Discussion on the Factors Affecting the Credibility of Regional Enterprises Based on Cluster Analysis

Lihong Guo*
School of Management, Harbin University of Science and Technology, Harbin 150000, Heilongjiang, China

Xiaoguang Luo
School of Economics, Harbin University of Science and Technology, Harbin 150000, Heilongjiang, China

Abstract
With China's continuous improvement of economic development, cooperation and exchanges between enterprises become more closely, enterprise credibility has become an important factor affecting the effect of enterprise inter cooperation. In order to strengthen the optimization of enterprise integrity construction, it is necessary to study the factors that affect the integrity of regional enterprises, and then make targeted construction. Based on the enterprise credit rating system, this thesis use clustering analysis method to study and construct the financial evaluation index system of enterprise, exactly reflect the influence factors of enterprise credit, it is convenient for the integrity differences comparison of enterprises in different industries. By the introduction of enterprise financial statements, the credit rating of different industry become more accurate.

Key words: Cluster Analysis, Enterprise Credibility, Influence Factors, Research Indicators.

1. INTRODUCTION
In view of the importance of enterprise credit rating to the construction of enterprises, this paper makes a thorough study through factor and cluster analysis on the index system of enterprise credit. It summaries various factors which influence the integrity of the enterprise based on traditional methods of credit rating, then finds the most accurate indicators from the financial statements of the most standard enterprise. Combined with relevant data, it analyses the enterprise credit index constructed by clustering, and tests the index through the related data, which provides a more scientific guidance for enterprise evaluation.

2. TRADITIONAL CREDIT RATING METHODS
2.1. Enterprise Integrity Rating Steps
In the development of enterprises, good faith is becoming more and more important. In the process of evaluating the integrity of enterprises, a set of inherent evaluation methods have been formed. The traditional method of credit rating is to determine the enterprise's credit rating index, and then weight the importance of each indicators and zone the different grades, ultimately to get credit level. Although this method can get the rating indicators, but there are many disadvantages, which are manifested as follows: the static evaluation results, the lack of contrast between the industries, the reduction of accuracy because off the weight of subjective assumptions. (Bonsall, Samuel, Koharki, Kevin, Neamtiu and Monica, 2017) After summarizing the experience and continuing to strengthen and improve the credit rating method, the paper puts forward the following rating methods: select the same industry enterprises during the same period to be the most standard sample data; arrange the sample data by using clustering analysis method, to obtain the different kinds of cluster centers; evaluate differently to different cluster centers, by comparing to determine the relationship between the clustering center and grade.
Credit evaluation index system has an important impact on the integrity of enterprises and is the core of the evaluation system. We must ensure that corporate credit rating is authoritative and rigorous. When evaluating the credit status of enterprises, the evaluation methods, indexes and weights are all indicators of the system, which affect the enterprise credit. In our country, no matter it is enterprise production or bank lending, should we fully study the credit rating. In this paper, factor analysis and cluster analysis are used to analyze the influencing factors of enterprise credit rating index system (Zhong Zheng, 2013).

2.2. Main Rating Agencies and Indicators System
In our country, there are very few credit rating agencies in large enterprises. There is organizations such as integrity and joint organizations, which undertake most of the enterprise credit rating work. The credit rating model mainly reflected in the “external support”, which rely on the evaluation of external support to not only communicate with government departmentsto get policy support, but also to involve in decision with the shareholders (Zhigang Ren, Jianxin Zhou and Xingkai Zhang, 2013). Liquidity evaluation is mainly embodied in
cash flow, financial flexibility and liquidity. Joint credit rating model evaluates single project liquid ity on the basis of the “paying the debt” and predicts the historical data to predict the future of enterprise credit rating, to forecast the corporate debt repayment more accurately (Bao feng Shi, Nan Chen and Jing Wang, 2016)

![Diagram of enterprise integrity rating steps]

**Figure 1. Enterprise integrity rating steps**

### 2.3 Theoretical Basis

There are two theories on the basis of enterprise credit rating. One is principal-agent theory and the other is system theory. The former focuses on the information asymmetry problem of internal enterprises and points out that a scientific form of economic organization for the enterprise, which is rather than a kind of contractual relationship. The enterprise acts as the principal agent granted some benefits to carry out some of the more legitimate activities. The purpose of entrustment is to make the enterprise division of labor more detailed and to produce a scale benefit. However, the information asymmetry exists between the principal and the agent, which increases the agency cost of the enterprise. Study on agency cost theory is mainly reflected in the following points: First, to make the agent's behavior more legitimate, we should focus on the result of agency rather than on the performance of agent behavior. It shows a result tendency, that agency risk will make enterprises increase and the agent will become dominant; Second, the client can establish an information platform and the information will be collected by the agent using information system, which can control the behavior of the agent on the basis of perfect compensation system. (Steinle, Claus, Schiele, Holger, Ernst and Tanja, 2014) The system contains two big ideas and can zone the different research object in a system. Plants, seeds, or even the universe can be used as a system. In order to have a further understanding of the structure and function; we need to learn the relationship between research elements, environment and operator, and it’s important to grasp the structure of the law. First, any one organic whole can be seen as a system rather than scattered, fragmented, the functions of each part are combined into a new material; Second, each part of the elements of the system is not a separate division. Each group of Chengdu has its specific function and only plays different roles. We should make mutual connection between the different elements so as to make the system too strong to break; Third, elements are not random, but from the whole. If these elements are lost, the system will not exist. For example, the human organ has its specific function. As the theoretical basis of the study, the system theory can be reflected from the corporate balance sheet, profit statement and cash flow, corporate credit rating. These financial statements are of great significance to reflect the integrity of enterprise.

### 3. RESEARCH METHODS AND INDEX SELECTION

#### 3.1 Research Methods

1. Analysis of factor optimization

   In the research of the index system of credit rating, through statistical analysis, different relational variables can be transformed into a number of comprehensive indicators. The concept of focusing intelligence and statistics is factor analysis. The factor analysis can process and convert the original data to digital standard. It will eliminate the difference between the distribution among the past and the sample, and to a certain extent, improve the quality of evaluation (Yueqiang Dai, Yan Li and Qingli Dai, 2012). The ideas of this evaluation method are: group all variables, make the correlation between variables increases. Each variable represents a
factor and the component is represented by special factor and linear function, which can make the factor independent so as to eliminate superposition index information. (Huizi Ma and Xianrong Wang, 2016)

The original variables are expressed as: \( X_1, X_2, X_3, \ldots X_n \), \( n \) variables influence each factor is a factor and can be divided into: \( E_1, E_2, E_3, \ldots E_m \), the relationship between these factors and the original variables can be expressed as:

\[
X_1 = a_{11}E_1 + a_{12}E_2 + \ldots + a_{1p}E_p + f_1
\]

\[
X_2 = a_{21}E_1 + a_{22}E_2 + \ldots + a_{2p}E_p + f_2
\]

\[
X_p = a_{p1}E_1 + a_{p2}E_2 + \ldots + a_{pn}E_n + f_p
\]

In the above formula, the special factors are \( f_1, f_2 \) and \( f_p \), these factors are reflected in specific indicators of \( X_n \) which other indicators don’t. These special factors also make the common factors more independent. In addition, factors of load also has very strong significance in quantity, such as \( a_{ij}(0 < i \leq p) \) means that there is a close relationship between \( X_i \) and \( f_j \). If the degree increases, the close degree will also increase. They are a relationship of interaction; the common dependence use index \( X_i \) and \( F \) component to explain. If the variance is close to the \( X_i \), then the \( F \) component can be represented by a combination of \( X_i \) without considering other special factors. The steps of factor analysis are: first, consider whether the atomic variable meet the conditions of the analysis or not and build the factor variables. Then let variables can be solved easier and calculate the molecular score. The factor variables in it can be explained by the rotation method.

2. Cluster analysis

Using statistical methods of analysis can increase the contact and reliability of the sample data. The clustering analysis method is a kind of common statistical methods, which can be expressed in different similarity index and obtain the similarity measure between samples and indicators through the observation of different sample index, so as to obtain accurate statistics. The basic steps of cluster analysis are as follows: first, choose the feature information and expand, to let the information cover all the information in the task demands. Reducing the margin of information is also a kind of method; then, by measuring the similarity finalize the feature vectors and reflect “similar” or “not similar” of the features amount; by using clustering algorithm, after selecting the similarity variables, can you use the clustering algorithm to reconstruct the clustering structure. Finally, the clustering results are verified and the most accurate conclusions can be obtained.

3.2 Select Indicators

In order to enhance the accuracy of index selection and make the system more reasonable, balance sheet (BS) and cash flow table (SCF) are listed to optimize the indexes.

### Table 1. Balance sheet

<table>
<thead>
<tr>
<th>Assets</th>
<th>The balance at the end of the year</th>
<th>The balance at the beginning of the year</th>
<th>Liabilities/shares of equity</th>
<th>The balance at the end of the year</th>
<th>The balance at the beginning of the year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current assets:</td>
<td>12250</td>
<td>1125</td>
<td>Current liabilities</td>
<td>14522</td>
<td>1245</td>
</tr>
<tr>
<td>Monetary Fund</td>
<td>25630</td>
<td>1250</td>
<td>Short-term borrowings</td>
<td>125630</td>
<td>12355</td>
</tr>
<tr>
<td>Transaction financial assets</td>
<td>12531</td>
<td>23563</td>
<td>Note payable</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Notes receivable</td>
<td>/</td>
<td>/</td>
<td>Accounts receivable</td>
<td>5653</td>
<td>2532</td>
</tr>
<tr>
<td>Prepaid type</td>
<td>/</td>
<td>/</td>
<td>Staff salary</td>
<td>3400</td>
<td>1256</td>
</tr>
<tr>
<td>Interest receivable</td>
<td>1253</td>
<td>235</td>
<td>Tax payable</td>
<td>1256</td>
<td>7230</td>
</tr>
</tbody>
</table>

### Table 2. Cash flow statement

<table>
<thead>
<tr>
<th>Item</th>
<th>Row</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash flow from operating activities</td>
<td>1</td>
<td>125533</td>
</tr>
<tr>
<td>Sales of goods, labor remuneration</td>
<td>2</td>
<td>12452</td>
</tr>
<tr>
<td>Taxes and fees refunded</td>
<td>4</td>
<td>2354</td>
</tr>
<tr>
<td>Other operating activities cash</td>
<td>7</td>
<td>1253</td>
</tr>
<tr>
<td>Cash flows from operating activities at total</td>
<td>10</td>
<td>3566</td>
</tr>
<tr>
<td>Cash paid for goods and services</td>
<td>14</td>
<td>14563</td>
</tr>
</tbody>
</table>
In accordance with two kinds of financial statement above, we can select the indicators in a more scientific way and get the more financial index. But if calculation is not accurate, it will make the data messy and complicated. In order to analyze the impact on the integrity of the enterprise index system in a more comprehensive and systematic way, we need follow the following principles:

Taking both science and utility into account, the evaluation index can reflect the operation of enterprises and the extent of assets and liabilities, and provide real services to enterprises. Therefore, it is necessary to make the indexes practical. The evaluation index system can be seen as a complex which needs indicators to reflect more elements, so as to enable to reflect the debt situation of enterprise. The financial indicators chosen in this paper are shown in the following table.

<table>
<thead>
<tr>
<th>Table 3. Financial indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Index source</strong></td>
</tr>
<tr>
<td>BS/BS</td>
</tr>
<tr>
<td>SCF/SCF</td>
</tr>
</tbody>
</table>

Overall, the indicators above and structural indicators are similar. The structure index is the division of the total assets in the table and core business revenue (Jinxing Wu and Zongjun Wang, 2012). The proportion of cash flow from operating activities can be obtained. Through the comparison of different vintages of data, we can predict the future trend and to a certain extent, obtain the integrity of the enterprise changes.

4. RESEARCH DESIGN

4.1 Data Sources

There are many approaches to obtain the enterprise credit data. It can be obtained from the company's official website, from the stock exchange website, enterprise database, financial statements and so on. The data can be seen to have the authority through the data acquisition channels, which is for listed companies. Some unlisted companies can only obtain through the rating report and the official website. Data access channels are less (Dongling Zhang and Qisheng Gao, 2012).

4.2 Hypothesis

The data chosen in this paper is from the company and has a certain authenticity. They are not free to publish in the network, which can ensure data authenticity and integrity. All the data assumed are able to reflect the real situation of enterprises and the false information are eliminated. This is one of the assumptions, namely, a hypothesis; credit evaluation index system of enterprise can be viewed as a different weight factor. Through the analysis of the weight factor, it can be reflected in the original index information, which is used to replace the original data type. Indicators have a very strong correlation. If there is a part of the index which can reflect the overall indicators information; you can replace the remaining indicators with these indexes and construct a new function to evaluate of enterprise credit. This is the second hypothesis, that is, B assumption.

5. EMPIRICAL RESEARCH AND RESULTS INQUIRY

5.1 Cluster Analysis

1. Data matrix

The structure of the data matrix is: object, attribute structure, in which objects have i and each object's attributes is called instance variables. For example, a supermarket can be an object and the commodity in the supermarket is considered to be some variables. This data structure is actually a form of relational tables which can form a \( i \times m \) data matrix.
\( x_{im} \) is the \( m \) attribute value of the first \( i \) object. Constructing a data matrix of object and attribute structure is to prepare for the calculation of the difference and cluster between objects.

2. Clustering algorithm

The clustering method is bottom-up aggregation, starting with each object as a separate point, and then merging adjacent objects one by one until all the points merge into one or meet the requirements. (Velez, Daniel1, Sueiras, Jorge, Ortega, Alejandro, Velez and Jose,2016) The idea of gathering: looking for the nearest two samples of “distance”.

1) Have a collection of \( m \) samples, \( S_m = \{ x_1, x_2, \ldots, x_m \} \)

2) Given a \( K \)

3) Want to assemble into \( K \) classes

\[ \begin{align*}
[1] & K = M, \ c_i = [x_j], i = 1, 2, \ldots, M \\
[2] & \text{If } k = k, \text{ then END} \\
[3] & \text{Find the nearest pair from distance } d(c_i, c_j) \text{ between } c_i \text{ and } c_j \\
[4] & \text{Synthesize } c_i \text{ and } c_j \text{ to be one class, and calculate the new center } c_i
\end{align*} \]

The distance between classes and classes is \( d (c_i, c_j) \), which is measured in four main ways:

1) Nearest: \( d_1 = \min (x_i \in c_i, x_j \in c_j) \left\| x_i - x_j \right\| \)

2) Farthest from the distance: \( d_2 = \max (x_i \in c_i, x_j \in c_j) \left\| x_i - x_j \right\| \)

3) Intermediate distance among them: \( d_3 = \| n_i - n_j \|, \text{ and } n_i = \frac{1}{z_j} \sum_{x_j \in c_j} x_j \)

4) Average distance: \( d_4 = \frac{1}{z_i z_j} \sum_{x_j \in c_j} \sum_{x_i \in c_i} \left\| x_i - x_j \right\| \)

Although this clustering method is simple, it often suffers from the difficulty of merging or the selection of splitting points. Merging and the selection of splitting points are very important, because once a group of objects are merged or split, the next step will be carried out in the new generation of clusters, which done processing cannot be withdrawn, and objects cannot be exchanged between clusters. In this way, different selections about the amounts of combinations and relatively the cost of calculation will be smaller. But on the other hand, if there is no good choice of merging and splitting points at one step, it may lead to low quality of clustering results. Moreover, because the decision of merging and splitting requires to check and estimate a large number of objects or clusters, the clustering method is not very scalable. (Erich Schubert, Jorg Sander, Martin Ester, Peter Kriegel and Xu Xiaowei,2017)

In view of the above features, we plan to improve the algorithm. The core of the improved algorithm isthat information about a cluster head is summarized by a cluster of three tuple TG. Thus, points within a cluster can be showed by the corresponding clustering features rather than specific object points, which clustering is constructed by constructing a clustering feature tree that satisfies the branch factor and the cluster diameter constraint Realization process is as follows:

For a class with \( d \) dimensional data points \( x_i (N), (i=1,2,\ldots,N) \), its clustering feature vector is defined as: \( TG = (N, LZ, ZZ) \), where \( N \) is the number of points in the class, LZ represents the linear sum of the N points \( \left( \sum_{i=1}^{N} X_i \right) \), which reflects the center of gravity of the class, and ZZ represents the sum of squares of the N points \( \left( \sum_{i=1}^{N} ||X_i||^2 \right) \), which reflects the size of the class diameter.

For this clustering feature, the following theorems are obtained:

**Theorem:** \( TG_1 = (N_1, LZ_1, ZZ_1) \), \( TG_2 = (N_2, LZ_2, ZZ_2) \), the merged clustering feature is: \( TG_1 + TG_2 = (N_1+N_2, LZ_1+LZ_2, ZZ_1+ZZ_2) \)

The algorithm can conveniently calculate the center, radius, diameter and the distance between class and class. The algorithm can do better clustering through one scan, and it has better scalability, so that the algorithm is suitable for large database.
5.2 Factor Analysis

In order to make the index more relevant, it is necessary to analyze the factors in the index, and at the same time, the accuracy of the factor is required to be verified further. The observed value by the use of the SPSS software and statistical analysis is 562.32, whichp value is very close to 0, the detected value is 0.297 by the analysis of the original variables and the use of KMO. The use of Bartlett deepen the analysis of the original indicators, test results as follows:

<table>
<thead>
<tr>
<th>Table 4. Data check value table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select sufficient metrics</td>
</tr>
<tr>
<td>and chi square approximation</td>
</tr>
<tr>
<td>Bartlett Sphericity test</td>
</tr>
<tr>
<td>Df</td>
</tr>
<tr>
<td>Sig</td>
</tr>
</tbody>
</table>

Then, main factors are extracted, and choose characteristic values according to the number of main factors. The first 1 > feature selection value, then the cumulative variance is calculated, the 0.70> factor is that the main factor. If you choose 5 main factors, the cumulative variance with 2 contributions can achieve >0.7. Under the condition of not changing the original factor, the total variance was 78.59%, which meets the condition of 1>, therefore, the selection of 5 main factors is more scientific. The common factor variance is shown in the following table:

<table>
<thead>
<tr>
<th>Table 5. Variance of common factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>C1 1.000</td>
</tr>
<tr>
<td>C2 1.000</td>
</tr>
<tr>
<td>C3 1.000</td>
</tr>
<tr>
<td>C4 1.000</td>
</tr>
<tr>
<td>C5 1.000</td>
</tr>
<tr>
<td>C6 1.000</td>
</tr>
<tr>
<td>C7 1.000</td>
</tr>
<tr>
<td>C8 1.000</td>
</tr>
</tbody>
</table>

5.3 Cluster Analysis Results

5 main factors which were obtained in the factor analysis is used to facilitate clustering analysis by PSS software. The above mentioned factors are regarded as analytical variables, and select 30 enterprise credit indexes as sets. Before calculating, standardize data, clear the relation between variables, the use combine classes by deviation square method. 30 sets of data entering into the analysis program, among which 1 set of data is missing with the probability of 0.1%, indicating the validity of the selection of data.

* * * * * * * H I E R A R C H I C A L  C L U S T E R  A N A L Y S I S * * * * * *

Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine

CASE                                      0  5 10 15 20 25
Label                                      Num +-------+--------+----------+--------+-------+
08 Weapon bonds                            9  +-
08 Weapon Equipment bonds                  20 +--+-
09 Hunan nonferrous Metals bonds           22 +-----+-
08 Anhui Hua Mao bonds                     2 +---+- |
09 Hua Run bonds                           11 +- +------+
08 National Grid bonds                     3 +-+-++++ |
09 Dong Te bonds                           39 +--- || |
08 China Southern Grid bonds               29 +++ ++++ ++
09 Hong Kong Tourism Administration bonds  36 +-+-+-+ || |
09 Wugang bonds                            34 +++; +++ || |
08 Jiangxi Coal bonds                      1 +++++ | +-----------+
08 Shou Gang Steel bonds                   28 +-----------+ | |
09 Shanxi Industrial Investment bonds      31 +-----------+ | ++++++
08 Lenovo bonds                            24 +-----------+ | |
09 China nonferrous Metals bonds           35 +--------+ | |

Figure 2. Cluster results (1)
In order to make the scope of the sample set narrow, reduce the type of collecting, make the analysis simpler, divide the above clustering analysis results. The 09 Tieling debt department is divided into two parts which will reduce the deviation caused by the increase of the distance clustering. The whole sample is divided into 4 categories. First class: there are 13 kinds of corporate bonds in the first category, which are in different industries and fields, for example, 09 Hunan nonferrous, 08 net bonds, debt to 09 Huarun. However, in the second class of bonds, there are only 2 kinds of corporate bonds, respectively Tieling bonds and Guangzhou Paper bonds which share both 09. The third class contains 17 kinds of corporate bonds: MCC bonds, state investment bonds, Su debt, Datang bonds and so on. The last class includes 8 kinds of corporate bonds: cloud investment bonds, Shanghai construction bonds, Dalian Port bonds and Jilin highway bonds.

In the first class in the sample, the highest net profit growth rate is cash flow and income, net profit factor, however, operating income tax, depreciation and amortization factor present outstanding debt ratio showing that the overall competitive strength of the company is strong; while the second is a special factor, the higher score is the comprehensive factor, and the lower is the net profit growth factor, profit factor and so on, which makes corporate debt repayment ability weaken, to some extent, and reduce the enterprise credibility; in the third class, the higher score is the net profit growth rate and sample return factor, and the lower is operating factor.

5.4 Comparison of Rating Results with Rating Agencies

The rating results obtained through factor analysis and cluster analysis, compared with realistic rating results and theoretical rating results first and fourth-class rating results are enhanced, which is consistent with the practical level basically. There exist differences between level of only a few enterprises and realistic rating results, for example, the A+ rating of Anhui Huamao bonds and AA - Jiangxi coal bonds. The ability of the second type in the rating are weak also lower the reality rating, but Shanghai Construction rating of AAA is different. From the above rating index, it can be seen that the above several rating agencies with significant difference in reality rating are issuers who have the stronger ability of issuing corporate bonds. Because of the downturn of the textile industry and the decline of corporate profits which greatly affect the Anhui Huamao bonds rating, it also begins to appear some wave; and under the influence of overcapacity in the steel industry, a lot of enterprises rating affect, for example, the influence of Dongte bonds is embodied in the decline of guarantee line; the rising prices of raw materials have affected many industries, for example, Wugang have been influenced largely; with the increasing coal enterprise competition, the fluctuation of price increases, so coal bonds by Jiangxi bear large fluctuations. Urban construction planning of Shanghai has achieved the national financial support, thus, the influence the Shanghai construction bonds suffer from shows the decline of guarantee line, but also to make the company's credit rating all the way up. Thus, the credibility of an enterprise can be not only reflected in the enterprise financial indicators, but also reflected in the corporate bonds rating, which relying solely on financial indicators cannot fully reflect the credit situation.


5.5. Comparative Analysis

Through the analysis of the above indicators at all levels, pick out the 15 important indexes to analyze comprehensively according to the financial statements which shows the credit status of the evaluated enterprises, including $F = 0.2003F_1 + 0.166F_2 + 0.158F_3 + 0.065F_4 + 0.014F_5 + 0.012F_6$. The $F_1, F_2, F_3, F_4$, and $F_5$ represent different factors, which are distributed in cash flow factor, comprehensive factor, net profit growth factor, and operation factor. These different clustering factors constitute a complete rating system. Cluster analysis finds that different index systems are consistent with the rating results. According to the rating, financial statements can be constructed, so that the result is true and the assumption A and B assumption has been verified.

6. CONCLUSIONS

The traditional methods of enterprise credit rating and the theoretical basis are studied in this paper, with the use of factor analysis method and cluster analysis method to construct the Financial Rating Index System of the enterprise. Through the analysis of the rating index, it can be reflected in the factors affecting the integrity of the enterprise. Rating index system will affect the enterprise credit evaluation index system. Through the introduction of enterprise financial statements, the credit rating of different industries can be clearly defined, and then the cluster analysis method is used to verify the analysis, which can make financial ratios more deterministic and comparable. Constructions of evaluation indicators and the establishment of corporate credit rating normative indicators, through this approach, understand the credibility and integrity of companies in different industries to provide a basis for more standard, perfect indicator system.

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