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# Credit strategy of micro, small, and medium enterprises with known reputation risk: Evidence from a comprehensive evaluation model

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## Abstract

With poor financial information transparency, and relatively weak profitability and asset strength stability, Small, medium and micro enterprises started late in China. This makes commercial banks need to bear more risks when providing loans to small, medium and micro enterprises than large enterprises. Big. When commercial banks do not have credit records of certain small, medium and micro enterprises, this will increase the risk that banks need to bear when lending to these small, medium and micro enterprises without credit records, and will also increase the difficulty of credit loan for small, medium and micro enterprises in commercial banks.First of all, we should comprehensively analyze the credit risk of enterprises, establish the TOPSIS comprehensive evaluation model, and then establish the constraint conditions according to the data given by the topic, calculate the interest rate of bank loans to each type of enterprises, so as to determine the bank's credit strategy. The

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paper seeks the bank's credit strategy for these enterprises when the annual total amount of credit is fixed. We use AHP (Analytic Hierarchy Process) to normalize the credit rating, and then get the relevant data ranking of enterprises with credit records through TOPSIS comprehensive evaluation model. Through cluster analysis, we divide them into nine categories, and make the optimal credit strategy from the perspective of interest rate and credit line.

***Subject Classification:*** *93E03, 93A14, 93C15 & 49J15.*

***Keywords:*** *AHP, TOPSIS comprehensive scoring model, K-means clustering algorithm.*

## 1. Background

Although small and medium-sized enterprises have relatively small asset scale and operation scale, they are a very important part of China's real economy [1,15]. It plays a very important role in the economic growth of small and medium-sized enterprises, the protection of employment and the development of science and technology [2-3, 16]. In practice, due to the small scale of small and medium-sized micro enterprises, there is a lack of mortgage assets. In order to solve the capital problem of small and medium-sized micro enterprises, bosses generally choose to borrow money from banks. In the process of bank lending, there is a certain proportion of risk, and reducing this risk to the minimum is the key to ensure the bank to collect money on time. Therefore, banks usually provide loans to enterprises with strong strength and stable supply and demand relationship according to credit policy, enterprise transaction bill information and the influence of upstream and downstream enterprises [4-5]. Then, according to the evaluation of the enterprise's strength, reputation and credit risk, we can determine whether to lend or not, and the credit strategies such as loan line, interest rate and term [6-7].

The loan amount of a bank to an enterprise is determined as 10~100 Ten thousand yuan; the annual interest rate is 4%~15%; the term of the loan is one year. Based on the relevant data, interest rate and customer churn rate in appendix 1, appendix 2 and appendix 3, a mathematical model is established to solve the following problems: In Appendix 1, there are 123 enterprises. Through the evaluation and quantitative analysis of the credit risk of these enterprises, when the total amount of bank credit is fixed, the bank's credit strategy for these enterprises is given.

## 2. Problem analysis

Under the new normal mode of economy, the credit service of banks has achieved rapid development. From the actual situation of bank debtors, all kinds of small and medium-sized enterprises are an important part.

We are required to give the bank's credit strategy for these enterprises when the annual total amount of credit is fixed. As the concept of enterprise credit risk is relatively vague, we use AHP algorithm to process the data in appendix 1, determine the grades of three types of assessment results for an enterprise, and obtain the relevant data ranking of 123 enterprises with credit records.

Then using TOPSIS comprehensive scoring model, the basic idea is to calculate the distance between each sample and the positive and negative ideal solutions by assuming the positive and negative ideal solutions, get the relative closeness with the ideal scheme, and rank the evaluation objects. That is to say, the higher the positive ideal solution is, the higher the cost the bank needs to pay and the lower the bank's profit; The larger the sub ideal solution is, the lower the cost the bank needs to pay and the higher the bank's profit. Based on this, we can determine the bank's future credit adjustment strategy.

## 3. Model hypothesis

Due to the limitation of TOPSIS comprehensive scoring model, the assumed positive and negative ideal solutions are too idealized. The following conditions should be assumed to meet the calculation requirements of TOPSIS comprehensive scoring model

1. Suppose the data given by the title is true and reliable.
2. It is assumed that the enterprise will not close down in the short term.
3. The hypothesis does not consider the influence of internal factors.
4. It is assumed that every economic activity of the enterprise is reasonable and real.

## 4. Data analysis and preprocessing

### 4.1 *Analytic hierarchy process*

First of all, because we need to normalize the data of enterprises, we need to convert the ABCD of credit rating into a number, which is

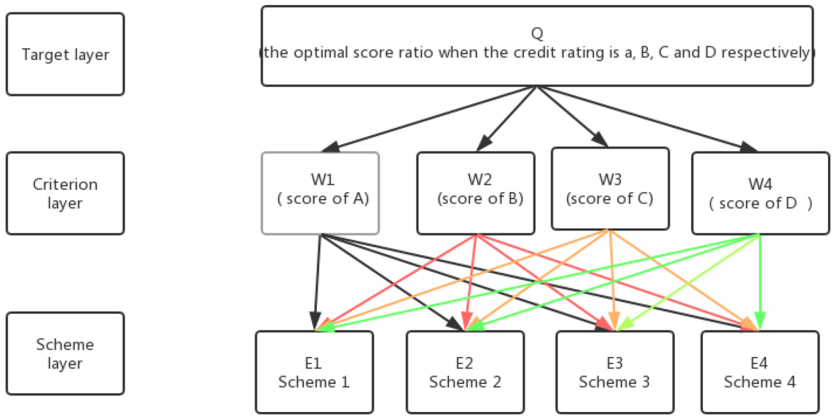


**Figure 1**

**The core idea of AHP**

convenient for us to establish the TOPSIS comprehensive evaluation model. We do not know the reasonable score proportion of ABCD.

Therefore, we use AHP to calculate the most suitable score proportion for ABCD, reduce the error of enterprise comprehensive ranking after normalization, and make the results more scientific. In the AHP algorithm, the highest level is the target layer, that is, the total goal of the system to achieve, generally there is only one goal. If there are multiple sub targets, a sub target layer can be established under this target layer. The middle layer is the criteria layer, which represents the criteria to be adopted to achieve the predetermined overall goal. The lowest layer is the solution layer, which indicates the various solutions and measures to be selected [8] The core idea of AHP is shown in Figure 1.

The CI value can be calculated by the criterion level judgment matrix. When the CI value is infinitely close to 0, the scheme can meet the requirements of the topic and has a certain accuracy.

Through the exhaustive method, a variety of schemes are listed, and four of them are selected to reflect the calculation process of CI value, as shown in Table 1, table 2, table 3 and table 4. In Table 1, after consistency test, CI = - 2.22e-16 has satisfactory consistency, and the weight vectors are 0.3333, 0.3333, 0.3333.In Table 2, the comparison matrix A does not pass the consistency test, so it is necessary to reconstruct the comparison matrix A. In Table 3, after the consistency test, the consistency empirical CI = 0.0684 has satisfactory consistency, and the calculation weight vectors are 0.0415, 0.0771, 0.2958 and 0.5857.In Table 4, after the consistency test, the consistency empirical CI = 0.000734439514301262 ≈ 0, there is a satisfactory consistency.

According to the CI value of scheme 1, scheme 2, scheme 3 and scheme 4, the weight vector is 0.1172, 0.1775, 0.2806 and 0.4247, and the proportion of scheme 4 is the best proportion of the four grades of ABCD, so scheme 4 is adopted, so a = 100, B = 88.28, C = 70.53 and d = 42.47 can be obtained.

**Table 1**

**Scheme 1**

| Q1 | W1 | W2 | W3 | W4 |
|---|---|---|---|---|
| W1 | 1 | 1 | 1 | 1 |
| W2 | 1 | 1 | 1 | 1 |
| W3 | 1 | 1 | 1 | 1 |
| W4 | 1 | 1 | 1 | 1 |

**Table 2**

**Scheme 2**

| Q1 | W1 | W2 | W3 | W4 |
|---|---|---|---|---|
| W1 | 1 | 0.5 | 1/6 | 1/7 |
| W2 | 2 | 1 | 1/3 | 1/6 |
| W3 | 6 | 3 | 1 | 5 |
| W4 | 7 | 6 | 1/5 | 1 |

**Table 3**

**Scheme 3**

| Q1 | W1 | W2 | W3 | W4 |
|---|---|---|---|---|
| W1 | 1 | 1/3 | 1/7 | 1/9 |
| W2 | 3 | 1 | 1/6 | 1/8 |
| W3 | 7 | 6 | 1 | 1/3 |
| W4 | 9 | 8 | 3 | 1 |

**Table 4**

**Scheme 4**

| Q1 | W1 | W2 | W3 | W4 |
|---|---|---|---|---|
| W1 | 1 | 2/3 | 2/5 | 2/7 |
| W2 | 3/2 | 1 | 2/3 | 2/5 |
| W3 | 5/2 | 3/2 | 1 | 2/3 |
| W4 | 7/2 | 5/2 | 3/2 | 1 |

### 4.2 *Data processing of the problem*

The data in Appendix 1 is preprocessed in two aspects, as shown in the flow chart in Figure 2.

On the one hand, we preprocess the data for the calculation of interest rate. After summarizing the invoice, we get the weight according to AHP, replace the index value, normalize the data, and then calculate the weight of each factor of TOPSIS comprehensive evaluation model according to entropy weight method. Finally, we establish the TOPSIS comprehensive evaluation model to calculate the corresponding interest rate of different enterprises.

On the other hand, we preprocess the data for the calculation of the quota direction. After summarizing the invoice, we transform it into array,

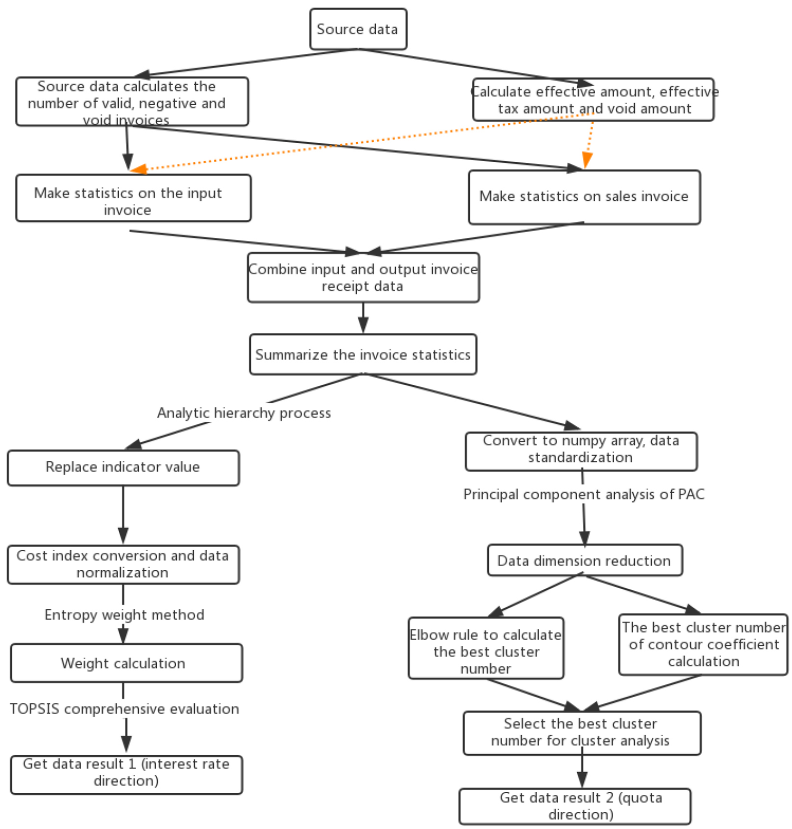


**Figure 2**

**Data Processing Flow chart for Problems**

and then reduce the dimension of the data. Through elbow method and contour counting method, we can get the best cluster number, and then cluster analysis to get the corresponding quota of different enterprises.

## 5. Model establishment and solution

### 5.1 *TOPSIS model*

#### 5.1.1 basic ideas

TOPSIS is a statistical analysis method to rank the evaluation objects with the help of positive and negative ideal solutions of multi-attribute problems. Positive ideal solution and negative ideal solution are a virtual optimal solution and the worst solution, respectively representing that each index value of itself has reached the optimal value and the worst value in the evaluation object[9].

By assuming the positive and negative ideal solutions, the distance between each sample and the positive and negative ideal solutions is calculated, and the relative closeness between the sample and the ideal solution is obtained (that is, the closer the sample is to the positive ideal solution, and the farther the sample is to the negative ideal solution), so as to rank the evaluation objects.

#### 5.1.2 content analysis

In other words, the larger the positive ideal solution is, the higher the cost the bank needs to pay and the lower the bank's profit. The larger the negative ideal solution is, the lower the cost the bank needs to pay and the higher the bank's profit. Then we calculate the comprehensive score according to the credit rating, default, income, supply and demand stability index, void invoice rate, negative invoice rate, positive ideal solution and negative ideal solution, and the weight is calculated according to the entropy weight method[10].

### 5.2 *Modeling*

#### 5.2.1 establish TOPSIS Model

Establishment steps: we establish TOPSIS model, which is a method of ranking according to the proximity between the evaluation object and the idealized target. It is a distance comprehensive evaluation method, and the relevant symbols of [11] are shown in Table 5.

**Table 5**

**Symbol description**

| | |
|---|---|
| $R$ | Raw data matrix |
| $m$ | Sample size |
| $n$ | Total index |
| p | Standardization matrix |
| $W$ | Weight vector |
| Z | Weighted normalized matrix |
| $D_i^+$ | The distance of rational thinking |
| $D_i^-$ | The distance of negative ideal solution |
| $C_i$ | Closeness |
| σ (z) | Activation function |
| $a_1^2, a_2^2, a_3^2$ | Output value of the second layer |
| $a_1^3$ | Output value of the third layer |

The specific steps are as follows:

(1) The indicators are in the same direction, standardized and weighted. In order to avoid the influence of subjective factors, the weight vector w and standardized matrix P are obtained.

$$Z = (Z_{ij})_{n \times m} = (p_{ij} * w_j) \tag{1}$$

(2) The weighted normalized matrix Z is obtained. The positive and negative ideal solutions of Z are obtained by multiplying P and W. The whole ideal solution means that each index reaches the best value in the sample, and the negative ideal solution means that each index is the worst value in the sample.

$$D_i^+ = \sqrt{\Sigma_{j=1}^m W_j (Z_{ij} - Z_j^+)^2}\ ,\ \ D_i^- = \sqrt{\Sigma_{j=1}^m w_j (Z_{ij} - Z_j^-)^2}\ ,\ (i = 1.......n) \tag{2}$$

(3) The distance between samples and positive and negative ideal solutions is calculated.

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{3}$$

### 5.3 *Problem analysis and solution*

#### 5.3.1 quantitative analysis of data in question 1

After data preprocessing, we collect and count the invoices, get the equivalent score proportion of credit rating according to AHP, normalize all the data, and then calculate the weight of various factors according to entropy weight method, as shown in Figure 3: credit rating, default, income, supply and demand stability index, void invoice rate. The negative invoice rate is used to weigh the comprehensive strength.

The data processed by TOPSIS model is shown in Figure 4. The results of our processed data are analyzed in detail below. At the same time, according to PCA principal component analysis and PCA difference retention graph analysis, we can get the result graph as shown in Figure 5. From the graph modification, we can see that when dimension = 6, 93% difference can be retained, which is more suitable for the next dimension reduction.

To reduce the dimension of the preprocessed data, we need to classify the data of result 1 by cluster analysis, and the best number of the classification can be tested by elbow method and contour analysis.

```
In [30]: w

Out[30]: array([0.34879028, 0.33512912, 0.01634661, 0.23958009, 0.03610335,
          0.02405056])
```

**Figure 3**

**Weight calculated by entropy weight method**

| | Credit rating | Breach of contract | income | Supply and demand s | Void invc | Negative invoic | Positive ideal sol | Negative ideal s | Comprehensive sc | sort | Company ider | interest rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.049640007 | 0.049640007 | 0 | 0.016471904 | 0.0458 | 0.04133833 | 0.017493608 | 0.043211536 | 0.711826602 | 28 | 1 | 6.547549804 |
| 1 | 0.049640007 | 0.049640007 | 0.031136116 | 0.005278701 | 0.0455 | 0.04596559 | 0.021863619 | 0.042817405 | 0.661977846 | 58 | 2 | 7.361549756 |
| 2 | 0.024211691 | 0.049640007 | 0.032989982 | 0.017493744 | 0.0475 | 0 | 0.023174662 | 0.034682224 | 0.599448503 | 87 | 3 | 8.382616007 |
| 3 | 0.024211691 | 0.049640007 | 0.049640007 | 0.02391935 | 0.0411 | 0.04814512 | 0.019665636 | 0.036389783 | 0.649175106 | 65 | 4 | 7.57061074 |
| 4 | 0.032624521 | 0.049640007 | 0.025203969 | 0.022070627 | 0.0451 | 0.04705763 | 0.017139381 | 0.038088188 | 0.689658958 | 39 | 5 | 6.909533985 |
| 5 | 0.049640007 | 0.049640007 | 0.026094864 | 0.006415487 | 0.044 | 0.04702544 | 0.021400823 | 0.042770909 | 0.666507009 | 55 | 6 | 7.28759128 |
| 6 | 0.049640007 | 0.049640007 | 0.032029225 | 0.004135795 | 0.0468 | 0.01418154 | 0.023058215 | 0.042309136 | 0.647251808 | 69 | 7 | 7.602017026 |
| 7 | 0.049640007 | 0.049640007 | 0.027852503 | 0.002942855 | 0.0436 | 0.04640891 | 0.023059807 | 0.042667387 | 0.649158813 | 66 | 8 | 7.570876797 |
| 8 | 0.049640007 | 0.049640007 | 0.029571881 | 0.005262885 | 0.0472 | 0.04498609 | 0.021889236 | 0.042838748 | 0.661827319 | 60 | 9 | 7.364007783 |
| 9 | 0.032624521 | 0.049640007 | 0.029610298 | 0.012257205 | 0.0431 | 0.04716507 | 0.021072215 | 0.036985807 | 0.637049041 | 74 | 10 | 7.768622024 |
| 10 | 0.024211691 | 0.049640007 | 0.025364324 | 0.033031292 | 0.0446 | 0.04761173 | 0.017385244 | 0.037797818 | 0.684953257 | 45 | 11 | 6.986375231 |
| 11 | 0.032624521 | 0.049640007 | 0.027038583 | 0.032729699 | 0.0465 | 0.04748241 | 0.013352958 | 0.039976072 | 0.749611839 | 10 | 12 | 5.930539809 |
| 12 | 0.049640007 | 0.049640007 | 0.026945211 | 0.010638575 | 0.0427 | 0.0479673 | 0.019355857 | 0.042958603 | 0.689384188 | 40 | 13 | 6.914020821 |
| 13 | 0.024211691 | 0.049640007 | 0.026638237 | 0.001353659 | 0.0416 | 0.04434256 | 0.028209141 | 0.033944282 | 0.546136966 | 96 | 14 | 9.253161088 |
| 14 | 0.049640007 | 0.049640007 | 0.027909793 | 0.036626192 | 0.0432 | 0.04964001 | 0.007055093 | 0.046326528 | 0.86783667 | 1 | 15 | 4 |
| 15 | 0.049640007 | 0.049640007 | 0.027889931 | 0.016296948 | 0.0424 | 0.04920007 | 0.016612734 | 0.043413714 | 0.723243095 | 19 | 16 | 6.3611254 |
| 16 | 0.049640007 | 0.049640007 | 0.025454644 | 0.004584507 | 0.0427 | 0.04559416 | 0.022316498 | 0.042624072 | 0.656355062 | 62 | 17 | 7.453366411 |
| 17 | 0.049640007 | 0.049640007 | 0.025902908 | 0.019476589 | 0.0437 | 0.047918 | 0.015117295 | 0.043718309 | 0.743058732 | 12 | 18 | 6.037548066 |
| 18 | 0.049640007 | 0.049640007 | 0.025087566 | 0.010563437 | 0.0424 | 0.04492265 | 0.019445403 | 0.042844838 | 0.687825846 | 42 | 19 | 6.939467591 |
| 19 | 0.032624521 | 0.049640007 | 0.025357161 | 0.01852188 | 0.0425 | 0.04913548 | 0.018559684 | 0.03759031 | 0.669462403 | 52 | 20 | 7.239331477 |
| 20 | 0.032624521 | 0.049640007 | 0.025211346 | 0.019730479 | 0.0439 | 0.04386755 | 0.018084118 | 0.037639041 | 0.675464948 | 48 | 21 | 7.141313573 |
| 21 | 0.049640007 | 0.049640007 | 0.025748631 | 0.015705681 | 0.0401 | 0.0466068 | 0.016991275 | 0.043192386 | 0.717676286 | 24 | 22 | 6.452028021 |
| 22 | 0.032624521 | 0.049640007 | 0.025269932 | 0.004536526 | 0.0468 | 0.04557513 | 0.024469748 | 0.036624758 | 0.599477115 | 86 | 23 | 8.382148795 |

**Figure 4**

**Result1 data (part)**

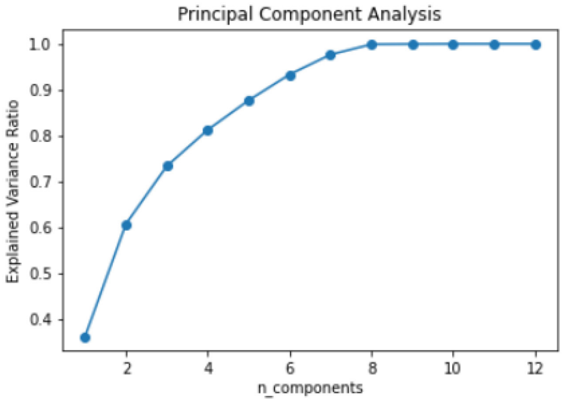


**Figure 5**
**PCA difference retention chart**

To classify the comprehensive strength of all enterprises to get the loan limit, the classification method needs to be classified by K-means clustering algorithm. K-means algorithm not only has good image and data set processing ability, but also has the advantages of high efficiency

It has good stability and scalability, and has good clustering effect [12]. The number of classification needs to be optimized by elbow method and contour coefficient method.

As shown in Figure 6, the elbow method is used to test the classification number of all data in result1[13].As can be seen from Figure 6, when k is from 1 to 9, the sum of squares of deviations decreases significantly, while after K is from 9 to 9, the reduction of squares of deviations is very limited,

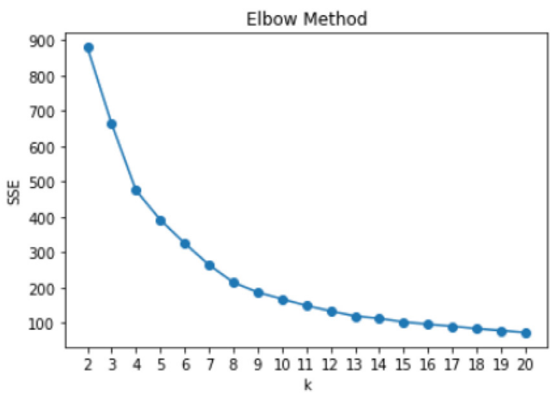


**Figure 6**

**Elbow rule test the best cluster number**

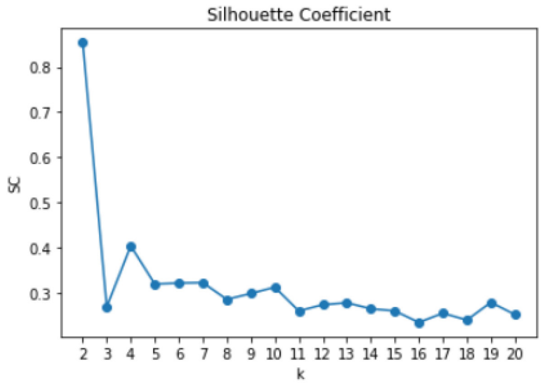


**Figure 7**

**The best clustering number of contour coefficient calculation**

so the optimal value of K should be 9 (corresponding to the parameter pairs of the simulation data set).That is to say, the best number tested by elbow method is 9.

As shown in Figure 7, it is the test of classification number of all data in result1 by contour coefficient method. The standard of contour coefficient method to test the number of classification is that the closer the curvature of K value is to 1, the higher the accuracy of K value is.[7]As can be seen from Figure 7, for the number of data classification of rusult1, the curvature of K from 1 to 8 is less than 0. When k = 9 or K = 10, the curvature is close to 1. When k from 10 or even after 10, the curvature is less than 1, so the best clustering number should be 9 or 10.

As a single test method is accidental, we adopt two different test methods, namely elbow method and contour coefficient method, to test the best number of clusters for the same data at the same time, and

```
Out[64]: 1    51
         8    36
         4    14
         7     8
         0     7
         3     3
         5     2
         6     1
         2     1
         Name: 0, dtype: int64
```

**Figure 8**

**Cluster analysis results**

| Enterprise coc | Input invoice c | Effective amount of | Effective input tax | Sales invoice q | Effective amount | Effective outpu | income | Advance stability | Pin stability index | Supply and deman | Void invoice rate | Negative invoice rate | classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E15 | 92 | 4238459 | 565485.44 | 2412 | 211824339.2 | 7776512.96 | 214796907.7 | 0.413043478 | 1 | 0.765050624 | 0.060702875 | 0 | 4 |
| E42 | 47 | 10425.63 | 1343.37 | 327 | 26235453.61 | 0 | 26223684.61 | 0.914893617 | 0.382262997 | 0.701125998 | 0.088235294 | 0.016042781 | 1 |
| E89 | 65 | 2587686.13 | 130734.56 | 172 | 1863249.86 | 295146.14 | -560024.69 | 0.769230769 | 0.459302326 | 0.633511879 | 0.037974684 | 0 | 1 |
| E95 | 4 | 1073.58 | 64.42 | 913 | 2310757.26 | 69323.19 | 2378942.45 | 1 | 1 | 1 | 0.053435115 | 0 | 4 |
| E97 | 9 | 18754.7 | 1125.3 | 264 | 971400.82 | 29142.08 | 980662.9 | 1 | 1 | 1 | 0.032967033 | 0.014652015 | 4 |
| E88 | 214 | 648069.06 | 35389.4 | 400 | 2525652.87 | 195526.78 | 2037721.19 | 0.799065421 | 0.2375 | 0.589453898 | 0.058631922 | 0.006514658 | 1 |
| E43 | 78 | 3367877.65 | 528652.1 | 245 | 18337561.2 | 1377885.94 | 15818917.39 | 0.628205128 | 0.902040816 | 0.77727708 | 0.126934985 | 0.046439628 | 4 |
| E84 | 54 | 1434513.7 | 224236.35 | 498 | 4830825.65 | 746079.7 | 3918155.3 | 0.574074074 | 0.439759036 | 0.511345799 | 0.097826087 | 0.010869565 | 1 |
| E28 | 169 | 1272115.79 | 142637.68 | 569 | 49029625.43 | 4743903.32 | 52358775.28 | 0.355029586 | 0.9771529 | 0.735144134 | 0.077235772 | 0 | 1 |
| E12 | 1796 | 88851680.77 | 6595331.93 | 285 | 223684403.1 | 19318617.42 | 147556007.8 | 0.184855234 | 0.964912281 | 0.694703954 | 0.02931283 | 0.006727535 | 1 |
| E32 | 2826 | 2351999.1 | 190576.62 | 552 | 44150482.29 | 1324770.99 | 42932677.56 | 0.58138712 | 0.78442029 | 0.690407913 | 0.029307282 | 0.002368265 | 1 |
| E18 | 5765 | 127926244.5 | 9826592.66 | 381 | 187726474.5 | 9929916.23 | 59903553.56 | 0.45151778 | 0.459317585 | 0.45543438 | 0.056296778 | 0.005369346 | 1 |
| E24 | 2047 | 75290120.82 | 10940548.59 | 1782 | 140520367.7 | 13728085.17 | 68017783.42 | 0.202735711 | 0.55667789 | 0.418922452 | 0.048837817 | 0.011491251 | 8 |
| E68 | 3 | 698.11 | 41.89 | 73 | 5867409.22 | 89668.98 | 5956338.2 | 1 | 1 | 1 | 0.105263158 | 0 | 4 |

**Figure 9**

**Result2 data (part)**

the best number of clusters is 9.As shown in Figure 8, it is the number of corresponding enterprises that are divided into 9 categories after we use the K-means clustering algorithm. As shown in Figure 9, it is the data result after the algorithm processing, and there is a detailed analysis later.

5.3.2 credit strategy

(1) According to the cluster analysis in 5.3.1, enterprises are divided into nine categories according to credit risk. The specific categories and relative lending strategies are shown in Table 6

**Table 6**

**Enterprises are divided into nine categories according to the degree of risk**

| Type | Enterprise code |
|---|---|
| 0 | E110 E115 E117 E123 E101 E107 E120 |
| 1 | E42 E89 E88 E84 E28 E12 E32 E18 E70 E65 E91 E16 E74 E30 E85 E38 E66 E60 E63 E34 E5 E61 E58 E11 E35 E21 E79 E20 E57 E44 E105 E78 E53 E41 E92 E90 E72 E56 E73 E45 E87 E113 E119 E52 E118 E121 E109 E108 E116 E114 E51 |
| 2 | E1 |
| 3 | E13 E2 E8 |
| 4 | E15 E95 E97 E43 E68 E104 E69 E96 E77 E39 E29 E99 E112 E82 |
| 5 | E7 E3 |
| 6 | E4 |
| 7 | E98 E50 E86 E94 E55 E100 E111 E122 |
| 8 | E24 E22 E26 E31 E64 E59 E19 E81 E48 E27 E6 E9 E17 E62 E67 E93 E10 E54 E76 E106 E37 E75 E83 E33 E23 E71 E80 E25 E49 E46 E40 E47 E14 E103 E102 E36 |

According to the degree of risk, it can be divided into nine categories. According to these nine categories, enterprises should limit the maximum amount of loans (loans) in a ladder shape. The lower the risk level of the front classification, the higher the risk level of the back classification. By

**Table 7**
**Loan scheme**

| Types (from low risk to high risk) | Enterprise loan amount (million) | Proportion of bank loans (%) |
|---|---|---|
| 2 | [0,100] | 100 |
| 1 | [0,90] | 95 |
| 8 | [0,80] | 90 |
| 5 | [0,70] | 85 |
| 3 | [0,60] | 80 |
| 4 | [0,50] | 75 |
| 6 | [0,40] | 70 |
| 7 | [0,30] | 65 |
| 0 | [0,20] | 60 |

limiting the maximum amount of loans (loans) in a ladder shape, the risk borne by banks can be reduced.

The loan amount and proportion of different types of enterprises are different, and the specific loan scheme is shown in Table 7. The interest rate of each enterprise has been calculated, as shown in the appendix material result2 data.

## 6. Type evaluation and promotion

### 6.1 *Model evaluation*

From the qualitative and quantitative perspectives to analyze the credit risk of enterprises, the established model is more rigorous, and the dimensions are more comprehensive.

It avoids the subjectivity of the data, does not need the objective function, does not need to pass the test, and can well describe the comprehensive impact of multiple impact indicators

There is no strict restriction on the data distribution, sample size and index of TOPSIS. It is suitable for small sample data and large-scale system with multi evaluation units and multi index, which is more flexible and convenient

### 6.2 *Future improvement*

It is difficult to select the corresponding quantitative indicators for the data of each indicator

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