Hui's notes and Li Chunfeng's supplementary notes, etc. [15]. The interpolation method in management accounting and financial management is only a modern thing; According to the production time, transmission path, records, practical scope, skills and methods of detailed reasoning, the art of surplus and deficiency is the origin of interpolation. The skills and tools in management accounting shine with the wisdom of our ancestors.

5.2. Accounting and Mathematics Are Closely Related

In Fudan University and the Chinese Social Science Academic Conference [16], Professor Chen Zhiwu has repeatedly listed the cases of economic and financial interest in Volume 7 of Nine Chapters of Arithmetic. The author uses modern Excel computing tools to solve the two methods in Liu Hui's Jiuzhang Arithmetical Notes. At the same time, the method of profit and loss, difference ratio, analytical formula method, solution equation, mathematical modeling, and linear programming [23] in mathematics of primary and secondary schools and universities is used to expand the solution of this case, which is an epitome of the connection between accounting and mathematics. Not only that, the author found in the study of our country's accounting history: four-column account was widely used as early as in the Qin Dynasty, four-column account is actually four elements comprehensive balance in the modern accounting equation; Comprehensive equality is divided into two, is the theoretical foundation of balance sheet, profit statement. In modern accounting statements, income and expenditure are separated in the profit statement, the assets corresponding to the profit are added to the beginning assets, and the balance of assets and equity at the end of the period (balance sheet), which is the contribution of our ancient four-column account to accounting.

5.3. Accounting Has Dual Attributes

The connection between accounting and mathematics is more important: in the cultural relics unearthed in the Qin and Han Dynasties, there is a nine-by-nine multiplication table formula beside the four-column book, which proves the connection between accounting and mathematics with practical arithmetic tools. Multiplication tables beside the books on the four posts prove the connection between accounting and mathematics with the real objects of arithmetic tools. The calculation method of accounting "meter" comes from mathematics, accounting is the basis of measurement, the method is mathematics, and the premise of accounting is mathematics. But today's accounting discipline is defined as a social science, which is biased. Accounting subject and system setting are social, but the association between accounting and mathematics is innate, accounting is not only has the social attribute of management, but also has the natural attribute of natural connection with mathematics, accounting is a duality subject. In the Journal of Finance and Accounting in recent years, Yu demonstrated the problems existing in factor analysis and cost difference analysis with calculus mathematical analysis [27]. In addition, the problems of this

knowledge point were successfully solved by the exponential logarithmic proportion calculation method, which also shows that the mathematical method is consistent with the accounting method [28-30].

5.4. Current Textbooks Should Highlight

In the current textbooks, the calculation methods cited are mainly marked with the names of foreign authors, such as DuPont formula method, Wall's specific gravity method, interpolation method and so on. The research results of Chinese people not only have the problem of non-citing, but also a key link, which is difficult to publish in journals, let alone cite. Some intellectual property rights drift to foreign countries and return to be cited by some professors, experts, in the book. Empirical accounting is popular recently, do not know some journals from the quantitative correlation analysis, inspection, the relative index of the core values of mean, is the computer software programming simple arithmetic mean (to adapt to the absolute value data) method to calculate, simulate the levels, variance, t test, regression coefficient significance level is all wrong. The mean value (weighted average method) was recalculated for programming modeling, and the regression coefficient results were compared with SPSS, Eviews, Stata, Excel, Matlab, Pyshon and other tools. The positive and negative signs of the coefficients were opposite. Unfortunately, no journal has dared to publish this research. It is suggested that the interpolation method should be changed to the PROFIT and loss method, so as to clear THE source, highlight the contribution The Nine Chapters of Arithmeticto the accounting method, highlight the wisdom of the people, and prove the dual attributes of accounting. To sum up, the integration of accounting methods, economic methods and mathematics is so important.

The direct significance of this paper is that it reduces the difficulty of solving equations of higher order, which is not only a contribution to the development history of mathematics; also for "Management accounting", "Financial Management" and other textbooks in the relevant calculation, revision, improvement provides a basis.

Acknowledgements

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