Research on the Influence Model of Technology Introduction and Intellectual Property Protection on Enterprise Innovation

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Abstract: In previous studies, technology introduction and intellectual property protection are considered to be important factors affecting enterprise innovation. On this basis, this paper firstly analyzes the influence of the combination of these two factors on enterprise innovation, holds that they can both promote and inhibit enterprise innovation ability. According to the local environment, human capital level and enterprise heterogeneity, the influence degree is not the same, or even completely opposite. Based on the theoretical analysis, this paper establishes the econometric model and tries to explore the influence of different factors on enterprise innovation in different regions.

1. Introduction

With the deepening and development of intellectual property trade and intellectual property protection system, the influence of technology introduction and intellectual property protection on the innovation ability of enterprises is obvious. However, more and more facts have proved that simply relying on technology introduction and intellectual property protection can not necessarily have a linear impact on the innovation ability of enterprises, and it is necessary to comprehensively consider the joint effect of the two and the heterogeneity of enterprise technology level and other factors. However, it is urgent to solve the problem of how and to what extent both of them have an effect on enterprise innovation. This paper theoretically analyzes and explores the influence mechanism of the two factors on the innovation ability of enterprises and presents them in the form of model.

2. Literature Review

2.1. Technological Progress and Enterprise Innovation

The innovative ability of an enterprise is one of the important competitiveness of a country. As mentioned by Michael porter (1990)[1], excellent enterprise innovation ability can not only bring considerable profits and benefits to the enterprise, and become the core competitive advantage of the

enterprise, but also have excellent performance under the influence of knowledge spillover and market competition factors. A single enterprise with innovation capability can even inspire other companies in the same industry to innovate, thereby forming industry competitiveness and ultimately becoming the core competitiveness of a country. On the issue of how companies improve innovation, the traditional view believes that capital, knowledge and human capital are all important sources of enterprise innovation. Therefore, enterprise innovation should be endogenous factors, in order to improve the innovation of enterprises, increase investment in research and development and improve the quality of personnel are the core. However, the above-mentioned traditional views are only applicable to developed countries. More and more practices have proved that if companies in developing countries want to improve their innovation capabilities, technology introduction is also an important source. Chou, Shy (1991) [2]and Van Elkan (1996) [3]pointed out that after introducing advanced technology, developing countries will actively imitate the technology, and further digest and absorb, promote technological progress within the enterprise, improve the quality of human capital, eventually improve their innovation ability.

2.2. Intellectual Property Protection and Enterprise Innovation

Regarding whether strengthening intellectual property protection and improving the intellectual property system can promote enterprise innovation, scholars currently agree that it can promote enterprise innovation in developed countries (Fu et al 2009)[4], but Chen (2004)[5] after the empirical analysis on factors, pointed out that there is a non-linear relationship between intellectual property protection and the innovation capabilities of enterprises and countries. The current accepted view in academia is represented by Gangopadhyay et al (2012)[6]. Strengthening the protection of intellectual property rights and enterprise innovation should present an “inverted U” relationship, that is, strengthening protection at an early stage can promote enterprise innovation, but with the further expansion of the strength, the innovation ability of enterprises will be inhibited. On the one hand, intellectual property protection can protect the interests of innovative companies, avoid the imitation of innovative technologies by other companies, and effectively improve the exclusivity of the technology to encourage innovation. But on the other hand, innovation behavior as knowledge inevitably has a spillover effect, and many companies in the early stages of development often need to rely on this spillover effect for innovation. Too strong an intellectual property protection system is likely to inhibit the innovation ability of enterprises. At the same time, too strong protection of intellectual property rights will enable companies with technology to hold technology for a long time and conduct internal technical exchanges, thereby exacerbating the occurrence of international technology monopoly.

The academic community has made a comprehensive and detailed study on the impact of individual intellectual property protection and technology introduction on corporate innovation. But at present, the research of combining these three to analyze its internal mechanism is not enough.

3. The Joint Effect of Intellectual Property Protection and Technology Introduction

The joint effect of technology introduction and intellectual property protection will not only promote and inhibit the innovation of enterprises. Due to the difference in regional environment, human capital level, and enterprise heterogeneity, the degree of promotion and inhibition is also different, and the final situation may be completely opposite.

3.1. The Promotion Effect of Intellectual Property Protection and Technology Introduction on Enterprise Innovation

Technology introduction has a strong threshold effect on the innovation ability of enterprises. Some enterprises in the technical bottleneck period can quickly achieve technological breakthroughs through technology introduction. After digesting and absorbing technology, they embark on the road of secondary innovation or even independent innovation. The intellectual property protection system acts as a "catalyst" in this process. After the enterprise chooses the technology that suits itself and the situation of the domestic market, it will digest and absorb it later, that is, transform the technology into an improvement in productivity or product quality to obtain a stronger profitability. The external economy brought by knowledge is an important factor restricting enterprises to adopt independent innovation. Enterprises cannot fully enjoy the benefits of innovation and lack the motivation to innovate. However, a strong and powerful intellectual property protection system can effectively reduce knowledge spillovers, technological imitation and other behaviors, significantly improve the vitality and motivation of enterprises' independent innovation, and make enterprises willing to innovate. After the second innovation of technology or independent innovation, the enterprise can gradually accumulate its own technical level, which in turn can improve the absorption capacity of the technological introduction, help the enterprise to use internal and external resources more reasonably, and help the enterprise the growth of innovation. Therefore, the protection of intellectual property rights has made the originally long three-stage process of technology introduction-simultaneous introduction and innovation-vigorously carrying out independent innovation more efficient, and enterprises can more targeted choose technologies that can help them make innovative breakthroughs, not just it is a profitable technology in the domestic market, improving the efficiency of technology introduction, and finally achieving a virtuous cycle of introduction-innovation-reintroduction-re-innovation.

3.2. The Inhibition of Intellectual Property Protection and Technology Introduction on Enterprise Innovation

The core of the intellectual property protection system is to reduce the external economy and reduce the occurrence of knowledge spillovers. However, many low-tech companies (especially those in developing countries) need to rely on these knowledge spillovers to realize the process from technology introduction to imitation innovation to independent innovation. Due to the lack of spillover effect, it is difficult for companies to effectively digest and absorb after technology introduction, and even less able to carry out secondary innovations when the company does not already have a certain technical foundation and the country does not have a strong innovation soil. In order to improve their own technological level and make up for the technological gap with advanced enterprises, enterprises will even fall into an endless loop of continuous introduction of technology and stagnate at this stage for a considerable period of time. Due to the extremely high substitution effect between technology introduction and independent research and development, the continuous repetition of the introduction of foreign technology by enterprises will make enterprises lack the awareness and enthusiasm for independent innovation in the long run, which is not conducive to the cultivation of innovation. At the same time, under the influence of international competition, the introduced technology is often a relatively mature or even backward technology, which will also lead to the inefficiency of technology introduction behavior. Excessive technology introduction has also caused excessive dependence on foreign technology, and even in turn forced foreign companies to innovate.

4. Model Setting and Variable Description

This paper introduces the technological innovation function model and adopts certain improvements to establish the analysis model.

4.1. Model Setting

The model of knowledge innovation function was first put forward by Griliches in 1979. He regarded the innovation behavior of enterprises as a function of R&D investment, Jaffe improved the model in 1989[7] in the following form:

$$TECH_{rit} = C(R\&D)^{\alpha} HR^{\beta} \varepsilon \quad (1)$$

In the knowledge innovation function, the innovation ability of an enterprise is highly correlated with its R&D investment and human resource level. TECH represents the innovation output capacity of enterprises, while r and t represent different regions and time respectively. R&D represents the expenditure of independent research and deve]lopment, and HR represents the level of human resource. Where, α and β represent the elasticity coefficient of independent research and development investment and human resource level, respectively. C is the constant term of the model and ε represents the random error term. By taking the logarithm of both sides of (1), we can get:

$$lnTECH_{rt} = \alpha_0 + \alpha_1 lnR\&D_{rt} + \alpha_2 lnHR_{rt} + \varepsilon_{rt} \quad (2)$$

Among them, $\alpha_0 = lnC \quad \alpha_1 = \alpha \quad \alpha_2 = \beta$

Since this paper mainly explores the influence of technology introduction and intellectual property protection on enterprise innovation, and technology introduction is composed of technology import and FDI technology spillover (Yongping Hu, 2014)[8], the three explanatory variables and the interactive term of exploring their joint effect are added. In addition, among the factors affecting the innovation ability of enterprises, independent research and development behavior, technology import and spillover effect are not factor that can play a role immediately once carried out, and there is a certain lag in the impact of the three on the innovation ability of enterprises. Therefore, the hysteresis first-order value is taken for all the three, and the model (3) is finally obtained:

$$lnTECH_{rt} = \alpha_0 + \alpha_1 lnR\&D_{rt-1} + \alpha_2 lnHR_{rt} + \alpha_3 lnTECHim_{rt-1} + \alpha_4 FDIso_{rt-1} + \alpha_5 IPP_{rt} + \alpha_6 FDIso_{rt-1} * IPP_{rt} + \alpha_7 IPP_{rt} * lnTECHim_{rt-1} + \varepsilon_{rt} \quad (3)$$

In model (3), TECHim represents the import of technique, FDIso represents FDI technology spillover, and IPP represents Intellectual property protection. In order to verify the relationship between technology introduction and enterprise innovation and intellectual property protection, the partial derivative of lnTECHim can be obtained by taking the expectation from both sides of model (3):

$$\frac{\partial E(lnTECH)}{\partial lnTECHim} = \alpha_3 + \alpha_7 IPP_{rt} \quad (4)$$

If $\frac{\partial E(lnTECH)}{\partial lnTECHim} > 0$, It shows that technology import can promote the innovation ability of enterprises

in this region; or $\frac{\partial E(lnTECH)}{\partial lnTECHim} < 0$, which means technology imports inhibit its ability to innovate. Similar results can be obtained by doing the same processing for both FDI so and IPP variables:

$$\frac{\partial E(FDIso)}{\partial lnTECHim} = \alpha_4 + \alpha_6 IPP_{rt} \quad (5)$$

If $\frac{\partial E(FDIso)}{\partial lnTECHim} > 0$, this shows that FDI technology spillover has a positive effect on the innovation of enterprises in this regio"n; or $\frac{\partial E(FDIso)}{\partial lnTECHim} < 0$, it has a negative effect. In terms of measuring the joint effect of technology introduction and intellectual property protection, if the coefficient α_6 of $FDIso_{rt-1} * IPP_{rt}$ is positive, it indicates that the joint effect of the two can promote the enterprise innovation; otherwise, it inhibits the innovation ability of enterprises. Similarly, similar results can be obtained from the interaction terms of intellectual property rights and technology import: if the coefficient of interaction terms IPP_{rt} and $TECHim_{rt}$ is greater than 0, the joint effect of the two will play a positive role in enterprise innovation; the contrary shows that it produces a negative effect.

4.2. Variable Description

1. Enterprise innovation (TECH). At present, most scholars use the number of patent applications as a measure of corporate innovation. Compared with the number of new product developments, patent indicators have the advantages of more intuitive and easy data access, and not all patented technologies can be finally converted into new products. Compared with the number of patents, the number of patent applications does not need to consider the human factors in the patent approval process in China and does not need to wait for a certain time for approval, which can reflect the innovative power of enterprises in a more timely and accurate manner.

2. The independent research and development investment (R&D) of an enterprise, taking the R&D expenditure of the enterprise as a measurement indicator, needs to consider the cumulative effect of its impact on innovation ability, so it needs to adopt the perpetual inventory method to estimate this:

$$R\&Ds_{rt} = R\&De_{rt} + (1-\gamma)R\&DS_{rt-1} \quad (6)$$

Among them, $R\&Ds_{rt}$ represents the current independent R&D capital stock in the r area, and $R\&De_{rt}$ represents the amount of independent R&D expenditure in the current period. $(1-\gamma)R\&DS_{rt-1}$ is the capital stock of the previous period multiplied by the depreciation rate. In addition, the specific calculation method of the independent research and development capital stock in the base period is the following equation:

$$R\&Ds_{rt} = \frac{R\&De_{rt}}{\gamma + g_r} \quad (7)$$

g_r is the average annual growth rate of the amount of independent R&D expenditure in the time zone selected by the region. In the following treatment of technology import expenditure ($lnTECHim_{rt}$), the same calculation method as the independent R&D investment can also be adopted.

3. Human capital level (HR). The level of technological innovation in an industry in a certain area is highly correlated with the level of human capital, so this is the control variable in the model. Using R&D researchers' full-time equivalent as a measurement index has the advantages of clear standards, narrower measurement range and easier access to data, which can well guarantee the

quality and quality of human capital.

4. FDI technology overflow (FDIso). By calculating the proportion of R&D expenditures of foreign-funded enterprises in the total expenditure of all R&D research activities in the region, exploring the degree of R&D participation of foreign-funded enterprises can well measure the impact of foreign direct investment spillovers on the innovation capacity of Chinese enterprises.

5. Intellectual Property Protection (IPP). This article uses explicit comparative advantage indicators to investigate the enforcement status of intellectual property protection in the region. The specific calculation method is as follows:

$$IPP_{rt} = \frac{cri_{rt}/app_{rt}}{\sum cri_t/\sum app_t} + 1 \qquad (8)$$

cri_{rt}/app_{rt} represents the ratio of all law enforcement cases related to the protection of intellectual property rights to the number of applications for intellectual property rights in a certain year in a certain area, $\sum cri_{rt}/\sum app_{rt}$ represents the ratio of all intellectual property law enforcement cases to the number of intellectual property applications in that year in China. Adding the number 1 after the formula is mainly to avoid the problem of missing variables caused by the IPR protection index of 0 if there are no IPR-related lawsuits in that year. In addition, adding the number 1 will not fundamentally change the statistical results.

5. Conclusion

This article discusses in detail the impact mechanism of the joint effect of technology introduction and intellectual property protection on enterprise innovation, concludes that the two and their joint effect are not a single linear relationship with enterprise innovation. The degree of influence is different due to different factors, and sometimes even opposite effects are produced. On this basis, we draw on the innovation output function and make some improvements, establish an analysis model, and try to use the model to get the influence of different factors on the innovation ability of enterprises in different regions. However, subject to the availability of data, the two indicators of FDI spillover effect and intellectual property protection are difficult to quantify, and other factors, the model setting in this paper still has certain shortcomings and needs further exploration.

References

[1] Michael Porter. Competitive advantages of government and country [J]. Theoretical Reference, 2002 (07): 2-4.

[2] Chou Chien-Fu, Shy Oz. An overlapping generations model of self-propelled growth[J].1991,13(3).

[3] Rachel van Elkan. Catching up and slowing down: Learning and growth patterns in an open economy[J]. Journal of International Economics,1996,41(1).

[4] Fu X, Yang Q G.2009. Exploring the cross-country gap in patenting: A stochastic frontier approach[J]. Research Policy,38(7):1203-1213.

[5] Yongmin Chen, Thitima Puttitanun. Intellectual property rights and innovation in developing countries[J]. Journal of Development Economics,2004,78(2).

[6] Kausik Gangopadhyay, Debasis Mondal. Does stronger protection of intellectual property stimulate innovation? [J]. Economics Letters,2012,116(1).

[7] Jaffe, A. B., (1989) "Real Effects of Academic Research," American Economic Review 79(5), 957-970

[8] Hu Yongping. Government subsidies, technology sources and innovation performance: an empirical study based on Chongqing 's large and medium-sized industrial enterprises [J]. Technology Economics and Management Research, 2014 (07): 46-50.