Hong-Bing You*, Meng-Yun Xu and Fang Sun

On the Relationship between Industrial Growth and Environmental Pollution in Jiangsu Province and Policy Recommendations

Abstract: Jiangsu Province has achieved spectacular economic growth in the past decades, but also has been faced with increasing environmental pressure. The paper draws on the decoupling framework proposed by Tapio to examine the relationship between Industrial Growth and environmental pollution for the period between 2006 and 2015 in Jiangsu Province. The data used include gross industrial output, industrial wastewater, industrial sulfur dioxide and solid waste. The results show that Jiangsu’s Industrial Growth is not consistently decoupled from environmental pressure. In particular, the decoupling relationship between Industrial Growth and solid waste is markedly inconsistent. The study finds that Industrial Growth has been strongly decoupled from both industrial wastewater and industrial sulfur dioxide for the period. To achieve sustained growth in the industrial sector for Jiangsu Province, the paper concludes with the following recommendations: Spreading the application of cleaner production technologies; Optimizing industrial structure and distribution, promoting the use of third-party environmental services; Implementing and updating environmental protection policies.

Keywords: Industrial Growth, environmental protection, decoupling theory

1 Introduction

The international situation is undergoing profound and complex changes. At the same time, China has a major task for achieving a sustainable economic growth. Against this backdrop, China has been endeavoring to look for new ways to manage macro-economic issues. The year 2016 marked a good start for the 13th Five-Year Plan. Jiangsu Province has always been a leading economic player in China, and the provincial government has been relentlessly optimizing and upgrading the local
economy. The economic growth rate has been down to single-digit levels from a decade of double-digits. In terms of ecological improvement and environmental protection, Jiangsu Province has outperformed many of its Chinese counterparts and achieved substantial results. However, problems persist: unreasonable industrial structure, excessive development, high waste emissions. Meanwhile, Jiangsu Province is confronted with a range of tough challenges: several lower-than-average environmental indicators, slower environmental progress, degrading ecological systems, increasing environmental risks and concerns.

Decoupling refers to the ending or removal of coupling between two interacting physical objects in the field of physics. Organization of Economic Cooperation and Development (OECD) applied the notion of decoupling to the study of agricultural policies in late 1990s. Then, when the notion of decoupling appeared in the study of environmental issues, the notion has referred to breaking the link between economic growth and resource use or that between economic growth and environmental pollution. Based on the definitions of decoupling provided in the OECD and other research, decoupling is defined in the paper as follows: Decoupling will occur when the economy grows faster than pollution in a given time period and that economic growth is ideally decoupled from environmental pollution when the economy grows and environmental pollution decreases during the same period.

OECD (2002) differentiates relative decoupling from absolute decoupling. Vehmas (2003) has separated six forms of de-linking: weak de-linking, strong de-linking, expansive re-linking, strong re-linking, weak re-linking and recessive de-linking. Tapio (2005) uses the concept of decoupling elasticity and distinguishes eight possibilities of decoupling: strong decoupling, weak decoupling, recessive decoupling, expansive coupling, recessive coupling, expansive negative decoupling, strong negative decoupling, and weak negative decoupling.

The research into decoupling started late in China and achieved substantial progress till this century. Research attention in China has focused on decoupling economic growth from carbon emissions, land use, water use, energy consumption and environmental pollution. Chinese researchers often use the decoupling framework constructed by Tapio and elasticity value.

2 Industrial Growth and Environmental Pollution in Jiangsu Province: Current Situation

2.1 Industrial Growth in Jiangsu Province

Since the start of China’s economic reforms in late 1980s, Jiangsu Province has always centered the economic growth policies around ensuring the quality of economic growth and economic efficiency. Jiangsu Province is among economically the
Industrial Growth and Environmental Pollution in Jiangsu Province

most advanced and dynamic province in China. In 2015, Jiangsu’s GDP was 7.01164 trillion RMB, an increase of 8.5% against the previous year. The primary sector grew by 3.2%, the secondary sector by 8.4%, and the tertiary sector by 9.3%. The size and output of the industrial sector have been ranked first in China for years. In 2015, value-added industrial output for enterprises above a designated size rose by 8.3% against the previous year. Advanced manufacturing industries grew robustly. In particular, output in auto manufacturing, computer telecommunications and electrical equipment manufacturing grew over 9% for the year (see Fig. 1).

The six energy-consuming industries in Jiangsu Province include chemical material and chemical product manufacturing, the nonmetallic mineral product manufacturing, ferrous metal smelting and rolling processing, non-ferrous metal smelting and rolling processing, petroleum processing, coal-coking and nuclear fuel processing. According to Jiangsu Statistical Yearbook, the gross industrial output value for enterprises above a designated size has grown on an annual basis and the growth rate has slowed down. However, the output value for enterprises above a designated size in ferrous metal smelting and rolling processing industry kept declining in the past several years and declined by as much as 9% in 2015. The output value for enterprises above a designated size in non-ferrous metal smelting and rolling processing industry dropped to 9% of the gross output value in 2015 from 36% in 2007.

During the same period, the output value of production and supply of electric power and thermal power always ranked first. But the rate of growth in the industry slowed down to 1.4% in 2015 from 16% in 2007.

The industrial sector in Jiangsu Province has sustained a sound growth momentum. With socio-economic development and accelerating urbanization, environmental pollution and resource scarcity are generating substantial impacts on the
balanced growth of the local economy. Jiangsu Province is a leading region in heading towards a new sustainable normalcy. Jiangsu Province is advised to stick to the principles of innovation, collaboration, environmental-friendliness, openness and sharing in growing the local economy.

2.2 Environmental Pollution in Jiangsu Province

According to Jiangsu Statistical Yearbook, the crude coal consumed by industrial enterprises above a designated size in the province has dropped since 2009 and fell somewhere under 250 million tons each year. The coke and petroleum consumption has remained fairly stable under 50 million tons each year. On the production side, the total output of industrial energy remained stable in 2015. The production of standard coal was 158.337 million tons in the year, a slight drop of 0.6%. The total output of primary energy was 19.558 million tons, a drop of 4.5%. As energy is a main source of pollution, its production and consumption should be managed effectively. There is also a pressing need for developing environment-friendly, low-carbon and high quality energy products.

Between 2013 and 2015, there was no marked increase in the amount of industrial wastewater, industrial sulfur dioxide and general industrial solid waste produced by the six high energy-consuming industries. And the aforesaid three types of waste was even under control in some industries. For example, the industrial solid waste produced by nonmetallic mineral product manufacturers fell to 81,920 tons from an average of 3 million tons between 2013 and 2014. There remains much room for controlling pollutant emissions in high energy-consuming industries led by chemical material and chemical product manufacturing, ferrous metal smelting and rolling processing, electric power and thermal power generation and supply.

3 Research Methods and Data Collection

3.1 Research Methods

OECD is the first to define decoupling as breaking the link between economic growth and environmental pressure. Decoupling occurs when environmental pressure grew slower than economy. Decoupling includes absolute decoupling and relative decoupling. Absolute decoupling indicates a stable or even declining environmental pressure over a growing economy. Relative decoupling refers to a state when the growth rate of the environmentally relevant variables is less than that of economy over a given time period.

Decoupling elasticity is primarily used to evaluate the extent of decoupling through a comparison and analysis of economic growth variables, environmental
pressure variables and the elasticity value between economic growth variables and environmental pressure variables. The paper draws on Tapio’s decoupling framework and applies the elasticity value analysis method to examine the emissions of the industrial “three wastes” (i.e. wastewater, industrial sulfur dioxide, and solid waste) and Industrial Growth in Jiangsu Province. The research results are expected to provide future directions for Jiangsu Province to grow a sustainable industrial economy.

The formula is constructed as follows:

\[
W = \frac{\Delta d}{\Delta g} = \frac{D_t - D_{t-1}}{D_{t-1}} \left( \frac{G_t - G_{t-1}}{G_{t-1}} \right)
\]  

(1)

In the formula, \(w\) means decoupling elasticity coefficient. \(\Delta d\) means the rate of change in pollutant emissions. \(\Delta g\) is the rate of change in economic growth. \(D_t\) and \(D_{t-1}\) represent the pollutant emissions at the end of the given year and at the beginning of the given year respectively. \(G_t\) and \(G_{t-1}\) represent economic growth at the end of the given year and at the beginning of the given year respectively. Tapio divides decoupling into three subcategories: decoupling, coupling and negative decoupling. To interpret subtle changes in elasticity, Tapio still regards a ±20% variation of the elasticity values around 1.0 as coupling and therefore defines coupling as elasticity values of 0.8...1.2. Tapio further divides the state of decoupling into eight subcategories: strong decoupling, weak decoupling, recessive decoupling, expansive coupling, recessive coupling, expansive negative decoupling, strong negative decoupling, and weak negative decoupling as illustrated in Table1. Strong decoupling is the most desired situation which occurs when economy grows and pollution decreases. Strong negative decoupling is the most undesirable situation which occurs when economy decreases and pollution increases.
### Tab. 1: 8 subcategories of decoupling between economic growth and pollutants in Tapio’s model

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>$\Delta d$</th>
<th>$\Delta g$</th>
<th>$W$</th>
<th>Degree of decoupling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decoupling</td>
<td>Strong decoupling</td>
<td>&lt;0</td>
<td>&gt;0</td>
<td>&lt;0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Weak decoupling</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>[0, 0.8)</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>recessive decoupling</td>
<td>&lt;0</td>
<td>&lt;0</td>
<td>&gt;1.2</td>
<td>C</td>
</tr>
<tr>
<td>Coupling</td>
<td>expansive coupling</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>[0.8, 1.2]</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>recessive coupling</td>
<td>&lt;0</td>
<td>&lt;0</td>
<td>[0.8, 1.2]</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>expansive negative</td>
<td>&gt;0</td>
<td>&gt;0</td>
<td>&gt;1.2</td>
<td>F</td>
</tr>
<tr>
<td>negative coupling</td>
<td>weak negative</td>
<td>&lt;0</td>
<td>&lt;0</td>
<td>(0, 0.8)</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>strong negative decoupling</td>
<td>&gt;0</td>
<td>&lt;0</td>
<td>&lt;0</td>
<td>H</td>
</tr>
</tbody>
</table>

A–H indicates declining orders of different degrees of decoupling.

### 3.2 Data Collection

Based on data availability and data significance, the data on major pollutant emissions in Jiangsu Province between 2006 and 2015 are used. For individual indicators, the value-added of the industrial output represents Industrial Growth. Three industrial pollution indicators including industrial wastewater discharge, industrial sulfur dioxide and industrial solid waste measure environmental pollution. All the data on economic growth and environmental pollution in the study are collected from Jiangsu Statistical Yearbook.
4 Decoupling Analysis of Industrial “Three Wastes” in Jiangsu Province

4.1 Measuring Decoupling

The actual annual growth rate of industrial output and that of pollutant emissions are calculated on the basis of the data on the value-added of industrial output and industrial pollutant emissions between 2006 and 2015 in Jiangsu Province. Then decoupling elasticity value and decoupling extent can be determined from Formula (1) as illustrated in Table 2.

<table>
<thead>
<tr>
<th>Year</th>
<th>industrial wastewater</th>
<th>decoupling extent</th>
<th>sulfur dioxide</th>
<th>decoupling extent</th>
<th>solid waste</th>
<th>decoupling extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>0.23</td>
<td>B weak decoupling</td>
<td>−0.63</td>
<td>A strong decoupling</td>
<td>0.01</td>
<td>B weak decoupling</td>
</tr>
<tr>
<td>2008</td>
<td>−0.20</td>
<td>A strong decoupling</td>
<td>−0.60</td>
<td>A strong decoupling</td>
<td>0.33</td>
<td>B weak decoupling</td>
</tr>
<tr>
<td>2009</td>
<td>0.19</td>
<td>B weak decoupling</td>
<td>0.69</td>
<td>B weak decoupling</td>
<td>0.80</td>
<td>D expansive coupling</td>
</tr>
<tr>
<td>2010</td>
<td>−0.17</td>
<td>A strong decoupling</td>
<td>−0.12</td>
<td>A strong decoupling</td>
<td>1.65</td>
<td>expansive negative decoupling</td>
</tr>
<tr>
<td>2011</td>
<td>−0.19</td>
<td>A strong decoupling</td>
<td>0.06</td>
<td>B weak decoupling</td>
<td>0.44</td>
<td>B weak decoupling</td>
</tr>
<tr>
<td>2012</td>
<td>−0.57</td>
<td>A strong decoupling</td>
<td>−0.88</td>
<td>A strong decoupling</td>
<td>−0.33</td>
<td>A strong decoupling</td>
</tr>
<tr>
<td>2013</td>
<td>−0.98</td>
<td>A strong decoupling</td>
<td>−0.78</td>
<td>A strong decoupling</td>
<td>0.93</td>
<td>D expansive coupling</td>
</tr>
<tr>
<td>2014</td>
<td>−1.24</td>
<td>A strong decoupling</td>
<td>−0.76</td>
<td>A strong decoupling</td>
<td>0.11</td>
<td>B weak decoupling</td>
</tr>
<tr>
<td>2015</td>
<td>0.19</td>
<td>B weak decoupling</td>
<td>−2.26</td>
<td>A strong decoupling</td>
<td>−0.53</td>
<td>A strong decoupling</td>
</tr>
</tbody>
</table>
4.2 Analyzing Results

Through the analysis of the varying degrees of decoupling between Industrial Growth and pollutant emissions in Jiangsu Province, the findings are summarized as follows:

First, the relationships between Industrial Growth and “three wastes” present the four subcategories of decoupling: strong decoupling, weak decoupling, expansive coupling and expansive negative decoupling. As shown by the four decoupling subcategories, industrial economy in Jiangsu Province maintained growth momentum between 2007 and 2015. The industrial economy slowed down to certain controllable percentage points. Recession did not occur during the period. The Industrial Growth presented a sound momentum and seemed to continue to be absolutely decoupled from environmental pollution in the years ahead.

Second, the results indicate that both industrial wastewater discharge and industrial sulfur dioxide emissions are effectively decoupled from industrial economy. In most years for the period from 2007 to 2015, there existed a strong decoupling. Affected by the 2008 Financial Crisis, the local economy grew slower in 2009. Both industrial wastewater discharge and industrial sulfur dioxide emissions turned out to be weakly decoupled from Industrial Growth rather than strongly decoupled. Industrial solid waste turned out to be expansively coupled with industrial economy. Before 2010, both industrial wastewater discharge and industrial sulfur dioxide emissions were decoupled again from Industrial Growth. But the relationship between industrial solid waste and Industrial Growth before 2010 was expansive negative decoupling. In 2013, the relationship between the two was expansive coupling. For the other years, the relationship between the two was strong or weak decoupling.

Third, the degrees of decoupling Industrial Growth from environmental pressure have not been consistent over the period. In particular, the decoupling of Industrial Growth from industrial solid waste was markedly inconsistent. Strong decoupling of industrial wastewater from Industrial Growth was observed possibly thanks to a lower proportion of industrial wastewater out of the total wastewater discharge in Jiangsu Province and also to the improved wastewater treatment.

5 Policy Recommendations

5.1 Spreading Application of Cleaner Production Technologies

Jiangsu Province has scarce energy resources and low environmental capacity available per person. However, rapid industrial development has led to worsening industrial pollution caused by energy consumption. With ongoing economic
transformation and upgrading, it is imperative to spread green, low-carbon, and cost-effective cleaner production technologies. Technological progress is a core element in achieving cleaner production. Main practices include reduction of energy consumption, substitution of poisonous materials, all-process control and reduction of pollutant emissions. Therefore, Jiangsu Province should promote the efficient use of energy and promote the wide use of clean energy. Meanwhile, Jiangsu Province should design policies and incentives on the use of state-of-the-art clean production technologies and facilities. The industrial enterprises in key industries should speed up technological transformation for the implementation of cleaner production. For non-electric power industries like steel and cement, the facilities for desulfurization, denitration and dedusting should be upgraded. For metallurgical, chemical and other heavy metal-related industries, cleaner production requirements should be strictly implemented. Throughout the industrial sector, consistent efforts should be made in extraction of clean energy, efficient use of energy, optimal allocation of energy resources, optimization of energy consumption structure and maximum reduction of pollutant emissions.

5.2 Optimizing Industrial Structure and Distribution

For industries where Jiangsu enjoys clear advantages, environmental-friendly and resource-friendly development approaches should be taken. Integration between industrialization and informatization should be promoted. The proportion between light industries and heavy industries is advised to be moderately adjusted. Outdated production facilities should be phased out. Industrial structure in Jiangsu Province needs to be further optimized. Ecological industries and modern service industries should get the incentives to expand and therefore contribute to industrialization. For highly polluting industries and industrial parks, agglomeration of industries and collaboration in pollution-control efforts should be exerted. Therefore, regional resources, energy and wastes can be recycled for use. Meanwhile, non-core industries can be relocated to Middle Jiangsu, North Jiangsu and other economically backward areas on account of complementary factor endowments.

5.3 Promoting the Use of Third-party Environmental Services

A third-party pollution control approach was proposed in China at the end of 2014. This approach operates on the principle that “Polluting enterprises pay; Specialized environmental service contractors clean”. The third-party pollution control approach has been in use for years in developed countries and the third-party service accounts for 45% of all pollution control approaches. In comparison, the third-party pollution control service is still in its fledgling stage in China. Polluting
enterprises can raise efficiency in pollution reduction by using specialized technologies and expertise provided by environmental service contractors. The third-party service is now used in some areas in Jiangsu Province and the results have turned out to be satisfactory. Towards better pollution control results, Jiangsu Province should further extend the use of the third-party environmental services and increase investment in the area and grow it into an industry. This particular industry can provide specialized pollution control services to public facilities, industrial parks and other related facilities.

5.4 Implementing and Updating Environmental Protection Tax Policies

Environmental Protection Tax Law of the People’s Republic of China was adopted in December 2016 and will be effective as of 1 January 2018. The Law is poised to replace the existing pollutant discharge fee system with a pollution tax as the main economic tool regulating environmental pollution by businesses in China. The law aims to initiate a tax collection and management method that will work like this: Businesses file their tax returns; Tax authorities collect taxes; Environmental protection authorities monitor pollutants; Environmental protection authorities and taxation authorities establish a tax related information sharing platform. In compliance with the Law, Jiangsu industrial enterprises should follow environmental protection tax policies and duly pay up taxable amounts. To prevent possible disputes, the provincial government authorities should specify each party’s rights and obligations when they administer taxation. Environmental protection tax evasion or any other form of tax fraud shall carry a hefty punishment. In addition, the environmental protection tax law should also be updated to address changing environmental needs. For example, taxes on CO2 emissions and lighting pollution can be included in taxable pollutants. In this way, the environmental protection tax will literally serve the purpose of green taxation.

6 Conclusion

More and more people have begun to pursue the green development. It is time to carry out the basic state policy of resource conservation and environmental protection and insist on sustainable development and to form the harmonious development of the human being and the nature.
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References


The Research on the Credit Evaluation System of Construction Cost Consultation Enterprise

Abstract: In order to solve the problems such as the lagging of credit management level and credit management system construction of construction cost consultation enterprise. According to the construction characteristics and development needs of the industry, establishing credit evaluation index system and rating calculation model of construction cost consultation enterprise, and using B/S architecture and C#.net language for the credit evaluation system development based on the SQL server database. In the end, the efficient and convenient project cost consulting enterprise credit evaluation system is established, and also have much more functions such as the sorting, querying and publicity for evaluation results. Fundamentally changing the evaluation methods, improving the credit evaluation management efficiency of project cost consulting enterprise by using the “Internet plus credit evaluation system”, and providing protection for the healthy development of the industry.

Keywords: Cost consulting, Credit evaluation, System research

1 Preface

The construction cost consulting enterprise is one of the Construction market subject, which undertakes some works such as the investment of construction projects, the determination and control of the project cost, and so on [1]. Up to now, there is no systematic study on the credit evaluation of construction cost consulting enterprise abroad, and the research in domestic is in the stage of establishing evaluation index system and evaluation method. There are some researches such as: Wei Liu built the construction cost consulting enterprise’s integrity evaluation index system from the staff quality, enterprise quality and so on 5 aspects, and used the quantification value weighted function method to evaluate the construction cost consultation enterprise [2]; Lei Shen established the suitable for Zhejiang province construction cost consulting enterprise credit evaluation system based on the analysis of the reason of construction cost consulting enterprise credit lack [3]; Xiao-Feng Liu calculated the index weight and index data by using analytic hierarchy process (AHP)
and fuzzy mathematics subordinate assignment method, and established the con-
struction enterprise credit information announcement platform in the end [4]; Alt-
ough the above research can realize the evaluation of enterprise credit rating, there
are some problems such as low efficiency, waste of resources and difficult filing. On
the basis of establishing the evaluation index system and determining the evalua-
tion method, author researched and developed a credit evaluation system for the
construction cost consulting enterprise, and introduced the concrete process and
method of realizing the credit evaluation on the system.

2 Evaluation Standard

The design of evaluation index system is based on the “Construction cost consulting
enterprise credit evaluation standards of Liaoning province”, enterprises with good
or bad credit behavior record and other government documents. At the same time,
considering the implementation of the evaluation index system and striving to make
the evaluation index system can entirely reflect the real situation of the participat-
ing enterprise. Based on the above, we come to the evaluation criteria, and make it
listed in the following table.

Tab. 1: Credit evaluation standard for the construction cost consulting enterprise

<table>
<thead>
<tr>
<th>first index</th>
<th>second index</th>
<th>scoring rules</th>
<th>basic points</th>
<th>add points limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>basic condition (0.2341)</td>
<td>computer assisted management (0.0228)</td>
<td>The enterprises using mature computational software, valuation software, project management software, enterprise management software plus 0.5 points each.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>cost engineer (0.0594)</td>
<td></td>
<td>10 basic people in class a enterprises and 6 people in class b enterprises. 0.2 points change with 1 people increase or decrease.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>intermediate title or above (0.0533)</td>
<td></td>
<td>16 basic people in class a enterprises and 8 people in class b enterprises. 0.2 points change with 1 people increase or decrease.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>stock structure (0.0549)</td>
<td></td>
<td>The number and the amount of investment of the cost engineer not less than 60%. If the capital wholly invested by cost engineers, the enterprises plus 1 points.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>revenue growth rate (0.0437)</td>
<td></td>
<td>The average annual revenue growth rate of not less than 5%. Adding 1% plus 0.1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>first index</td>
<td>second index</td>
<td>scoring rules</td>
<td>basic points</td>
<td>add points</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>achievements quality (0.5543)</td>
<td>consulting contract management (0.0977)</td>
<td>Without consulting contracts, each item is reduced by 1 point; The consulting contract has no definite agreement on the term of the consultation, the quality of the results, the charging standards and the liabilities for breach of contract. Each of these items is reduced by 0.1 points, and each item is limited by 0.5 points.</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>consulting service charges (0.0583)</td>
<td>quality control (0.1215)</td>
<td>The actual charge exceeds 20% of the floating rate of the prescribed price, and each item is limited reduced by 0.5 points.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>trial system of major issues(0.0694)</td>
<td>consultation results (0.1199)</td>
<td>The enterprise reduces 2 points if it has no level 3 quality control process list; and the audit data is filled in detailed, each increments 0.1 points.</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>file management(0.0537)</td>
<td>statistical reports(0.0338)</td>
<td>If the enterprise has written meeting minutes about consultation on major issues, it can plus 1 point with each.</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>operating performance (0.2116)</td>
<td>consulting income (0.0614)</td>
<td>The enterprise reduces 2 points if it has no level 3 quality control process list; and the audit data is filled in detailed, each increments 0.1 points.</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>personal performance(0.0903)</td>
<td>customer satisfaction</td>
<td>The enterprise reduces 2 points if it has no level 3 quality control process list; and the audit data is filled in detailed, each increments 0.1 points.</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

The research on the credit evaluation system.
3 The Rating Calculation Model

Analytic hierarchy process (AHP) is adopted to evaluate the credit of construction cost consulting enterprise, and the calculation steps are as follows:

3.1 Determine Index Weight

3.1.1 Construct Judgment Matrix

The analytic hierarchy process requires that the relative importance of each index in each level is judged, and these judgments are expressed by numerical values, which are the judgment matrix [5–6]. Assuming the weight of the first index $A_k$ ($K = 1, 2, ..., r$) is $a_k$, the second index $B_i$ is $b_i^{(k)}$ relative to the first index $A_k$. In this case, the second index associated with $A_k$ is $B_1^{(k)}, B_2^{(k)}, ..., B_n^{(k)}$, the corresponding index weights are $b_1^{(k)}, b_2^{(k)}, ..., b_n^{(k)}$.

\[
B = \begin{bmatrix}
    b_{11} & b_{12} & \cdots & b_{1n} \\
    b_{21} & b_{22} & \cdots & b_{2n} \\
    \vdots  & \vdots  & \ddots & \vdots  \\
    b_{n1} & b_{n2} & \cdots & b_{nn}
\end{bmatrix}
\]  

(1)

3.1.2 Calculate the Eigenvector and the Maximum Eigenvalue of the Judgment Matrix

3.1.3 Check Consistency

\[
CI = \frac{\lambda_{max} - n}{n - 1}
\]  

(2)
Considering the possible error in the expert evaluation process, the CI is processed by 1/RI. The results for

$$CR = \frac{CI}{RI}$$

(3)

In the formula, RI is the average random consistency index of the same order as CI, the values are taken from the following table:

**Tab. 2: Table of values for different levels of RI**

<table>
<thead>
<tr>
<th>levels of RI</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>values of RI</td>
<td>0.00</td>
<td>0.00</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
<td>1.52</td>
<td>1.54</td>
</tr>
</tbody>
</table>

When CR≤0.1, the judgment matrix is satisfied, otherwise the judgment matrix is adjusted and the analysis is redone.

### 3.1.4 Calculate the Total Weight

$$b_i = \sum_{k=1}^{r} a_k \times b_i^{(k)} \quad (i=1,2,...,n)$$

(4)

### 3.2 Calculate the Credit Scores

$$F = \sum_{i=1}^{n} f_i \times b_i$$

(5)

### 3.3 Rating

The enterprise credit rating standard adopts the hundred percent system, which consists of the basic division and the increment or decrease [6]. The specific classification standard is shown in the following table:
4 Design and Implementation of the System

4.1 Structured Design

The credit evaluation system of this paper is based on SQL server database, adopts B/S framework, develops and designs with C#.net language, and realizes the interaction of browser and server, server and backstage database [7]. The information collection of the government credit management department and the uploading of enterprise information are used as the information input of the system, and the announcement platform is used as the information output of the system.

4.2 Functional Module Design

According to the reality demand analysis, the system is divided into six functional modules: credit declaration information inquiry, query and statistic, credit evaluation, data summary, system management, announcement. Among them, each function module has different sub modules.

4.3 Database Design

The credit archives database of construction cost consulting enterprise is the comprehensive record, which reflects the credit behavior in the course of its operation and the behavior of the project cost consultant in the business dealings [8]. The database needs to cover the basic information of enterprise personnel and condition of enterprise participates in the project, and so on. The content of each part contains many sub items, and the relation is complex and the data is huge. In order to realize the functions of credit rating, query and statistics, the system needs to query the information across the tables and operate across the tables [9-10]. Through the anal-
ysis of the functional requirements of the system, we get the part E-R diagram of the database entity and relation, as shown in Fig. 1.

![E-R diagram of the database entity and relation](image)

**Fig. 1:** E-R diagram of the database entity and relation

### 4.4 System Function Implementation

1) Users log in the system from the main interface (Fig. 2) through the applying user name and password.

![System main interface](image)

**Fig. 2:** System main interface
2) According to the credit evaluation requirements, the enterprise organization code, legal representative and other information are entered into the basic information table of the enterprise. At the same time, the required information should be uploading to the specified location according to the table 1.

3) After the enterprises’ basic information and relevant data are submitted, the municipal administration organization shall review the information submitted by the enterprises. If the enterprises through the audition, which will be submitted to the province to audit, or else the materials will be returned to the original enterprises, this part of the enterprises are not allowed to participate in the rating, and the provincial administration approved enterprises can participate in the rating. The pending state after the enterprises fill in the information is shown as Fig. 3.

![Fig. 3: Declaration of enterprise information to be audited interface](image)

### 5 Conclusion

Applying modern technology of network information to research and develop the credit evaluation system of construction cost consulting enterprise, and solving the past common problems such as the work efficiency is low in the process of credit evaluation, the data is easy to lose, human disturbance and controversy and so on. Finally, realizing that the declaration and evaluation of the credit level of the construction cost consulting enterprise are carried out online.

The research results change the traditional pattern of submission of written materials for evaluation, and provide a paperless online reporting credit evaluation system for many construction cost consulting enterprises. The method of “Internet plus credit evaluation system” means that one investment and continuously use for many years. It will reduces annual credit evaluation costs, saves manpower, financial and material resources, and further improves the modernization level of the
construction cost consulting enterprise management mechanism service for enterprise members. The main functions of this system can be achieved by testing, but the system’s responding time is a little longer when querying cross tables and data extraction, and then need to improve the technology to solve the problems.

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