

## Mechanism Analysis of Intellectual Property System and Technological Innovation Function

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### Abstract

The theoretical foundation of intellectual property system is that it corrects market failure and encourages private departments to invest more element resources in innovation by endowing monopoly right, so as to promote technological innovation. Accordingly, enhancing intellectual property protection can significantly promote innovation and economic growth. However, there are significant differences between empirical results and the above-mentioned theoretical expectation, and these empirical results cannot completely support the inference that "enhancing intellectual property protection is conducive to technological innovation". Therefore, on the basis of empirical study, the generation cause of property system and the transmission mechanism of influencing technological innovation were deeply analyzed; in addition, intellectual property system and technological innovation function were analyzed periodically, which demonstrated existing empirical results.

### Keywords

Technological innovation; intellectual property system; transmission mechanism

### 1. Introduction

Most domestic and foreign scholars think intellectual property system has both positive and negative effects on technological innovation. On the one hand, intellectual property system has a positive effect on technological innovation, and intellectual property protection is the source of innovation. Intellectual property protection improves the technological level of the whole society by information disclosure. Meanwhile, it also provides system guarantee for the owners of intellectual property to obtain monopoly interests, protects relevant interests of innovators, stimulates innovation enthusiasm and attracts investment. On the other hand, the influences of intellectual property system on technological innovation are not same. Excessive intellectual property protection has a negative effect and prevents innovation from spreading. Moreover, the level of intellectual property protection must adapt to the period and level of technological innovation, so as to really promote technological innovation. Excessive or insufficient intellectual property protection impedes technological innovation, and the interaction between the two has different manifestation forms in different periods of innovation.

### 2. Features of Market Failure of Technological Innovation Activities

Technological innovation has obvious features of market failure, including knowledge overflowing and innovation risk.

Technological innovation should first create and produce innovative knowledge. Knowledge itself is a kind of information, and is characterized by liquidity and diffusivity as well as non-competitiveness and non-exclusiveness which are characteristics of public products. Therefore, the innovative knowledge generated based on innovation activities is inevitably outflowed, that is, transmitting from innovative subjects to outside world. Moreover, in product innovation, innovative knowledge is materialized to various innovative products, and the sales and circulation of innovative products will also make innovative knowledge outflow.

Essentially, innovative knowledge outflow means that commercial returns that should be obtained by innovators through innovation activities are shared by other social members through the circulation and transmission of innovative knowledge. According to the patterns of innovation returns sharing, innovative knowledge outflow includes rent outflow and pure knowledge outflow. Rent outflow means that when innovative knowledge is materialized to new products for sale, its market price cannot completely reflect the improvement of quality and performance of innovative products, or is lower than the due value of innovative knowledge; downstream enterprises of an industry chain take innovative products of upstream enterprises as intermediate input to form final products and obtain extra commercial value because of the improvement of quality and performance; that is, downstream enterprises obtain external benefits because upstream innovation activity outflows and upstream innovative products do not completely obtain innovation rent which transfers backward. Therefore, it is called as rent outflow. Pure knowledge outflow means that other enterprises besides innovative subjects gradually grasp innovative knowledge through personnel communication, talent flow and research cooperation, and share the market rent of innovation activities by imitating and developing competitive products.

During above-mentioned two types of innovative knowledge outflow, other social members finally share the positive externality of innovative achievements made by innovative subjects, which positively promotes economic growth and social development. Rent outflow motivates constant extension of industry chains, that is, expanding the overall scale of an industry longitudinally; pure knowledge outflow directly results in lateral expansion of industrial scale. Innovative subjects cannot avoid the two types of innovative knowledge outflow. In the process of rent outflow, innovative subjects can obtain considerable commercial benefits through a market mechanism. Therefore, innovative subjects can accept this type of outflow. In contrast, in the process of pure knowledge outflow, innovative subjects cannot obtain any commercial returns, and a large number of competitors rapidly share the excess profits and social benefits from innovation activities. All innovations require a lot of investment. Innovation benefits are unable to make up innovation costs due to excessive pure knowledge outflow, leading to seriously short supply of innovation activity.

High risk and uncertainty of innovation are also important influencing factors of innovation supply. Innovation itself is adventurous activity, and may fail at any time. Usually, innovative decision is made under high uncertainty. It is difficult to predict the development of knowledge and technology, market, product demands and potential purpose of technology in the future; product innovation, process innovation, market innovation, and organizational innovation are also uncertain. Meanwhile, each link of innovation needs high investment and even information collection in the early state is time-consuming and high-cost. Therefore, it can be seen that innovation is risky.

Radical technological innovation is more risky, and each link, such as basic study, application research, technological development and production, is likely to fail. Because there have been technologies and new technologies are not mature, even if application study and technological development are successful, there are still many risks during realizing commercial values, including "market (acceptance) risk", "operation and management risk", and "government regulation risks".

High risk and uncertainty affect enterprises' innovation decision, and also make enterprises more difficult to obtain external funds for innovation, finally reduce the innovation will of innovative subjects and the innovation supply of the whole society.

### **3. Transmission Mechanism of Intellectual Property System Influencing Technological Innovation**

Intellectual property system influences technological innovation through certain channels and transmission mechanisms by acting on behavior decision of micro main body (enterprises). In transmission mechanisms, as the conductive media, the changes of R&D investment, technological transmission and expansion, enterprise financing ability, FDI and technology transfer, directly determine the final effect of an intellectual property system. The differences of empirical study results

are caused by different reactions of beneficial media under different conditions to a large extent. This part mainly reviewed the possible transmission mechanism in terms of different conducive medias.

### 3.1 Intellectual Property System and R&D Investment

In general, intellectual property system is initially implemented in a country, and its basic logic is to make innovative enterprises obtain more special revenues from their innovation activities through authorized monopoly, so as to encourage innovative enterprises to invest more in R&D. In the case that the input and output efficiency of R&D does not change, innovation output of innovative enterprises increases with the increase of R&D investment. From the perspective of comparative statics, it is assumed that other conditions do not change, intellectual property system increases R&D investment of innovative enterprises, and finally increase innovation output and promote economic growth. However, the hypothesis that "other conditions do not change" is too idealistic, and each link from R&D investment decision of micro main body (enterprises) to innovation output of R&D activities is influenced by other factors; intellectual property system under different conditions may produce different innovation and growth results.

First, when intellectual property system increases existing innovation activity compensation and returns, it may also reduce the opportunities of technological innovation, increase the difficulty of subsequent innovation activities, and affect the input and output efficiency of R&D investment. "Opportunity", namely innovation potential, is more important to innovation; this is related to the knowledge pools to be developed, that is, the stock knowledge that will be transferred to process and products to realize market value. The scale of stock knowledge is endogenous; each individual or enterprise engaged in research and learning contributes to knowledge pools and obtains existing stock knowledge. The nature of a patent system is "enclosing the knowledge which are public products in the form of system; or implementing intellectual property system reduce knowledge pools where others obtain benefits". Meanwhile, innovations without being authorized with patent expand knowledge pools and support further innovation. The design and protection effort of intellectual property system influences the size of stock knowledge pools or technological opportunity. A stricter intellectual property protection system breaks the balance of public knowledge pool, and reduces its growth caused by innovation activities. Meanwhile, existing stock knowledge is obtained and developed from it, so that knowledge pools becomes smaller and technological innovation opportunities are less.

Second, output efficiency of innovation in dynamic R&D investment directly affects R&D investment decision. In the face of the decrease of technological innovation opportunities and innovation output efficiency, enterprises may reduce R&D investment. Therefore, the relationship between intellectual property protection effort and R&D investment is uncertain, which has been proved by empirical studies.

Finally, if intellectual property protection is too strict, the monopoly status of existing enterprises will be enhanced, and high monopoly profits may reduce their driving force of further innovation. There are many examples in the history. In 1894, the patent scope granted by the United States to Edison in the field of electric light was so wide that there was almost no technological progress in the field in the next 11 years.

### 3.2 Intellectual Property System and FDI and International Technology Transfer

Under the circumstance of the open economy, intellectual property system influences technology innovation through FDI and international technology transfer. As an important composition of WTO

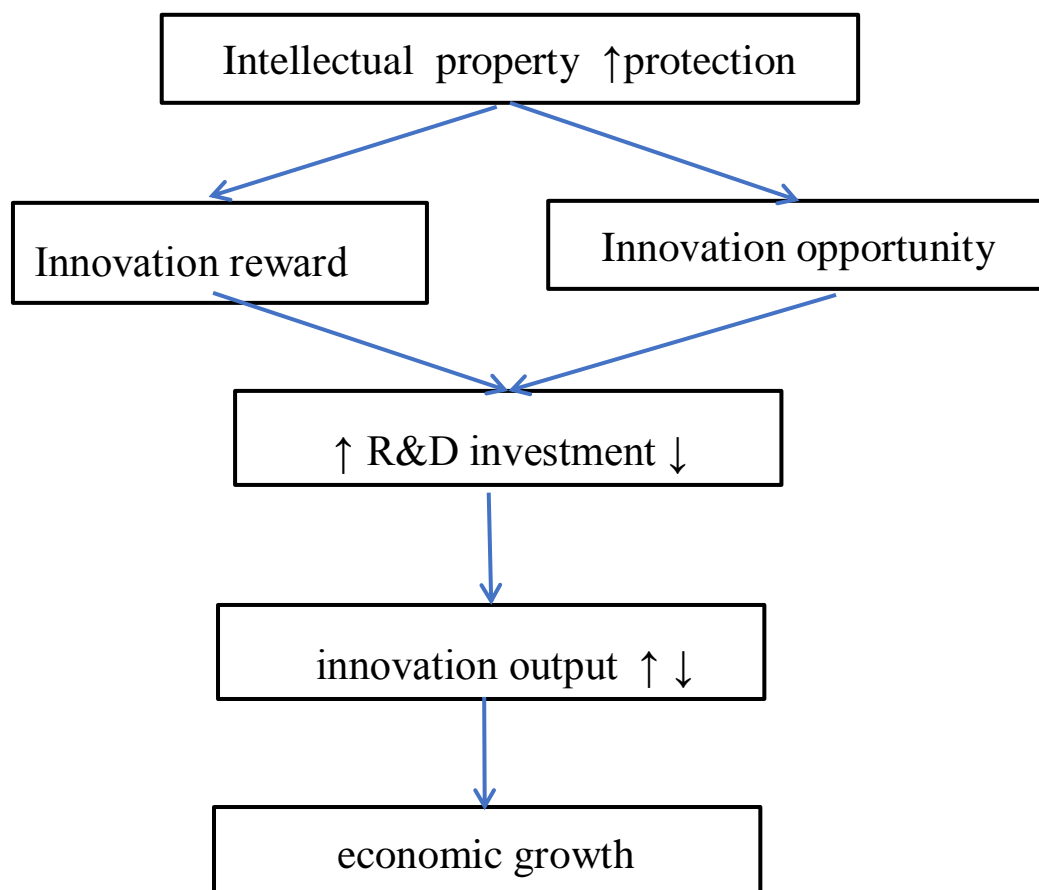


Figure 1 Transmission mechanism of intellectual property protection influencing R&D and innovation output

Uruguay Round, Agreement on Trade-Related Aspects of Intellectual Property advocates WTO members to uniformly establish an intellectual property protection system with the lowest standard. In reality, developed countries have more advanced technologies and stricter intellectual property protection systems, which can completely reach the requirements of TRIPs; therefore, after signing TRIPs, whether enhancing intellectual property protection becomes the trade-off and choice faced by developing countries. Because of international liquidity of capital and trade, enhancing intellectual property protection by developing countries will have an influence on technological innovation and economic growth through FDI inflow and accompanied international technology transfer.

Generally, developed countries have more obvious advantages than developing countries in terms of technology, while the labor cost in developing countries is low. Multinational enterprises whose home country is a developed country transfer production process to developing countries to reduce costs; the host country's enterprises imitate multinational enterprises to produce similar products, leading to the competition between the subsidiaries of multinational enterprises and the host country's enterprises. In such case, developing countries intensify efforts to intellectual property protection, so that the imitation cost of local enterprises increases, and the profits of multinational enterprises in host countries increase; as a result, internal technology transfer of multinational enterprises accelerates, and there are more FDI and high technologies transferring from the headquarters of developed countries to branches in host countries. In the process, developed countries are beneficiaries. However, as for developing countries, the influence of acceleration of FDI and multinational enterprises' internal technology transfer on their technology innovation and economic growth is uncertain, which is closely related to technological absorptive capacity, secondary innovation ability, human resource endowment, and market size of local enterprises.

As for the countries with weak human resource endowment and technological absorptive capacity, although multinational enterprises transfer more technologies, these countries lack necessary capability of undertaking and independent innovation. As for the countries with strong technological absorptive capacity, although the spread speed of single technology slows down because of intellectual property protection enhancement, more technologies are transferred, and overall technological innovation accelerates.

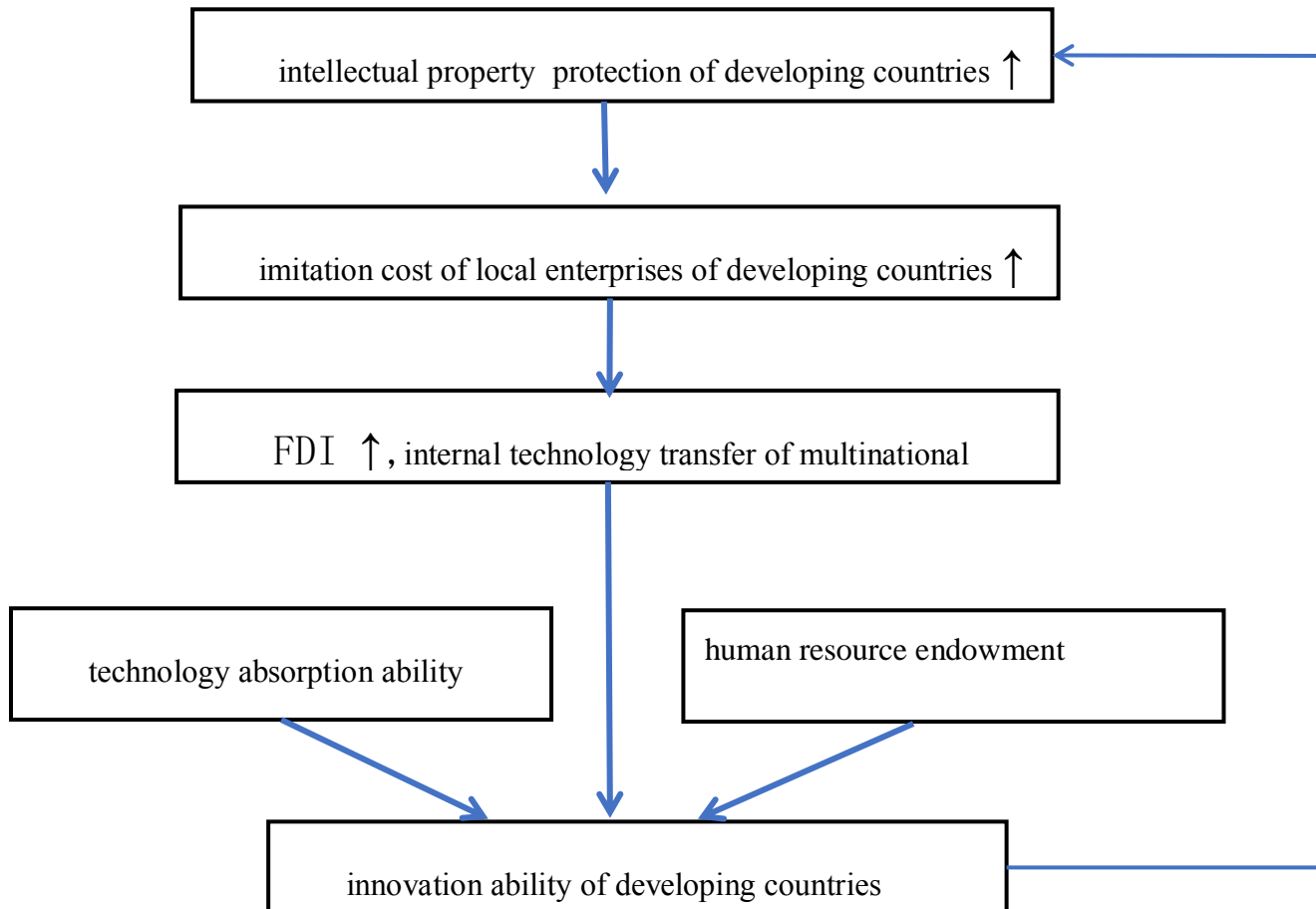


Figure 2 Transmission mechanism of intellectual property protection influencing FDI and multinational technology transfer

**3.3 Intellectual Property System and Information Disclosure and Diffusion**

In addition, intellectual property system promotes innovation through systematic information disclosure mechanism under the framework of relevant systems, especially the framework of patent system. Intellectual property system not only guarantees the returns of innovation activities, but is conducive to promoting knowledge acquisition and diffusion. Because relevant information in patent statement can be obtained by other potential inventors, the patent information disclosed openly can realize the connectivity and sharing of global technological information; comprehensively collecting and analyzing the patent information in relevant fields help innovative subjects better grasp the development trend and direction of technologies in the field, so as to effectively allocate innovative resources, prevent repeated investment, and promote innovation on a higher starting point.

Intellectual property system promotes innovation and growth through information disclosure and diffusion, which has been proved by empirical studies. Moser (2013) analyzed the data of innovative products in Britain and American exhibitions during 1851 - 1915, and found that patent information disclosure system (compared with various internal technical know-how of enterprises) obviously promoted the transmission and diffusion of technical information. On the basis of the quantitative analysis of China's patent for invention data, Ye Jingyi (2012) also supported the judgment that "advanced disclosure of patent information is beneficial to transmitting high-quality technology".

### 3.4 Intellectual Property System and Enterprises' Financing Ability

The implementation of intellectual property system is helpful to enhancing enterprises' financing ability, so as to relieve capital restriction faced by innovative enterprises, help enterprises re-innovate, and better support macro-economic growth.

In reality, the production and operation granted by intellectual property to innovative subjects are also an implicit endorsement. Moreover, with the wide development of collateral financing of intellectual property, innovative subjects with intellectual property can make full use of the intangible asset for external financing and relieve the capital restrictions faced by enterprises in innovation activities.

On the one hand, every intellectual property authorization owned by innovative subjects is an intangible asset with specific value. With the improvement of assets appraisal means and risk control level of commercial banks, there are more and more collateral financing activities in terms of intellectual property, which provides powerful financial support for innovative enterprises, especially medium- and small-sized innovative enterprises. On the other hand, in a sense, intellectual property includes a positive affirmation and implicit endorsement of current intellectual property system to innovative subjects; affirmation and endorsement from governmental authorities are of great help to innovative enterprises to attract risk investment. Enhancing intellectual property protection means that the intellectual property owned by enterprises has higher exclusive rights to earnings and market value. As a result, enterprises' financing ability is improved.

### 3.5 Other Influencing Factors of the Effect of Intellectual Property System

Sometimes, the effect of intellectual property system on innovation and growth is also influenced by other factors.

First, development degree of countries (economic entity). Generally, the higher the development degree of economic entity, the more obvious the positive effect of intellectual property system. Compared with undeveloped economic entity, developed economic entities have obvious advantages in the starting points and elements of innovation; strict intellectual property protection system is conducive to enhancing incentive and inventing more innovative resources in innovative resources.

Second, the length of time of implementing intellectual property system. For example, as for developing countries, the establishment of an intellectual property system inhibits innovation imitation of advanced countries in a short time. However, it is beneficial to transmitting foreign technologies and cultivating local innovation ability in the long run.

Third, the influences of intellectual property system on different types of innovation activities are different. In the field with obvious gradual innovation feature, stricter intellectual property protection hinders followers or subsequent innovation activities; however, strict intellectual property protection may promote latecomers to open or find a new path or snap course, resulting in subversive and radical innovation.

## 4. Periodical Analysis of the Effect of Intellectual Property System on Technological Innovation

The process of technological innovation is different from general production process (as shown in the following figure). General production process produces physical products. However, technological innovation process not only produces physical products but also new technologies of new products which are intangible knowledge. Other competitors except innovative subjects may be attracted by high profits of new products, and then carry out reverse engineering of products or physical and chemical analysis to obtain production technology and manufacture the same products sold in the market. As a result, they share the market. Therefore, during technology innovation, if there is not a intellectual property system protecting the intangible knowledge assets, innovative subjects will suffer huge losses and even cannot withdraw expected investment.

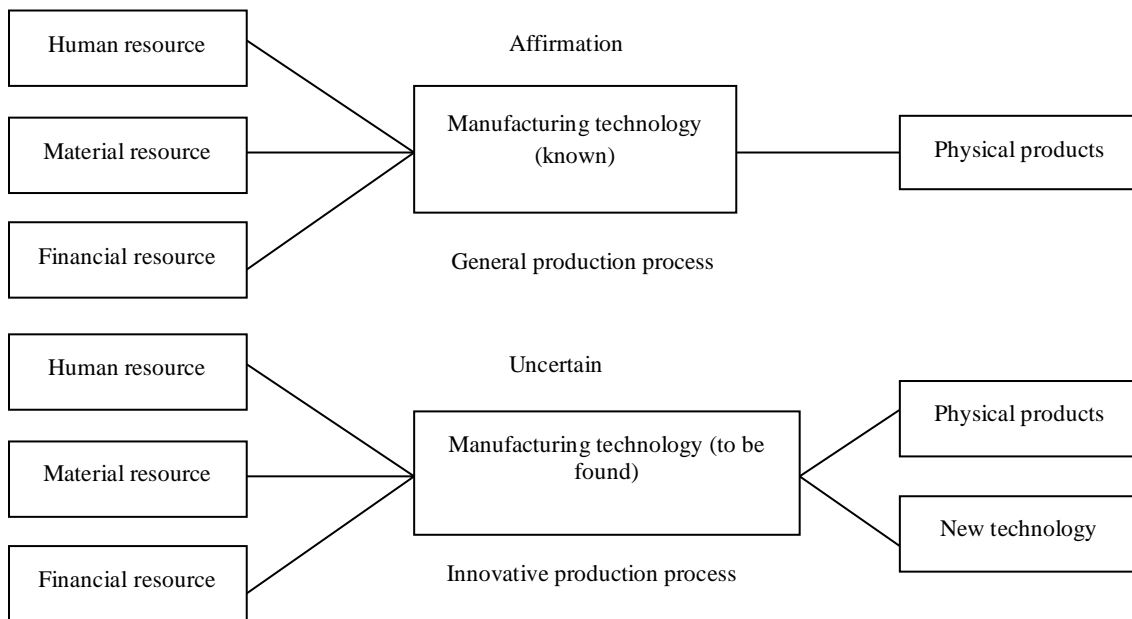


Figure 3 Comparison of technological innovation process and general production process

Technological innovation process has been long marked with the cause of technological innovation activities, and is divided into technology-push model, technological invention-caused model and demand-pull model. However, all technological innovation models include four periods, namely technological study, product development, technological introduction and commercialization (as shown in Figure 1-4, 1-5 and 1-6).

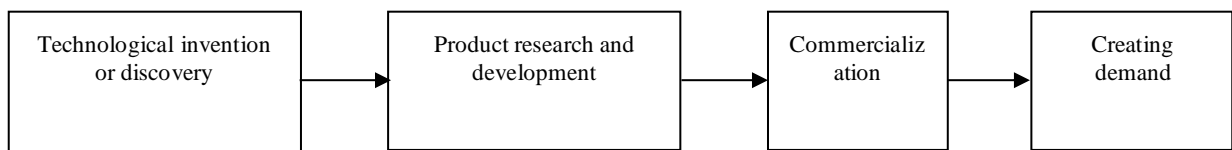


Figure 4 Track of technology-push innovation

### 4.1 Technological Study

In the period of technological study, scientific research project initiation is very important. In scientific research project initiation, making good use of patents is very helpful to avoiding repeated research, improving the starting point of research, and accelerating research. Intellectual property can provide three aspects of materials for innovative subjects: ① taking technology as the center, significance and blank or relevant alternative technology are provided in a certain technology field. ② Taking applicants and inventors as the center, trend of technological development and the development situation of other enterprises are provided. ③ Taking time as the center, context of a certain technology is provided. In fact, if innovative subjects reasonably use intellectual property, infringement can be effectively prevented. Many persons may develop and research one product at the same time, and someone may have applied for a patent. If the information of a patent cannot be comprehensively and accurately grasped, it is difficult to comprehensively understand the technology trend and clarify which is public technology and which is others' intellectual property. As a result, it is easy to fall into others' patent trap and make themselves spend a lot of human resources, material resources and financial resources on researching the product that has been applied for a patent. In the process of technological study, many main bodies of research and development are used to publishing papers or exchanging academic achievements when the technology is not successful, which tends to make them lose the opportunity to apply for relevant intellectual property because of the disclosure of technology contents, and provides reference for competitors who take it as their own invention and apply for a patent after making a little improvement of the technology, and legally "steal" the

technology. In this sense, non-disclosure of technology is a good method in the early stage of intellectual property protection.

#### **4.2 Technological Introduction**

In the early stage of technological introduction, it is necessary to clarify the situation of the imported technology with intellectual property, so as to provide a foundation for decision-making and subsequent negotiations. The main task is to understand technological development and evolution and advanced degree, and judge its development trend by analyzing the changes of relevant intellectual property in the field where the technology is, so as to determine whether it will be introduced; the complexity degree of the introduced technology can be judged by analyzing the contents and protection scope of the technology, so as to judge the enterprise' ability to absorb and redevelop the technology; the price of the technology will be understood by analyzing the protection period, effectiveness and regional scope of relevant intellectual property of the technology, so as to provide a basis for pricing.

During secondary innovation after introducing the technology, intellectual property system is mainly manifested in application for a patent, implementation of innovative achievements and use of patent right, so as to monopolize technology, control the market and form late-mover advantage.

#### **4.3 Product Development**

In product development period, namely spot test period, technology innovation theory is used in practice. Intellectual property system can prevent similar enterprises from applying the same technology or product in advance to occupy the market and obtain the priority right after understanding the technology, or prevent similar competitors from registering relevant intellectual property in advance, which makes human resources, material resources and financial resources invested by researchers come to naught. Therefore, intellectual property system enables innovation achievements to be protected by laws, and effectively guarantees safe development of new technologies and products. Some innovative subjects do not pay attention to intellectual property protection, and apply for intellectual property when research achievements are very mature. As a result, competitors who research the technology at the same time may be the first to apply for a patent. Intellectual property may not belong to the innovator who studies a technology or makes achievements earliest but the innovator who applies earliest. In order to prevent their own research achievements from losing property value, it is important to register relevant intellectual property in the period of product development.

#### **4.4 Commercialization**

In the period of commercialization of technology innovation, also known as the period of technology innovation achievement diffusion, an intellectual property system is more necessary to guarantee the completion of commercialization. If a new technology or product plans to be commercialized or launched and occupy the market to the largest extent, it is necessary to guarantee that the technology or product is not infringed. In addition, it is necessary to have its own intellectual property such as patent right and trademark right. If the new technology or product is not protected by an intellectual property system, it will not only lose market share, but also be prosecuted. Therefore, in the period of commercialization, it is necessary to emphasize the comprehensive protection of intellectual property of new technologies and products. Although different intellectual property departments protect different objects, they have certain cross relations under certain circumstances. Intellectual property protection is a systematic engineering in many cases. Good expected effects can be reached if only one a certain intellectual property protection means is used. In different situations, comprehensively applying multiple legal means to protect intellectual property is an effective method. In terms of the development and application of a new product, its method can be applied for a patent for invention, and its structure can be applied for a patent for utility models, and the appearance and package of the product can be applied for a design patent. If necessary, some technology secrets can be remained to increase the actual effect of protection. In addition to trademark application, the



product can own a three-dimensional intellectual property protection system which plays the role of cross protection. As a result, it is difficult for others to infringe the product.

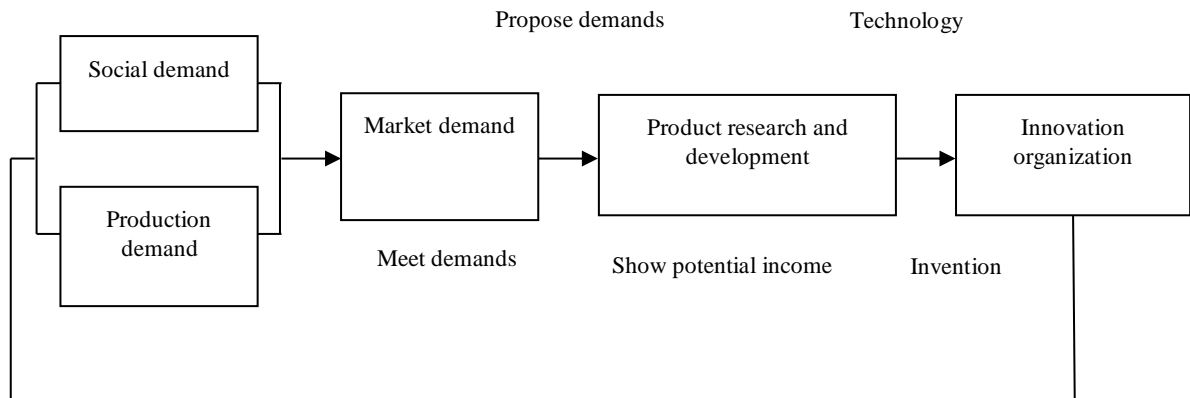


Figure 5 Requirement of demand-pull innovation

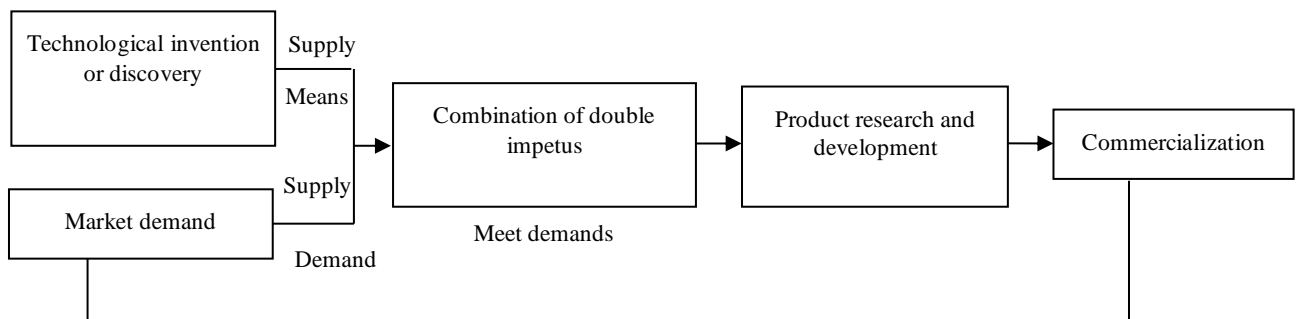


Figure 6 Track of push- and pull-innovation

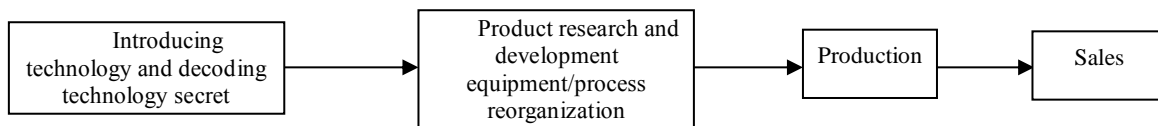


Figure 7 General process of imitating innovation

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