Paths and Countermeasures of Information Technology in Underdeveloped Areas to Improve Technological Innovation Efficiency of Enterprises

Rixing Liu*
School of Economics and Management, Yichun University, Jiangxi, China.

*Corresponding author

Abstract: In the context of the information economy era, China's economy has entered a new normal. Underdeveloped regions are facing industrial undertakings and industrial upgrading. Enterprise innovation capabilities are the key factors for industrial upgrading. In view of this, this article first have analyzed the problem of information technology to improve the efficiency of technological innovation in underdeveloped areas, used Eviews8.0 to empirically analyze the influencing factors of information technology to improve the efficiency of technological innovation in enterprises, and finally used Deap2.1 software to analyze the information technology improve the efficiency of technological innovation in enterprises. The two empirical results unanimously show that in China's underdeveloped regions, information technology has not been closely integrated with local human capital, and information technology has generally been inefficient or inefficient in improving enterprise innovation efficiency. It is necessary to strengthen the construction of information technology infrastructure in underdeveloped regions, and make some measures to improve local information technology level and communication capacity. Strengthening education investment and training is to enhance the level of human capital accumulation, and with policy guidance to enable the majority of workers to use information technology, it can improve work skills and actively engage in technological innovation activities.

1. Introduction
As early as in 1981, "Sources of the Third World Technology Capability", Larry E. WestPhal believed that the enterprise's technological innovation capability was a combination of innovation capability, technical information acquisition capability, organizational capability, and adaptive capability. In 1990, Adler and Shenbar from the ability to meet market demand through the development of new products and technologies, the ability to use related technologies and processes for product production, the ability to continuously update and improve the level of technology and processes, and the response to changes in the external environment to define new capabilities. In addition, Shapiro S.M carried out research on the composition and source of innovation ability in the book "Sustainable Innovation" published in 2003 and 2004, Bettina Von Stamen's book "Innovation" systematically studied the influencing factors of enterprise's innovation ability, and at the same time found a way to cultivate enterprise's innovation ability. In 2005, Wang Yiming not only studied how to effectively use internal and external resources to obtain relevant core technologies and intellectual property rights in the process of studying enterprise innovation activities, but also believed that the organic synthesis of various capabilities and qualities exhibited by enterprises in their continuous competitive advantages formed innovation. Ability. Liu Fengchao and others analyzed the three key links from research and
development, manufacturing, and market-oriented operations involved in innovation activities, and considered that the company's innovation capability is composed of resource capabilities, carrier capabilities, results capabilities, brand capabilities, and environmental capabilities. Crespi, Criscuolo, and Haskel (2007) use British CIS data research to find that the interaction of information technology and organizational innovation has a positive effect on corporate performance. Gera (2004) analyzed data on the use of information technology and human resources by 5,501 companies in Canada in 1999 and found that, on the whole, there is a positive complementary effect between corporate innovation capabilities and information technology. However, there are still some differences in different industries. For example, in the manufacturing sector, the complementary effects of production innovation and human resource reorganization and information technology are stronger. In the service industry, information technology investment and product or service innovation are conducive to improving corporate performance. Similar studies on the impact of the complementary effects of information technology and innovation capabilities on corporate productivity have been conducted in Western countries such as the Netherlands (Polder, 2010), Australia (Gretton, 2004), and the United States (Mansury, 2008). The conclusions are basically the same, and the differences are mainly in the dimensional division of innovation and the measurement of information technology. In 2014, Han Xianfeng and other researchers believed that informatization can promote the improvement of technological innovation capabilities.

The study of economic problems in underdeveloped areas is a classic problem studied by scholars at home and abroad. Compared with economically developed areas, the concept of underdeveloped areas is a description of the state of economic development. After the 1960s, the development process of various countries in the world tells us that the path from the underdeveloped to the developed is the industrialization process, the driving force of the industrialization process is innovation, and information technology is the propagation channel of the innovation exchange medium. It is of practical significance to study the relationship between information technology and technological innovation of enterprises. After the Chinese economy has entered the new normal, the economy has entered an important period of transformation and upgrading. In this stage of economic development, information technology is one of the main promoters of enterprise technological innovation. In China's less developed regions, how to improve the efficiency of technological innovation of enterprises is a key issue that affects the economic transformation and upgrading of the region, and it is the main research content of this article. Generally speaking, the less-developed regions mentioned in the introduction of this article mainly consider such regions. These regions are relatively developed compared to the eastern regions in terms of per capita income, economic development speed, local technological level, research and development capabilities, and human capital accumulation a regional concept. The underdeveloped areas mentioned in this article mainly refer to the underdeveloped areas in central and western China.

2. The Problems of Information Technology to Improve the Efficiency of Technological Innovation in Less Developed Regions

The underdeveloped regions in the central and western regions of China still have certain gaps with the developed regions in the east in terms of economic development level, education level, production technology, scientific research level, and information technology. Technical innovation, organizational innovation, and management systems are relatively backward. The efficiency of information technology to improve technological innovation of enterprises is not high, which is mainly reflected in the following aspects:

First, there is a large gap between eastern and western regions in terms of information technology to improve the efficiency of technological innovation in enterprises. In relatively developed areas such as Guangdong, Shenzhen, Shanghai, and Beijing in the east of China, the level of information technology is high, the level of human capital accumulation is high, organizational and institutional innovation methods are perfect, and the efficiency of information technology to enhance corporate technology innovation is relatively high. Compared with these regions, China’s central and western less developed areas are relatively backward in terms of information facilities, media, human capital, organizational structure, and institutional arrangements, and cannot compete at one level.
Second, compared with the developed areas in the east of China, the gap in human capital between the less developed areas in the central and western regions is significant, and there is a tendency to increase further. The gap in the level of human capital will directly affect the use, promotion and innovation of information technology, thereby affecting the level of information technology to improve the efficiency of technological innovation in enterprises. Current research shows that in relatively developed regions such as Beijing, Guangdong, Jiangsu, Shandong, Shenzhen, and Shanghai, the level of human capital is much higher than that of Gansu, Ningxia, Qinghai, Hainan, and Tibet, which are relatively poor in human capital. In the less developed regions of the central and western regions, these huge differences in human capital will affect China’s developed and underdeveloped regions for a long time, causing differences in the use of information technology to improve the technological innovation efficiency of enterprises.

Thirdly, in terms of development concepts, information technology in underdeveloped areas has lagging behind in technological innovation. The main concepts of less developed areas are to wait for national policy support and financial assistance. They have not taken the initiative to innovate in terms of internal organizational structure, human resources system, and management system. Through these aspects of innovation, they can improve the information level, enhance information technology, and improve the efficiency of technological innovation in enterprises. In addition, as an underdeveloped area, due to the long-term constraints of old ideas in the past, such as economic development level, capital, technology, concepts, and government macro policies, the path dependence of the management system of managers has been formed, which has led to information technology markets and technological innovation. The weakening of the market and the lack of its due vitality will also affect the efficiency level of information technology to improve the technological innovation capabilities of enterprises.

Fourth, in the process of improving the technological innovation efficiency of enterprises in information technology in less-developed regions in China, they rely too much on the use of methods, ways, system design, and personnel matching in developed regions in the east. Human resources introduction policy, corporate organizational structure, information technology network design, information technology promotion methods and ways, information technology measures to improve the efficiency of technological innovation in enterprises, corporate organizational production design, personnel matching, etc. In this way, the industrial value chain in the less developed regions has been at the low end for a long time, and the technological innovation efficiency of enterprises is obviously not high.

3. Analysis of the Impact of Information Technology on Enterprise Technological Innovation in Less Developed Areas

The previous analysis from the theory and current analysis of the low efficiency of information technology to improve enterprises' technological innovation in China's less developed regions, the following analysis is empirical analysis.

3.1. Selection of Data Sources and Indicators

In order to empirically analyze the situation that information technology promotes the technological innovation of enterprises, this article uses NL to represent the annual number of Internet users in less developed regions. This indicator represents the level of information technology diffusion in less developed regions. GDP stands for gross domestic product of less developed regions. JK is education investment in less developed areas, this indicator represents the level of education in less developed areas. NJSQ indicates the year-end technology market turnover in less developed regions. This indicator represents the technological innovation capabilities of enterprises in less developed regions. The data in this article are from the China Statistical Yearbook 2007-2014. Due to incomplete data in some regions, the panel data of 13 provinces (municipalities) in the central and western regions with relatively complete data were selected for analysis. jiangxi, Henan, Hubei, Hunan, Sichuan, Chongqing, Yunnan, Shaanxi, and Xinjiang. The following tables is fact used EVIEW8.0 to perform descriptive statistics on the values of various variables, and the results are shown in Tables 1 and 2 below.
Table 1. Descriptive statistics of variables in less developed regions.

|         | Mean  | Median | Maxima       | Skewness | Kurtosis | Probability | cross |
|---------|-------|--------|--------------|----------|----------|-------------|-------|
| GDP     | 13112.970 | 11830 | 34938        | 1.0613   | 3.6325   | 0.0000***   | 13    |
| JK      | 5461707  | 4880214 | 1557712     | 1.14516  | 4.2384   | 0.0000***   | 13    |
| NJSQ    | 724953   | 416284 | 6400198      | 3.5770   | 16.6143  | 0.0000***   | 13    |
| NL      | 1366.3270 | 1224.5000 | 3474       | 0.8499   | 3.2051   | 0.0017***   | 13    |

Note: ***, **, * indicate significant at 1%, 5%, and 10% levels, respectively. The sample size is 104.

Table 1 above shows the average number and median of the number of people accessing the internet, the annual GDP, the annual investment in education, and the year-end technology market turnover in less-developed regions.

3.2. Empirical Analysis

According to the previous theoretical design, establish an empirical model, and establish models 1 and 2 of the role of enterprises in less-developed regions to promote innovation through information technology. Regression is based on NL (annual number of Internet users) and JK (education funding) as interaction variables, indicating the interaction of vocational and technical training and the diffusion of information technology, which together have an impact on technological innovation, or indicate that employees of the company use information. The influence of improving one's own quality level on technological innovation.

3.2.1. Establish an Empirical Analysis Model. Information technology in underdeveloped areas to improve enterprises' technological innovation capability model one.

\[ NJSQ = \beta_0 + \gamma_1 JK * NL + \gamma_2 GDP + \gamma_3 AR(3) + \omega_2 \] (1)

Information technology in underdeveloped areas to improve technological innovation capabilities of enterprises model two

\[ NJSQ = \beta_0 + \beta_1 JK + \beta_2 NL + \beta_3 GDP + \beta_4 AR(4) + \omega_1 \] (2)

In the above formula, \( \beta_0 \), \( \gamma_0 \) represent constants, respectively, \( \beta_1 \), \( \beta_2 \), \( \beta_3 \), \( \beta_4 \), \( \gamma_1 \), \( \gamma_2 \), \( \gamma_3 \) represents the coefficient term, and \( \omega_1 \), \( \omega_2 \) represent the interference term.

3.2.2. Analysis of Empirical Results in Less Developed Areas. The results of regression analysis of Model 1 and Model 2 in the less developed regions are shown in Table 3 below.
Table 2. Regression results of models 1 and 2 in less developed regions.

|                | Underdeveloped Area Model 1 | Underdeveloped Area Model 2 |
|----------------|-----------------------------|-----------------------------|
|                | Coefficient | Pvalue | Margin | Coefficient | Pvalue |
| JK*NL          | -2.82E-05   | 0.0002*** | JK   | 0.0255      | 0.0266** |
| GDP            | 18.5793     | 0.0000*** | NL   | -244.7839   | 0.0000*** |
| AR(3)          | 2.9780      | 0.0000*** | GDP  | 29.4860     | 0.0000*** |
| AR(4)          |             |         |       | 4.0728      | 0.0000*** |
| Adjust R square| 0.8693      |         | Adjust R square | 0.8275 |
| D.W. Statistics| 0.8646      |         | D.W. Statistics | 0.8040 |

Note: ***, **, * indicate significant at 1%, 5%, and 10% levels, respectively. The sample size is 104. D.W. is Durbin-watson. GDP stands for gross domestic product of less developed regions. JK said education investment in less developed areas, this indicator represents the level of education in less developed areas. NJSQ indicates the year-end technology market turnover in less developed regions. NL is annual number of Internet users.

The regression analysis results in Table 2 above show that: from the regression results of Model 1 in the less-developed regions, although the interaction between education and training and the diffusion of information technology and the technological innovation capacity of the enterprise have a reverse direction, but if the economy grows, the technological innovation capacity of the enterprise also is increasing, it shows that economic growth has promoted the improvement of technological innovation capabilities of enterprises in the central and western regions. It can be seen from the results of the regression of the less developed region model that although the education level in the central and western regions is conducive to the use and development of information technology, promote technological innovation, and improve innovation capacity. However, for the enterprises in this region, the more the information technology develops, the greater the scope and depth of diffusion, and the faster the technology innovation capabilities of enterprises are, it cannot be tested.

4. The Analysis of Information Technology to Improve the Efficiency of Technological Innovation in Less Developed Regions

4.1. Model Design
The impact of information technology on the innovation capability of underdeveloped regions has been analyzed above. The data envelopment analysis method will be used to analyze the efficiency of information technology to improve the innovation capability of underdeveloped regions. NL represents the annual number of Internet users in less-developed regions. This indicator represents the level of information technology diffusion in less-developed regions. GDP stands for gross domestic product of less developed regions. JK is education investment in less developed areas, this indicator represents the level of education in less developed areas. NJSQ indicates the year-end technology market turnover in less developed regions. This indicator represents the technological innovation capabilities of enterprises in less developed regions. NL and JK are used as input variables, NJSQ is used as output variable, and Deap 2.1 software had been used to analyze the efficiency of information technology in underdeveloped areas to improve the technological innovation capability of enterprises. Deap 2.1 software analysis is mainly based on the DEA model analysis. Generally, the DEA model analysis has a relative efficiency between (0, 1), and the efficiency value at the leading edge of the efficiency in this interval is 1. According to the change of scale, the DEA model can be divided into two types, that is, BC2 under variable returns to scale (VRS) and CCR under constant returns to scale (CRS) and two models. In the BC2 analysis model, the efficiency of information technology to enhance the innovation capacity of technology companies in less developed regions is decomposed into pure technology efficiency and scale efficiency, which is equal to the product of pure technology efficiency and scale efficiency. According to the actual situation, the BC2 model will be used to judge and analyze the efficiency of information technology in underdeveloped regions to enhance the
innovation capacity of enterprises.

According to the DEA model operating mode, the overall requirement is that the number of decision-making units (research objects) must be more than twice the sum of the total of input indicators and output indicators. In view of this, this article selects two input indicators, one output indicator, 13 research objects, so the empirical analysis meets the basic requirements of the DEA model. The data of the indicators in this article are from the values of China Statistical Yearbook 2007-2014. Due to incomplete data in some areas, the panel data of 13 provinces (municipalities) in the central and western regions with relatively complete data are used for analysis. These 13 provinces (municipalities) are Shanxi, Jilin, Heilongjiang, Anhui, and Jiangxi Province, Henan Province, Hubei Province, Hunan Province, Sichuan Province, Chongqing City, Yunnan Province, Shaanxi Province, Xinjiang Uygur Autonomous Region.

4.2. Analysis of Empirical Conclusions

The data was analyzed by Deap2.1 software, and the results are shown in Table 3 below. The data in Table 3 shows:

|                | 2007  | 2010  | 2014  |
|----------------|-------|-------|-------|
|                | Mean  | Mean  | Mean  |
| Shanxi         | 0.266 | 0.148 | 0.037 |
| Jilin          | 0.764 | 0.728 | 0.903 |
| Heilongjiang   | 0.601 | 0.295 | 0.986 |
| Anhui          | 0.160 | 0.202 | 0.908 |
| Jiangxi        | 0.431 | 0.266 | 0.073 |
| Henan          | 0.405 | 0.413 | 0.227 |
| Hubei          | 0.191 | 0.302 | 0.090 |
| Hunan          | 0.667 | 0.632 | 0.279 |
| Sichuan        | 0.353 | 0.341 | 0.201 |
| Chongqing      | 1.000 | 1.000 | 0.332 |
| Yunnan         | 0.560 | 0.986 | 1.000 |
| Shaanxi        | 0.290 | 0.133 | 0.080 |
| Xinjiang       | 0.199 | 0.069 | 0.007 |
| **Mean**       | 0.453 | 0.424 | 0.266 |

Note: - means constant returns to scale; drs means decreasing returns to scale; irs means increasing returns to scale. The sample size is 104.

2010 and 2014. Jilin Province was in a state of low efficiency in 2007 and 2010, and in a state of medium efficiency in 2014. The other provinces were basically inefficient in 2007, 2010 and 2014.
4.2.2. In Terms of Pure Technical Efficiency and Scale Efficiency in Less Developed Regions. On the whole, the pure technology efficiency in the less developed regions was on the rise from 2007 to 2010, but from 2010 to 2014, it showed a slight decline in stability and it was in a state of low efficiency. Specifically, Jilin Province was in high efficiency in 2007. In Jiangxi Province in 2010 and 2014, Chongqing City in 2007 and 2010, Yunnan Province in 2010 and 2014, Xinjiang Uygur Autonomous Region in 2007, 2010 and 2014, Jilin Province in 2014, Anhui Province in 2010, Hubei Province in 2010, Hunan Province in 2010 and 2014, Chongqing City in 2014, and Shaanxi Province in 2010, they were in a state of medium efficiency. At other times, these provinces are in an inefficient or inefficient state.

From the perspective of scale efficiency, from 2007 to 2014, generally speaking, the less developed regions showed a downward trend from low scale efficiency, and they were inefficient in 2010 and 2014. Specifically, Chongqing was in a state of high efficiency in 2007 and 2010 and Yunnan Province in 2014. In 2010 and 2014, Jilin Province and Hunan Province, they were in a medium-scale efficiency state in 2007. Other provinces were inefficient or inefficient in other periods.

4.2.3. In Terms of Scale Returns in Less Developed Regions. Jilin Province 2007 and 2010, Heilongjiang Province 2007, and Yunnan Province 2010, they were the stages of diminishing returns to scale, Chongqing 2007 and 2010, and Yunnan Province were in the stage of constant returns to scale in 2014, and other provinces were in the stage of increasing returns to scale at other times.

4.2.4. Analysis of Information Technology in Underdeveloped Regions to Enhance Innovation Efficiency of Technology Enterprises. The above research shows that, in general, after entering the new economic normal, the interaction between information technology and education investment in underdeveloped areas had been a factor affecting the efficiency of technological innovation in enterprises, but information technology has not been well integrated with education, and information technology has improved enterprise technology. The efficiency of innovation capacity was inefficient. Although very few provinces and periods were efficient, due to the influence of various factors in the transition period and local factors, information technology cannot improve the local level of human capital accumulation (the role of education), which leaded to the inefficiency of information technology to basically improve the technological innovation capacity of enterprises. And basically showed a downward trend. From the perspective of efficiency decomposition, it was mainly that the underdeveloped areas are in the primary stage of development, the level of economic development is not high, and the scale is basically in the stage of increasing returns to scale, which indicates that there is huge room for enterprise production and development. It is possible to increase the level of human capital accumulation by expanding the scale of information technology investment. Through active use of information technology, the majority of workers will earnestly master professional skills, strive to devote themselves to technological innovation, and actively improve the efficiency of technological innovation in enterprises. Therefore, the path for information technology in underdeveloped areas to improve the innovation efficiency of enterprises is to increase pure technology efficiency through the introduction of technology or technological innovation, and increase the level of human capital accumulation; By increasing investment in information technology facilities and education, enhancing the ability of information technology to diffuse. Information technology spreads new technologies, new methods, new management levels, new organizational structures, and new institutional arrangements to the region, and it is closely combined with educational methods, so that information technology and human resources are tightly integrated, so that the majority of workers can learn about the spread of information in other regions. Knowledge, learning new technologies, new methods, new management levels, new organizational structures, new institutional arrangements, etc. in the cadre, and it ultimately improve the efficiency of technological innovation in enterprises.

5. Conclusion and Countermeasure Analysis
This paper believes that the efficiency of innovation in information technology in underdeveloped regions in China is generally ineffective. Underdeveloped regions must enhance the level of information technology in underdeveloped regions by enhancing information technology facilities,
expanding education and information technology investment, and ultimately improve the local enterprises' technical innovation capabilities. The implications of this policy are:

5.1. From a Macro Perspective
Governments in less-developed regions should actively build information technology facilities and equipment, upgrade information technology platforms and networks, and actively advocate the role of information technology in economic development, strengthen the ability of information technology to connect with developed regions in the east and the world's advanced regions, and increase the quality and quantity of information dissemination. Governments at all levels in less-developed areas should build various labor training and re-education systems according to local conditions. Actively carry out and mobilize the majority of workers to participate in technical learning and technological innovation. Actively participate in the construction and study of information network learning platforms, earnestly learn advanced cutting-edge knowledge, strive for diamond technical knowledge, and be bold in devoting to technological innovation and improve innovation efficiency.

5.2. From a Micro-level Perspective
The vast number of enterprises in less developed areas should build their own information technology platforms and networks, establish a lifelong training system for their employees, and increase capital investment. Actively guide employees to strive for diamond expertise, innovate organizational structures, create new systems, and improve the efficiency of technological innovation in enterprises.

5.3. From the Perspective of Family Behavior Choices
Enterprise employees must seriously and actively cooperate with the system arrangements of actively organized education and training and the diffusion of information technology, accept and master technological spillovers in advanced regions, study carefully, study hard, and make good use of information technology. They must carry out technological innovation, technological transformation, and institutional innovation, and learn advanced skills, advanced processes, cutting-edge theoretical knowledge, and advanced management decision-making levels through the diffusion of information technology, and ultimately improve the efficiency of technological innovation in enterprises in the region.

6. Limitations of This Article
Although this article analyzes the problem of information technology to improve the efficiency of technological innovation in underdeveloped regions, it uses Eviews8.0 to empirically analyze the influencing factors of information technology to improve the efficiency of technological innovation in enterprises, and finally uses Deap2.1 software to empirically analyze the information technology to improve technological innovation Efficiency path. However, this article does not compare and analyze the efficiency of technological innovation of enterprises in information technology in eastern and central and western in China, find differences, and propose related countermeasures. This is the direction of research in the future.

Acknowledgements
Project Fund: Jiangxi Provincial Science and Technology Plan Project: Paths and Countermeasures for Information Technology to Improve Enterprise Innovation Efficiency in Less Developed Areas (GJJ170912); Social Science Planning Project of Yichun: Research on the Path and Countermeasure of Wage Incentives to Enhance the Innovation Ability of Enterprises (YCSKL2017-027)

References
[1] Rixing-Liu, Research on the Spatial Diffusion Path of Information Technology to Promote Enterprise Innovation Ability [J], Journal of Dongbei University of Finance and Economics, 2018 (02).
[2] Yonghong-Ma, et al. Research on the path of improving technological innovation capabilities of enterprises in underdeveloped regions based on the perspective of inter-regional industrial
transfer [J], "Science & Technology Progress and Policy" 2015 (07).

[3] Jiangyun-Tang, et al. Analysis of potato production efficiency in Sichuan Province based on super-efficiency DEA model [J], Jiangsu Agricultural Sciences, 2018 (08).

[4] Liyang-Zhang, The Promotion Effect of Training Mechanism Construction on the Urban-rural Integration Development: With the County Economic Development as the Background [J], "People's Forum" 2015 (12).

[5] Haining-Long, Strategic Transformation and Institutional Innovation of Human Resources Management in State-owned Enterprises from Temasek's Experience [J], Journal of Nanjing University of Aeronautics and Astronautics (Social Science Edition), 2008 (09).

[6] Shuhui-Liu, Research on H Aviation Input-Output Efficiency Evaluation [D], Guangxi University 2018 (05).