Analytic hierarchy process and research on tax incentive policies to enterprise innovation performance influence

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ABSTRACT

Nowadays, economic construction is primary mission of China. However main impetus that drives Chinese economic continuous development is from Chinese economic structural innovation, from which innovation on enterprises is core of impetus. To find out tax incentive policies influential aspects on enterprise innovation, the paper according to analytic hierarchy process, it gets that in case considering the structure of enterprise network, technical system, enterprise policy and social resources as well as other influence factors, tax incentive policies to enterprise innovation performance influence links are mainly as income tax preferential, the transformation of scientific achievements, technology and equipment updates such three links. Therefore, it gets Chinese tax incentive policies most influential link on enterprise innovation performance, and makes Chinese economic development corresponding policies for these links.

KEYWORDS

Tax incentive policies; Enterprise innovation; Analytic hierarchy process; Performance assessment; Economic structure.
INTRODUCTION

Whether a country comprehensive strength is strong or not is up to how the nation economic development is to a
great aspect. The cause is economic base decides superstructure; first step to develop a country is strengthening economic
construction, and driving national other aspects development by developing economy. Therefore under our party’s correct
guiding, China now is centered on economic development, makes all-round development of every aspect, and builds a
prosperous, democratic, civilian and harmonious socialist harmonious society.

Due to in Chinese economic structure, enterprise takes very important positions, regards enterprises as innovation
subjects are main impetuses of Chinese economic advancement. However, due to China is still in the initial phase of
socialism, domestic most enterprises have not their own core techniques, therefore they still have strong attachment on
foreign enterprises and techniques, and domestic most enterprises lack of innovation capacity. And due to enterprises
economic characteristics that lead to Chinese market resources cannot arrive at optimization allocation. In this case, nation
should incent enterprise innovation by some beneficial policies, from which tax incentive is a kind of effective incentive way.
In order to more clearly understand tax incentive influence on enterprise innovation, the paper will analyze and research on
the issue.

MODEL ESTABLISHMENTS

Construct hierarchical structure

To find out tax incentive policies influence on enterprise innovation performance, firstly it should find out tax
incentive policies most influential links on enterprise innovation that is to find out tax incentive policies to enterprise
innovation performance main influence aspects. And then, the paper bases on analytic hierarchy process to make quantization
on tax incentive policies to enterprise innovation performance most influential links. After that, establish target layer,
criterion layer and scheme layer relations.

Target layer
The incentive of the most influential

Criterion layer
Scheme influence factors, $Y_1$ is the structure of enterprise network, $Y_2$ is technical system, $Y_3$ is enterprise policy,
$Y_4$ is social resources.

Scheme layer
$V_1$ is income tax preferential, $V_2$ is the transformation of scientific achievements, $V_3$ is technology and equipment
updates, it gets hierarchical structure as Figure 1 shows.

![Hierarchical structure](image)

Figure 1: Hierarchical structure

Construct judgment matrix
In order to get each factor comparison quantified judgment matrix, here set 1~9 scale, as TABLE 1 shows.
TABLE 1 : 1–9 scale table

<table>
<thead>
<tr>
<th>Scale $a_{ij}$</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>factor i and factor j have equal importance</td>
</tr>
<tr>
<td>3</td>
<td>factor i is slightly more important than factor j</td>
</tr>
<tr>
<td>5</td>
<td>factor i is relative more important than factor j</td>
</tr>
<tr>
<td>7</td>
<td>factor i is extremely more important than factor j</td>
</tr>
<tr>
<td>9</td>
<td>factor i is absolute more important than factor j</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Indicates middle state corresponding scale value of above judgments</td>
</tr>
</tbody>
</table>

Reciprocal $a_{ji} = 1/ a_{ij}$, $a_{ii} = 1$

Now set $a_{ij}$ to represent ratio of $\beta_i$ and $\beta_j$ to $G$ influence, and get judgment matrix $A$, in the paper set judgment matrix between layer two and layer one is $A_i$, element $a_{ij}$, divisor $a_i, a_j$, factor is $A_i$, then it has following formula showed judgment matrix $A_i$:

$$A_i = \begin{bmatrix}
A_1 & a_1 & a_2 & a_3 & a_4 \\
A_1 & a_{11} & a_{12} & a_{13} & a_{14} \\
A_2 & a_{21} & a_{22} & a_{23} & a_{24} \\
A_3 & a_{31} & a_{32} & a_{33} & a_{34} \\
A_4 & a_{41} & a_{42} & a_{43} & a_{44}
\end{bmatrix}$$

And in above formula, for $a_{ij}$ values defining, we generally adopt 1–9 proportion scale to assign value on influence extent, as Figure 2 shows.

![Figure 2: Nine scale assignment schematic diagram](image)

According to lots of experts experiences and refer to lots of documents as well as 1–9 scale setting, it gets paired comparison matrix that are respective as TABLE 2-6.

TABLE 2 : Comparison matrix G

<table>
<thead>
<tr>
<th>G</th>
<th>$Y_1$</th>
<th>$Y_2$</th>
<th>$Y_3$</th>
<th>$Y_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_1$</td>
<td>1</td>
<td>1/5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>1/5</td>
<td>1/5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>1/4</td>
<td>1/4</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Analytic hierarchy process and research on tax incentive policies to enterprise innovation performance influence

BTAIJ, 10(18) 2014

### TABLE 3: Comparison matrix $Y_1$

<table>
<thead>
<tr>
<th></th>
<th>$Y_1$</th>
<th>$V_1$</th>
<th>$V_2$</th>
<th>$V_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
<td>1</td>
<td>1</td>
<td>1/5</td>
<td></td>
</tr>
<tr>
<td>$V_2$</td>
<td>1</td>
<td>1</td>
<td>1/5</td>
<td></td>
</tr>
<tr>
<td>$V_3$</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 4: Comparison matrix $Y_2$

<table>
<thead>
<tr>
<th></th>
<th>$Y_2$</th>
<th>$V_1$</th>
<th>$V_2$</th>
<th>$V_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>$V_2$</td>
<td>1/4</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>$V_3$</td>
<td>1/4</td>
<td>1/3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 5: Comparison matrix $Y_3$

<table>
<thead>
<tr>
<th></th>
<th>$Y_3$</th>
<th>$V_1$</th>
<th>$V_2$</th>
<th>$V_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>$V_2$</td>
<td>1/3</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>$V_3$</td>
<td>1/4</td>
<td>1/5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 6: Comparison matrix $Y_4$

<table>
<thead>
<tr>
<th></th>
<th>$Y_4$</th>
<th>$V_1$</th>
<th>$V_2$</th>
<th>$V_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>$V_2$</td>
<td>1/6</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>$V_3$</td>
<td>1/5</td>
<td>1/4</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Consistency test**

Use consistency indicator test formula as: $CI = \frac{\lambda_{max} - n}{n-1}$. From which $\lambda_{max}$ is comparison matrix maximum feature value; $n$ is comparison matrix order. It is clear that judgment matrix is inversely proportional to $CI$ value.
\[
C^{(0)} = \begin{pmatrix}
1 & 1/5 & 5 & 4 \\
5 & 1 & 5 & 4 \\
1/5 & 1/5 & 1 & 1 \\
1/4 & 1/4 & 1 & 1
\end{pmatrix} = \begin{pmatrix}
0.275 \\
0.549 \\
0.083 \\
0.093
\end{pmatrix}
\]
\[
\lambda_{\text{max}}^{(0)} = \frac{1}{4} \left( 2.752 + 5.459 + 1.183 + 1.196 \right) = 4.32
\]
\[
w^{(0)} = \begin{pmatrix}
0.260 \\
0.515 \\
0.112 \\
0.113
\end{pmatrix}
\]

Judgment matrix is:
\[
C_1 = \begin{pmatrix}
1 & 1 & 1/5 \\
1/5 & 5 & 1 \\
1 & 1/5 & 1
\end{pmatrix}, C_2 = \begin{pmatrix}
1 & 4 & 4 \\
1/4 & 1 & 3 \\
1/4 & 1 & 1
\end{pmatrix}, C_3 = \begin{pmatrix}
1 & 3 & 4 \\
1/3 & 1 & 5 \\
1/3 & 1/5 & 1
\end{pmatrix}, C_4 = \begin{pmatrix}
1 & 6 & 5 \\
1/6 & 1 & 4 \\
1/6 & 1/4 & 1
\end{pmatrix}
\]

Corresponding maximum feature value and feature vector in successive are:
\[
\lambda_{\text{max}}^{(1)} = 4.43, w^{(1)} = \begin{pmatrix}
0.345 \\
0.345 \\
0.424
\end{pmatrix}
\]
\[
\lambda_{\text{max}}^{(2)} = 4.52, w^{(2)} = \begin{pmatrix}
0.526 \\
0.269 \\
0.058
\end{pmatrix}
\]
\[
\lambda_{\text{max}}^{(3)} = 2.30, w^{(3)} = \begin{pmatrix}
0.652 \\
0.230 \\
0.103
\end{pmatrix}
\]
\[
\lambda_{\text{max}}^{(4)} = 3.61, w^{(4)} = \begin{pmatrix}
0.614 \\
0.240 \\
0.148
\end{pmatrix}
\]

According to \( CI = \frac{\lambda_{\text{max}} - n}{n - 1} \) it gets \( RI \) value that can refer to TABLE 7.

<table>
<thead>
<tr>
<th>n</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>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0</td>
<td>0</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>1.51</td>
</tr>
</tbody>
</table>

For judgment matrix \( C \), \( \lambda_{\text{max}}^{(0)} = 4.52, RI = 1.01 \)
\[
RI = \frac{4.52 - 4}{4 - 1} = 0.17
\]
It shows C inconsistency degree within permissible range, at this time it can use C feature vector to replace weight vector. Similarly, to judgment matrix $C_1$, $C_2$, $C_3$, $C_4$, all passed consistency test by using above principle. Therefore, calculation results from object layer to scheme layer can refer to Figure 3.

**Figure 3 : Target layer to scheme layer calculation result**

\[
\begin{align*}
0.345 & \quad 0.526 & \quad 0.652 & \quad 0.614 \\
0.345 & \quad 0.269 & \quad 0.230 & \quad 0.240 \\
0.424 & \quad 0.058 & \quad 0.103 & \quad 0.148
\end{align*}
\]

Calculation structure is as following:

\[
w^{(1)} = (w^{(1)}, w^{(1)}, w^{(1)}, w^{(1)}) = \\
\begin{align*}
0.345 & \quad 0.526 & \quad 0.652 & \quad 0.614 \\
0.345 & \quad 0.269 & \quad 0.230 & \quad 0.240 \\
0.424 & \quad 0.058 & \quad 0.103 & \quad 0.148
\end{align*}
\]

\[
w = w^{(1)}w^{(0)} = \\
\begin{align*}
0.345 & \quad 0.526 & \quad 0.652 & \quad 0.614 & \quad 0.260 \\
0.345 & \quad 0.269 & \quad 0.230 & \quad 0.240 & \quad 0.515 \\
0.424 & \quad 0.058 & \quad 0.103 & \quad 0.148 & \quad 0.112 \\
& \quad & \quad & \quad & \quad 0.113
\end{align*}
\]

By above analysis, it is clear that Chinese tax incentive policies influence on enterprise innovation performance have various aspects. According to analytic hierarchy process, it gets in case considering the structure of enterprise network,
technical system, enterprise policy and social resources as well as other influence factors, tax incentive policies to enterprise innovation performance influence links are mainly as income tax preferential, the transformation of scientific achievements, technology and equipment updates such three links, the proportions are respectively 0.445, 0.286 and 0.269. Therefore, it gets Chinese tax incentive policies most influential link on enterprise innovation performance, and makes Chinese economic development corresponding policies for these links.

CONCLUSION

The paper firstly analyzes national economic development required main impetus that is enterprise innovation system. And then according to analytic hierarchy process, it gets in case considering the structure of enterprise network, technical system, enterprise policy and social resources as well as other influence factors, tax incentive policies to enterprise innovation performance influence links are mainly as income tax preferential, the transformation of scientific achievements, technology and equipment updates such three links, the proportions are respectively 0.445, 0.286 and 0.269. Therefore, it gets Chinese tax incentive policies most influential link on enterprise innovation performance, and makes Chinese economic development corresponding policies for these links.

REFERENCES