Industrial Innovation for Structural Optimization of Industry: Case of Fujian Province

Chen Ling\textsuperscript{a,\ast}, Xie Bihui\textsuperscript{b}, Fang Ruoxi\textsuperscript{b}

\textsuperscript{a} College of management, Fuzhou university, 350108, Fujian, China
\textsuperscript{b} College of management, Fuzhou university, 350002, Fujian, China

Abstract

This article is according to the characteristics of the industrial development in Fujian province. First, we set an evolution game model. Second, we use the mechanism that industrial innovation promotes structural optimization of industry to analyze how industrial innovation promotes industrial structural optimization. Then we combine the model deduced before with the realistic development situation of the industry to test and verify. We thereby obtain some attributes and characteristics of the industrial development in Fujian province, and then we will also analyze and explain about these attributes and characteristics. On the base of the analysis and explain before, we finally come up with policy suggestions about industrial innovation for industrial structural optimization.

1. Introduction

Since reform and opening up, economic growth has continued over 30 years, and the economic construction of Fujian province has made great achievements. During more than twenty years, the economy in Fujian keeps growing as fast as 10\% over a long period. But the worries are hidden behind the great achievements. Resources tend to be exhausted because of long-term immoderate exploitation, and industrial division is lying in the low end of international division for a long time. All these problems are related to the extensive economic growth pattern that our country relies on energy, minerals and labor resources, and the key to solve these problem is industrial innovation.

2. The basic theory and basic model

* Corresponding author. Tel.: +1-307-597-3668.
E-mail address: clppp666@126.com
2.1. The effect analysis model of innovative policy for industrial innovation: evolution game theory

2.1.1. Evolution game in replicator dynamic mechanism

Investigate an evolution game. The number of pure strategies every gamer can choose is \( i (i=1,2,\ldots,n) \). The game is repeated during a period of \( t (t=1, 2\ldots) \). Set \( P_i^t \) as the proportion of the gamers using strategy \( S_i \). The payoff of strategy \( S_i \) is \( \pi_i = \pi_i( P^t) \). We label the strategies so as to make \( \pi_1 \leq \pi_2 \leq \ldots \pi_n \). Set \( P_i' \) as the probability of those gamers who first adopted \( S_i \) and then turn to \( S_j \). \( P_i' \) are decided by the following formula:

\[
P_i' = \begin{cases} 
\beta(\pi_i' - \pi_j') \text{ when } \pi_i' > \pi_j' \\
0 \text{ when } \pi_i' \leq \pi_j'
\end{cases}
\]

Here, \( \beta \) is a number which is small enough to make \( P_i' \leq 1 \) for all \( i, j \). The expected value of the probability that gamers adopt \( S_i \) in the period of \( t+dt \) is shown as \( E_P^i \), and:

\[
E_P^i = P_i^t + \alpha dt P_i^t \beta(\pi_i' - \pi_j')
\]

Here, \( \bar{\pi} = \pi_1P_1^t + \ldots + \pi_nP_n^t \) represents the average payoff of the whole group. Minus \( P_i' \) from both sides of the equation, then divided by \( dt \). When \( dt \) approaches 0, we get the following formula:

\[
P_i'' = \alpha \beta P_i^t (P_i'' - \bar{\pi}) \quad i=1,2\ldots,n
\]

We call formula (1) replicator dynamic equation, and we may suppose \( \alpha \beta = 1 \).

2.1.2. The evolution game model of industrial innovation in replicator dynamic mechanism

2.1.2.1. The hypothesis of the model

- The enterprise’s scales are all the same.
- The group is very large in scale, that is to say, the number of the gamers approaches infinity.
- Every gamer can only use pure strategy: innovative strategy or conservative strategy.
- The payoff of innovative strategy is greater than conservative strategy.

Supposing that an industry consists of \( n \) enterprises (\( n \) approaches infinity). Pairwise enterprises repeat confrontations in random matching. Each enterprise can use innovative strategy \( S_i \) or conservative strategy \( S_j \). It’s shown as Fig.1. If the two enterprises both use conservative strategy, they divide the payoff of 2v (\( v > 0 \)) equally. If they both use innovative strategy, they divide the payoff of 2u (2u>2v > 0) equally, also, they had to bear the cost of innovative working: c. If one uses innovative strategy while the other uses conservative strategy, the one using innovative strategy gains 2u-c while the other gains v.

![Fig. 1. Matrix representation of random matching game on industrial innovation](image)

We presume \( P_i' \) as the probability of those gamers who first adopted \( S_i \) and then turn to \( S_j \).

Supposing that the proportion of those enterprises who take strategy \( S_i \) among all the enterprises is \( x \). Because \( n \) approaches infinity, \( x \) may be regarded as a continuous variable. According to the replicator dynamic equation (1), we get:
\[
\frac{dx}{dt} = x(\pi_1 - \pi) = x(1-x)[(2u-c-v)-ux] = f(x)
\]

2.1.2.2. The equilibrium analysis of the model

The equilibrium point of the evolution game model under replicator dynamic mechanism is in the place where \( f(x) = 0 \). Solve the equation, and we get \( x = 0, (2u-c-v)/u \).

According to replicator dynamic linear theory we see that it will be stabilized when \( f'(x^*) < 0 \), on the contrary, when \( f'(x^*) > 0 \), it won’t be stabilized. As we can’t judge the stability when \( f'(x^*) = 0 \), we discuss it by using the character of \( f(x) \) and then we will get Table 1 shown below.

Table 1. The evolution equilibrium of industrial innovation replicator evolution system

<table>
<thead>
<tr>
<th>Evolution equilibrium</th>
<th>(2u-c-v)/u ( \leq 0 )</th>
<th>0&lt;(2u-c-v)/u&lt;1</th>
<th>(2u-c-v)/u ( \geq 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game equilibrium</td>
<td>( x=0 )</td>
<td>( x=(2u-c-v)/u )</td>
<td>( x=1 )</td>
</tr>
<tr>
<td>(conservative, conservative)</td>
<td>(innovative, conservative), (conservative, innovative)</td>
<td>And innovate with the probability of ( x=(2u-c-v)/u )</td>
<td>(innovative, innovative)</td>
</tr>
</tbody>
</table>

2.2. The mechanism of industrial innovation for industrial structural adjustment

Innovation has changed the production function. The direct result of production function’s change reflects the rearrangement of the resources and the optimization, upgrade and transformation of the industrial structure, and the final result is to promote the development of the economy. The mechanism is shown as Fig. 2:

![Fig. 2. The mechanism of industrial innovation for industrial structural optimization](image)

3. The empirical analysis of industrial innovation and industrial structure in Fujian province

3.1. The analyze of the effect on industrial innovation by the government’s supply policy

Presume an industry is constituted by \( n \) enterprises (\( n \) approaches infinity). In this industry, supposing that the government reduces innovative cost \( c_0 \) by supply policy. Pairwise enterprises repeat confrontations in random matching. Each enterprise can use innovative management \( S_1 \) or conservative management \( S_2 \). By analyzing we get Fig.3 shown below:
So we come to this system’s replicator dynamic equation:

$$\frac{dx}{dt} = x(1-x)[(2u-c+c_0-v)-ux]$$

There are three anchors: $x=0$, $1$, $(2u-c+c_0-v)/u$. Through the analysis, we work out the industrial innovation’s evolution equilibrium shown as Table 2:

<table>
<thead>
<tr>
<th>Evolution equilibrium</th>
<th>$(2u-c+c_0-v)/u \leq 0$</th>
<th>$0 &lt; (2u-c+c_0-v)/u &lt; 1$</th>
<th>$(2u-c+c_0-v)/u \geq 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x=0$</td>
<td>$x=(2u-c+c_0-v)/u$</td>
<td>$x=1$</td>
<td></td>
</tr>
</tbody>
</table>

By analyzing Table 1, we can find that if we want to make the innovation succeeded, we need to make $2u-c-v>0$. So $(c+v)/2$ can be regarded as a critical value. If the innovative payoff is lower than the critical value, the industrial innovation will be a failure; otherwise the industrial innovation will succeed. After the government takes the supply policy into effect, the cost will reduce to $c-c_0$. At this time, the critical value also correspondingly decrease to $(c-c_0+v)/2$. Some innovative payoff may be lower than the critical value $(c+v)/2$ before the government intervention and then may be higher than $(c-c_0+v)/2$ after government intervention. In popular words, the government supply policy reduces the “threshold” of industrial innovative success. So it has an effect on encouraging innovative strategy adopted throughout the industry. In other words, it encourages industrial innovation.

3.2. The analysis of industrial innovation for industrial structural optimization

We will analyze the embodiment of industrial innovation during industrial transformation of Fujian province from four aspects.

3.2.1. Industrial innovation is the foundation of traditional industries’ transformation and upgrade and new industries’ formation.

On one hand, the traditional industries are great advantages of Fujian, and the key to keeping the advantages is to use high and new technology to transform and upgrade the competitiveness of traditional industries. On the other hand, industrial innovation is the main factor of accelerating the formation of new industries. Innovation will lead a certain industrial market demand become saturated and industrial development may stagnate. Also, innovation can prompt new industries’ formation by technology-driven and demand towing.

3.2.2. Technological innovation is the key to enhancing the industrial core competitive power and transform the industrial current development model

Relying on technological innovation is the key to cultivating the enterprise’s core competitive power, and changing the current extensive and high cost industrial development pattern, reducing the adverse effect of high dependence on foreign trade and foreign technology on economic development. If an industry wants to keep developing, scientific and technological innovation is necessary.

3.2.3. Industrial innovation is a requirement of extending the industrial lifecycle
In Fujian province, many industries are faced with the phenomenon of short industrial lifecycle. For the industries consisted of enterprise groups, Technology in different stages of industrial lifecycle affects the industrial development through working on the relevant factors among different enterprise groups. The improvement of the products’ performance and the reduction of the cost caused by technological innovation will expand production demand, so as to extend the products’ golden cycle.

3.2.4. Technological innovation is the core of industrial structural optimization

Technological innovation adjusts the industrial structure through affecting demand structure and supply structure. A new technology can make the production cost reduced and the demand increased, and it can also make consumer goods and consumer demand structure upgraded. The direct result of technological innovation is the improvement of social labour productivity. This will promote industrial division to deepen and new industries to appear, and the industrial structure will constantly optimize and upgrade.

4. Further explanation of the conclusion

The analysis above shows that the competition between enterprises can not always make innovation a success in the entire industry. Therefore, government’s appropriate intervention is necessary. For a successful intervention of the government, the following several tasks remains to be done:

- The subject localization of industrial innovation for Fujian industrial optimization.
- The system arrangement of industrial innovation for Fujian industrial optimization.
- Adopt market-oriented operation pattern and structure the industrial innovative system which consist of officer, production, study and research.

References