Research and Optimization of Computer Intelligent Evaluation Model under C2C Mode by Fuzzy Matter-Element

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Abstract. This paper discusses the establishment of credit evaluation model suitable for the characteristics of C2C e-commerce, taking the C2C model as an example, so as to reduce the risk cost in e-commerce trade. This model synthesizes the advantages of Hamming nearness degree and variable weight theory, and puts forward the design idea of variable entropy weight with fuzzy matter-element, which has the characteristics of simple operation, strong applicability, and close to reality. From the results of empirical analysis, the model calculates the credit level of different e-commerce, and effectively solves the problem of multi-index evaluation incompatibility in the evaluation of e-commerce credit. This model provides a feasible method for selecting the best supplier, improving the scientific decision, and achieve a good application prospect.

Keywords: Electronic commerce, credit evaluation, Hamming nearness degree, fuzzy matter-element, variable weight, entropy.

1. Introduction
The C2C (Consumer to Consumer) e-commerce model is a form of transactions between consumers and consumers to carry out economic activities. Due to its good development prospects, wide range of applications, flexible and convenient transactions and other obvious advantages, this model gained a favorable popularity among consumers. Accompanied by this is the credit risk problem of the C2C e-commerce model. Due to the high uncertainty, virtuality and concealment of the model, it is easy to trigger the credit crisis of online procurement commodities, thus hindering the healthy development of the e-commerce market. E-commerce credit risk usually refers to the extent to which the buyer or seller may cause potential losses to the other side of the transaction because of the refusal of the buyer or seller to execute the trade contract due to subjective reasons or force majeure. This research illustrates that in order to effectively control the credit risk of C2C electronic commerce, it is applicable to establish a C2C electronic commerce credit evaluation system, and carry out effective electronic commerce credit evaluation work to scientifically select the best supplier. It will have an important significance [1-4] on improving the credit evaluation mechanism of C2C electronic commerce in China.

By combing relevant literature, the current research content of e-commerce credit evaluation in academic circles mainly focuses on two aspects: the establishment of index system and the choice of
evaluation method. Regarding the establishment of indicator system, the establishment structure of indicator system is constantly being optimized and improved with the deepening of research, which pay more attention to achieving the functional integrity and overall balance of indicator design from different angles. Regarding the choice of evaluation methods, in former researches, the common evaluation methods are mostly single evaluation methods, such as analytic hierarchy process (AHP) [5], entropy [6], and factor analysis. However, although the AHP method is simple for application, the subjective color of the index selection is quite strong, and the artificial segmentation trace of the weight design is heavy as well. Although the entropy method and factor analysis embody the objective data information characteristics of the index, they are usually not strong to use the conclusions to explain the problems clearly.

At the same time, the current e-commerce qualifications in the C2C model are uneven, the market supervision is insufficient, and there is a lack of a standardized and unified credit evaluation system. There is less literature on the analysis of C2C, a special e-commerce model. The subjectivity and objectivity of credit evaluation are insufficient, lack of effective empirical analysis, and the literature conclusions are not convincing.

On the basis of taking advantage of the traditional single evaluation method, this paper introduces Hamming nearness degree and variable weight theory, and establishes a variable entropy weight fuzzy matter-element model to provide a recommendation for E-commerce credit evaluation and strategy under C2C mode. New ideas and methods. Hamming nearness degree has the advantages of simple calculation and strong applicability. Variable weight theory can continuously correct the empirical weight by mining data information, effectively overcoming C2C e-commerce credit evaluation and supplier optimization process. The interpretative and persuasive conclusions make the supplier's choice more scientific and concise.

2. Establishment of Evaluation Index System for C2C Electronic Commerce Credit

E-commerce credit evaluation is usually determined by combining qualitative analysis and quantitative analysis. Compared with other models, the C2C e-commerce model is the most risky. The risks mainly come from the seller's credit risks arising from the process of information screening, commodity ordering, customer evaluation, and quality assurance services. Therefore, this paper constructs the C2C credit evaluation index system for the seller's subject as the evaluation object shall be shown as Figure 1.

![Figure 1. C2C Credit Evaluation Index System for Electronic Commerce.](image-url)
C2C e-commerce credit evaluation should focus on the main information data of e-commerce trade, and form effective information indicators through data analysis. This paper divides the overall objectives into two major evaluation dimensions according to the basic idea of system decomposition: static indicators and dynamic indicators. Static indicators are qualitative evaluation indicators, mainly reflecting whether the basic qualification information of e-commerce is compliant, complete, true, and accurate. Dynamic index is a quantitative evaluation index, which mainly collects, collates, and counts various quantifiable information that occurred in the course of e-commerce transactions and customer evaluation feedback, and forms an evaluation basis. According to the indicators status of basic information, transaction information, evaluation information and technical information, it is possible to completely restore the entire process from the establishment of qualifications to the development of trade activities of an e-commerce entity, which better reflects the true credit level of the merchants. The objective data of commercial credit evaluation, so the evaluation index system established in Figure 1 is scientific and comprehensive.

3. Design of Fuzzy Matter-Element Model Based on Variable Entropy Weight of Hamming Nearness Degree

3.1. Basic Principle of Fuzzy Matter-Element
The main feature of fuzzy matter-element analysis is that it can turn the contradictory problems that are easy to appear in multi-index evaluation into compatibility problems, so that the problems can be solved easily. In real world, because the quantitative matter-element usually have fuzzy properties, a new fuzzy compatibility problem has been formed. The new method is called fuzzy matter-element analysis method by introducing fuzzy mathematics theory and combining it with matter element analysis method. The method has the characteristics of simple calculation, reliable conclusion and strong adaptability.

3.1.1. Fuzzy matter element and Composite Fuzzy Matter-Element. Matter-element refers to the establishment of an ordered ternary \( R=(N, C, V) \) for describing something, where the name of something is \( N \), the eigenvalue is \( C \), and the quantitative value shall be \( V \). When \( V \) has fuzzy properties, it constitutes a fuzzy matter element. As for multidimensional features \( n \) with \( n \) features \( c_1, c_2, \cdots, c_n \) and corresponding \( n \) quantitative \( v_1, v_2, \cdots, v_n \), \( R \) is called \( n \)-dimensional fuzzy matter element. The combination of \( n \)-dimensional elements for \( m \) items constitutes an \( n \)-dimensional complex element for \( m \) items, which is denoted as \( R_{nm} \). Furthermore, if \( R_{nm} \) quantitative value has a fuzzy attribute, it is called as \( n \)-dimensional composite fuzzy matter element of \( m \) items, denoted as \( \otimes R_{nm} \).

\[
R_{nm} = \begin{bmatrix}
M_1 & M_2 & \cdots & M_m \\
c_1 & X_{11} & X_{12} & \cdots & X_{1m} \\
c_2 & X_{21} & X_{22} & \cdots & X_{2m} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
c_n & X_{n1} & X_{n2} & \cdots & X_{nm}
\end{bmatrix}
\]  

(1)

\[
\otimes R_{nm} = \begin{bmatrix}
M_1 & M_2 & \cdots & M_m \\
c_1 \otimes_{11} & \otimes_{12} & \cdots & \otimes_{1m} \\
c_2 \otimes_{21} & \otimes_{22} & \cdots & \otimes_{2m} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
c_n \otimes_{n1} & \otimes_{n2} & \cdots & \otimes_{nm}
\end{bmatrix}
\]  

(2)
In the formula, subscript \( n \) represents the number of eigenvalues that the item has; the subscript \( m \) represents the number of items; \( X_{ij} \) represents the quantitative values corresponding to the \( j \) eigenvalues of the value \( i \); \( \oplus_{ij} \) represents the fuzzy value \((1, 2, \ldots, n; j = 1, 2, \ldots, m)\) corresponding to the number \( j \) eigenvalue of the value \( i \):

### 3.1.2. Principle of Preference Membership and Standard Fuzzy Matter Element

In credit evaluation system of electronic business, the characteristic value is corresponding to the evaluation index of the evaluation object, and the fuzzy value is corresponding to the evaluation index value of the evaluation index. The fuzzy values corresponding to each individual indicator are subordinate to the corresponding fuzzy values of the corresponding evaluation indicators of the standard scheme, which is defined as the degree of subordinate membership. The process of converting the \( X_{ij} \) to \( \oplus_{ij} \) is actually a process of setting a membership function to determine the degree of membership. Generally, the membership function is constructed from the principle of optimal degree of membership. For the cost type and benefit type evaluation index, the membership shall be calculated as follows:

\[
\oplus_{ij} = \begin{cases} 
1 & X_{ij} \leq m_i \\
\frac{M_i - X_{ij}}{M_i - m_i} & m_i \leq X_{ij} \leq M_i \\
0 & X_{ij} \geq M_i
\end{cases} \quad (3)
\]

\[
\oplus_{ij} = \begin{cases} 
0 & X_{ij} \leq m_i \\
\frac{X_{ij} - m_i}{M_i - m_i} & m_i \leq X_{ij} \leq M_i \\
1 & X_{ij} \geq M_i
\end{cases} \quad (4)
\]

In the formula, \( m_{ij} \) and \( M_i \) correspond to the lower and upper limits of each evaluation object at the \( i \) index, respectively. The \( \oplus_{ij} \) reflects the degree of membership of the \( j \) evaluation object at the \( i \) indicator. For the evaluation type index, this paper combines the research practice and selects the formula for the degree of affiliation as \((\text{excellent}, \text{good}, \text{medium}, \text{low}, \text{difference}) = (1, 0.8, 0.6, 0.4, 0)\).

According to the principle of superior subordination, select the maximum degree of superior affiliation in each evaluation index, and form a standard fuzzy matter element, denoted as \( \oplus R_{nm}^0 \).

\[
\oplus R_{nm}^0 = \begin{bmatrix} 
M_0 \\
c_1 \oplus_{10} \\
c_2 \oplus_{20} \\
\vdots \\
c_n \oplus_{n0}
\end{bmatrix}
\]

### 3.2. Principle and Weight Design of Variable Entropy Value

In the electronic business credit evaluation, it is necessary to scientifically allocate the weight coefficient to measure the difference in the importance of each evaluation index. In this paper, the principle of variable entropy weight is applied for weight value design. The principle of variable entropy is a combination concept, which consists of entropy theory and variable weight theory. The main principle of the theory is that entropy theory is used to determine the constant weight, and on the
other hand, variable weight theory is used to determine the variable weight, and after reasonable superposition, a comprehensive variable entropy weight is formed.

3.2.1. Constant Weight Defined with Entropy Method. With the higher the order of a system, the smaller the entropy and the greater the amount of information it contains. On the contrary, if the degree of disorder of the system is higher, the greater the entropy, the lower the information content shall be formed. In general, as for the evaluation object set \( \{ B_j \} (j = 1, 2, \cdots, m) \) containing \( m \) items, each item contains \( n \) evaluation indicators, and the establishment of the original indicator score \( n \times m \) matrix shall be \( Z = (z_{ij})_{n \times m} \) \((i = 1, 2, \cdots, n; j = 1, 2, \cdots, m)\). For a certain indicator \( Z_i \) in matrix \( Z \), the greater the error of the indicator \( z_{ij} \) obtained by different measurement methods, the greater the role of the indicator in the comprehensive evaluation, the indicator should be valued, and the weight value coefficient shall be greater as well. Therefore, the corresponding information entropy is smaller, and vice versa. By using information entropy to provide a basis for the evaluation of indicators, the data dimension of the evaluation of indicators shall be unified. Data standardization of the original indicator matrix \( Z \) is required to obtain a standardized matrix \( Y = (y_{ij})_{n \times m} \) \((i = 1, 2, \cdots, n; j = 1, 2, \cdots, m)\).

Therefore, the information entropy \( e_i \) of the relative strength of the first indicator value is obtained.

\[
e_i = -k \sum_{j=1}^{m} y_{ij} \ln y_{ij}
\]  

(6)

It is generally believed that \( k = 1/\ln m \), \( m \) is the number of items, that is, the number of C2C e-commerce credit evaluation suppliers. The smaller the entropy \( e_i \), the greater the difference in \( y_{ij} \). Assuming the difference coefficient is \( g_i \), there is \( g_i = 1 - e_i \). At this point, the entropy weight of the \( i \) indicator is written as \( w_i^e \).

\[
w_i^e = \frac{g_i}{\sum_{j=1}^{n} g_j}
\]  

(7)

3.2.2. Variable Weight Defined with Variable Weight Theory. The theory of variable weight holds that the degree of importance between indicators is not constant, but will change with the change of index values. In the C2C credit evaluation index system, when indexes are far away from the standard value, it will accelerate the negative impact on the level of e-commerce credit. However, because of the fixed weight, the final evaluation results can not truly reflect the influence of the state of index, thus causing distortion of the evaluation results. Based on this, we use the local state variable vector with positive and negative excitation effect to correct the constant weight \( w_i^c \).

Define the constant weight vector as \( W^c = (w_1^c, w_2^c, \cdots, w_n^c) \), the local state variable vector as \( W^b(\otimes) = \{ w^b(\otimes_1), w^b(\otimes_2), \cdots, w^b(\otimes_n) \} \), and the local variable vector as \( W = (w_1, w_2, \cdots, w_n) \), thus, according to the multiplication rule:

\[
w_i = \frac{w_i^c w^b(\otimes_i)}{\sum_{j=1}^{n} w_j^c w^b(\otimes_j)}
\]  

(8)
In the formula, $\otimes_i$ is the optimal membership function value of the item evaluation indicator. The expression of $w^i(\otimes_i)$ in the local state variable vector shall be:

$$w^i(\otimes_i) = \begin{cases} 
1 & 0 \leq \otimes_i < \alpha \\
\frac{c-1}{\beta-\alpha} \otimes_i + \left(1 - \frac{c-1}{\beta-\alpha}\right) & \alpha \leq \otimes_i < \beta \\
\frac{c}{\gamma - \alpha} \otimes_i + \left(1 - \frac{c}{\gamma - \alpha}\right) & \beta \leq \otimes_i < \gamma \\
1 - \frac{c}{1 - \gamma} \otimes_i + \left(1 - \frac{c}{1 - \gamma}\right) & \gamma \leq \otimes_i < 1 
\end{cases}$$  

(9)

In the formula, $\alpha, \beta, \gamma, c$ is the parameter within $[0, 1]$, $\alpha$ is the negative level, $\beta$ is the penalty level, $\gamma$ is the incentive level, and $c$ is the adjustment level. According to literature, take $\alpha = 0.25, \beta = 0.65, \gamma = 0.8, c = 0.2$ in the paper.

3.3. Nearness Degree and Comprehensive Evaluation of Hamming

Proximity degree is a measure of the proximity of two fuzzy sets. Define the domain as $U$, the mapping $n(A, B) \rightarrow [0,1]$ of direct product $U \times U$ for the two fuzzy subsets $A$ and $B$ of $U$ shall satisfy the following three conditions, then the $n(A, B) \rightarrow [0,1]$ shall be defined as the degree of closeness of $A$ and $B$ : (1) $n(A, A) = 1$ , $n(\emptyset, U) = 0$ ; (2) $n(A, B) = n(B, A)$ ; (3) $A \subseteq B \subseteq C \Rightarrow n(A, C) \leq n(A, B) \wedge n(B, C)$. The basic principle formula shall be:

$$n(A, B) = 1 - d(A, B) = (\sum |A(U_k) - B(U_k)|^p)^{1/p}$$  

(10)

In the formula, when $p = 1$, $d(A, B)$ is defined Hamming distance: $P = 2$, $d(A, B)$ is defined as Euclidean distance. Combining with the evaluation practice of this article, a fuzzy matter-element model is established, a variable entropy weight is introduced, a distance matrix is generated, and a widely used and simple calculation of the Heiming closeness is selected as the evaluation standard. The $M(\cdot, +)$ algorithm is used to rewrite the formula (10) as follows:

$$\rho H_j = 1 - \left[ \sum_{i=1}^{n} w_i |u_j - u_i| \right]$$  

(11)

In the formula, $\rho H_j$ is called the Heiming closeness, $w_i$ is the variable entropy weight, and $|u_j - u_i|$ represents the absolute value of the difference between each element in the superior membership fuzzy matter element $\otimes R_m$ and the standard element $\otimes R_m^o$. The establishment of Hamming nearness degree composite fuzzy matter element $R_{\rho H}$ shall be:

$$R_{\rho H} = \left[ \begin{array}{cccc} M_1 & M_2 & \cdots & M_m \\
\rho H_1 & \rho H_1 & \rho H_2 & \cdots & \rho H_m \end{array} \right]$$  

(12)

According to formula (12), different suppliers $R_{\rho H}$ are sorted from large to small to determine the optimal choice.
4. Empirical Analysis

4.1. Research Background and Data Collection

The equipment management experimental center of our institute plans to purchase a set of fault data acquisition and analysis integrated equipment online to improve the equipment fault analysis and reliability prediction function. According to the preliminary market investigation, the procurement expert group initially screened three integrated equipment suppliers that met the experimental requirements, namely, Tianrenxing, B-Fenghua Electronic Devices Supply Department, and C-Huachu Intelligent Technology. A survey of the three vendors 'e-commerce credit levels for 2017 is now being established. Through online consultation and field visits, the basic data of the verification of the three vendors are as shown in table 1:

| Table 1. Basic Data Table for Credit Evaluation. |
|-----------------------------------------------|
| Index  | I   | II  | III  | Upper limit | Lower limit | Index  | I   | II  | III  | Upper limit | Lower limit |
|--------|-----|-----|------|-------------|-------------|--------|-----|-----|------|-------------|-------------|
| U11    | 95.00% | 88.50% | 92.00% | 100% | 80% | U25 | 2.50% | 3.50% | 4.10% | 20% | 0% |
| U12    | 93.00% | 96.20% | 92.50% | 100% | 80% | U31 | 1.00% | 2.25% | 1.50% | 5% | 1% |
| U13    | 96.00% | 94.50% | 91.50% | 100% | 80% | U32 | 3 E 2 G | 3 E 1 G | 1 E 4 G | None | None |
| U14    | 95.00% | 97.40% | 98.80% | 100% | 80% | U33 | 2 E 3 G | 4 E 1 G | 4 E 4 G | None | None |
| U15    | 92.00% | 90.00% | 88.00% | 100% | 80% | U34 | 1 E 4 G | 1 E 4 G | None | None |
| U16    | 87.00% | 95.00% | 94.00% | 100% | 70% | U35 | 5 E | 1 E 4 G | 3 E 2 G | None | None |
| U21    | 28.50% | 32.00% | 31.00% | 30% | 0% | U41 | 97.50% | 90.00% | 92.50% | 100% | 70% |
| U22    | 89.00% | 91.00% | 86.00% | 100% | 75% | U42 | 3.00% | 5.50% | 3.40% | 10% | 1% |
| U23    | 9.20%  | 11.00% | 6.00%  | 30% | 0% | U43 | 88.00% | 88.00% | 90.00% | 95% | 60% |
| U24    | 3.40%  | 5.00%  | 3.80%  | 20% | 0% | U44 | 43.90% | 48.50% | 42.00% | 60% | 20% |

In table 1, "E" is respect for "excellent", "G" is respect for "good".

In the above table, the indicator U33-U35 is a qualitative evaluation indicator. The five experts of the procurement expert group combine the relevant information of the evaluation indicator, judge and give corresponding comments, and conduct a comprehensive evaluation. Among them, the indicators U21-U23, U24, U42 are cost indicators, and the remaining indicators are benefit indicators.

4.2. Case Solving

From the data in table 1, the cost type index, benefit type index, and comment type index are treated by fuzzy normalization respectively according to the principle of superior subordination. Therefore, the composite fuzzy matter element \( R_{nm} \) and the standard fuzzy matter element \( R_{nm}^{0} \) are obtained.

According to the principle of variable entropy weight, combined with (6) ~ (9), the four-level evaluation index variable entropy weight of the three suppliers A, B, and C is determined. The specific results are detailed in table 2:

| Table 2. Indicator Weight Comparison of Suppliers. |
|-----------------------------------------------|
| Index  | Constant Weight | Partly Change Value | Variable Entropy Weight | Index  | Constant Weight | Partly Change Value | Variable Entropy Weight |
|--------|-----------------|---------------------|-------------------------|--------|-----------------|---------------------|-------------------------|
| U11    | 0.08            | 0.2                 | 0.65                    | U25    | 0.04            | 0.5                 | 0.3                     |
| U12    | 0.05            | 0.2                 | 0.49                    | U31    | 0.05            | 0.3                 | 0.2                     |
| U13    | 0.06            | 0.2                 | 0.2                     | U32    | 0.07            | 0.2                 | 0.4                     |
| U14    | 0.03            | 0.2                 | 0.48                    | U33    | 0.01            | 0.68                | 1                      |
| U15    | 0.09            | 0.3                 | 0.5                     | U34    | 0.03            | 0.52                | 0.84                    |
| U16    | 0.06            | 0.37                | 0.33                    | U35    | 0.02            | 1                   | 0.36                    |
| U21    | 0.00            | 0.8                 | 1                       | U41    | 0.05            | 0.67                | 0.2                     |
| U22    | 0.08            | 0.38                | 0.22                    | U42    | 0.06            | 0.42                | 0.5                     |
| U23    | 0.06            | 0.2                 | 0.23                    | U43    | 0.04            | 0.2                 | 0.2                     |
| U24    | 0.05            | 0.32                | 0.2                     | U44    | 0.08            | 0.3                 | 0.2                     |
Similarly, the results of the calculation of the weights of the previous evaluation indicators are shown in table 3:

### Table 3. Indicator Weight Comparison of Suppliers.

| Index | Constant Weight | Variable Entropy Weight | I  | II | III |
|-------|-----------------|-------------------------|----|----|-----|
|       |                 |                         | 0.27 | 0.45 | 0.24 |
|       |                 |                         | 0.25 | 0.16 | 0.24 |
|       |                 |                         | 0.21 | 0.21 | 0.15 |
|       |                 |                         | 0.27 | 0.18 | 0.19 |

By using the (11) ~ (12) formula to calculate the Hamming nearness degree, the Hamming nearness degree composite fuzzy matter-element \( R_{\rho I} \) is:

\[
R_{\rho I} = \begin{bmatrix}
0.953 & 0.863 & 0.880 \\
\end{bmatrix}
\]

Obviously, the greater the Hamming nearness degree is, the better the scheme shall be achieved. Therefore, I should be chosen as the relatively optimal supplier.

4.3. Conclusion Analysis

According to further analysis of the distance matrix \( H \), it is easy to find that there are different degrees of room for improvement in the credit evaluation of supplier I, II, and III. For supplier I, the indicators that need to be improved are in descending order of importance. The top three are U_{22}, U_{44}, and U_{23}. That is, the three indicators of “Success Rate of E-commerce Transactions”, “User Forwarding Rate of E-commerce Links” and “Arrears Rate of E-commerce Transactions” need to be further strengthened to identify the reasons for transaction failure, strengthen the promotion of commodity brands, and strengthen the management of funds. As for supplier B, the key improvement indicators are U_{11}, U_{42} and U_{32}, which are the three indicators of “Completeness of Business Registration Information”, “Return Rate of E-commerce Transactions” and “Complaint Rate of E-commerce Transactions”. In particular, it is required to make effort to reduce the return rate and complaint rate, so as to improve the quality of e-commerce products and services. As for supplier III, the key improvement indicators are U_{22}, U_{13} and U_{11}, which are the three indicators of “Success Rate of E-commerce Transactions”, “Completeness of Declaration and Contact Information” and “Completeness of Industrial and Commercial Registration Information”. In the performance of the high transaction failure rate and the lack of static information related to e-commerce qualifications, the focus is on finding out whether the lack of e-commerce qualification information is the direct cause of customer trust crisis, and then the transaction failure, we need to supplement the missing information as soon as possible.

5. Conclusion

With the rapid development of network technology and the emergence of new transaction patterns, C2C e-commerce has been promoted continuously. The credit problem in the process of e-commerce transactions has increasingly become a bottleneck problem that restricts the development of e-commerce operations. In order to solve the problem of incompatibility of multi-index assessment, Hamming nearness degree is introduced and the fuzzy matter-element model is established. In order to overcome the defect of the traditional subjective weight determination method, the variable entropy weight is designed with the theory of variable weight. Through empirical test, this method effectively mines the C2C e-commerce credit evaluation information elements, analyzes the credit advantages and shortcomings of different C2C e-commerce merchants, and has a good comprehensive evaluation effect. The evaluation conclusion is highly credible and can better solve C2C e-commerce credit. This
method is also a scientific and practical C2C e-commerce credit evaluation method with bright application prospects.

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