# Spatial Spillover of Technological Market Development to Innovation Performance of Industrial Enterprises

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**Abstract.** How does the development of China's technology market affect the performance of industrial innovation? This paper selects industries of various provinces (cities and districts) as examples, takes industrial invention patents and product innovation as the analysis objects of innovation performance, uses the panel data of 29 provinces in China from 2011 to 2017, and uses spatial autoregression models to analyze the spatial spillover and threshold characteristic effects of China's technology market development on industrial innovation performance. It is found that there is spatial spillover effect in industrial innovation performance, namely the contribution value of the development of local technology market to the local industrial invention patents is 0.078, and the contribution value of the development of local technology market to the industrial invention patents in neighboring areas is 0.013.

**Keywords:** Technology market development; enterprise innovation performance; patent; spatial spillover

## 1 Introduction

After more than 30 years of development, the activity of China's technology market has been increasing, and the turnover of technology market has grown from 26.8 billion yuan in 1995 to 2,800 billion yuan in 2020. Therefore, the only way for the development of Chinese enterprises is to establish an orderly competitive technology market, to improve the ability of independent research and development and innovation of enterprises, and to break through and master the key core technologies. At the same time we should break the foreign technology blockade, and seize the international market by various forms of innovation. The 14th Five-Year plan mentions that "we should enhance the technological innovation ability of enterprises, strengthen the dominant position of enterprises in innovation, and promote the agglomeration of various innovation elements to enterprises". The government should encourage the

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enterprises to increase R&D investment and promote the development of advanced manufacturing clusters.

## 2. Literature Review

There are many researches on the influencing factors of enterprise innovation performance, but few on industrial innovation performance. Industrial innovation performance includes product innovation and technological innovation, and the mechanism of influencing innovation performance is proposed. (Feng Hua, Han Xiaohong,2020) [1]. According to the different degree of enterprise innovation, it puts forward the heterogeneous innovation strategy of enterprise including breakthrough and progressive product innovation strategy (Han Chen, Gao Shanxing, 2018) [2]. From the perspective of enterprise R&D input (R&D refers to research and development, which is abbreviated as R&D in the following articles), some people think that enterprise R&D input has a significant positive effect on innovation performance (Lin Peng, Meng Nana, 2018) [3], and others think that its positive effect on patent output is not obvious or has no significant relationship (Cao Jianhai, Deng Jing, 2014) [4], Other studies have found that R&D investment has a "negative positive negative" nonlinear relationship with technological innovation performance (Wang Kang, Zhou Xiao, 2017) [5]. From the perspective of government funding for R&D, it is concluded that government funding for R&D has a significant positive effect on technological innovation efficiency and innovation output of enterprises (Gao Yuchen et al., 2018) [6]. There is also the view that R&D government funding has no significant relationship with enterprise innovation output (Zhang tingfa, 2017) [7], or has a slight negative effect on enterprise technological knowledge output (Lin Peng et al., 2018) [8]. From the perspective of R&D personnel and scientific and technological personnel, it is considered that R&D personnel can have a significant positive impact on patent output (Bai Junhong, Li Jing, 2011) [9], and that the importance of scientific and technological personnel on patent output is higher than that of financial input (Guo Bing, Luo shougui, 2015) [10]. The development of China's technology market promotes the transformation of technological achievements and accelerates the efficiency of cross regional technology transfer. At the same time, as a platform for the transformation of scientific and technological achievements, the technology market promotes technological innovation (Dai kuizao, 2018) [11]. China's industrial industry is facing the dilemma of "blocking the high-tech field of the first developing countries and squeezing the labor-intensive industries with the advantage of labor force" in the new era. Under the dual influence of changes in the international environment and industrial transformation and upgrading, China's industrial growth slows down, and some industries show overcapacity (Shi Dan, Li Peng, 2019) [12]. To achieve high-quality industrial development is an important strategy to deal with the dilemma of "blockade of high-tech fields and extrusion of labor-intensive industries".

# 3 Theoretical basis

## 3.1 The mechanism of the development of technology market

The transformation of technological achievements is the most important link of technological innovation. Only when new technologies and inventions are transformed into new production processes and new products can they realize their market value (Dai Kuizao, 2018) [11]. The development of China's technology market has an impact on enterprises' independent innovation ability (Zhang Jiangxue, 2011) [13], and the mature technology market can more effectively promote the enterprises to transform technological achievements into new products and new production processes (Sui Lizu, Kou Zonglai, 2011) [14]. The development of the technology market, which has increased the demand for patents, has also given rise to the manufacture of new products.

## 3.2 The spatial spillover effect of technology market development on industrial innovation performance

The patent is an innovation output that directly affects productivity, an important link to realize the transformation of scientific and technological achievements, a form of intellectual property rights, a fairly reliable measure of innovation, and a core driving force to realize China's innovation drive. Patent is playing an increasingly important role in the process of industrial structure adjustment. In the era of knowledge-based economy, patent, as an emerging innovative production factor, will produce the corresponding external-spillover effect of MAR in its specialization agglomeration. A sound technology market is the prerequisite to promote the positive spatial spillover effect of innovative production factors.

## 3.3 There is a non-linear relationship between technological market development and industrial innovation performance

Lerner (2002) [15] pointed out that the strengthening of the patent system may have an optimal scale of protection, and the patent system can achieve more positive effects when it exceeds a certain scale. Compared with technological innovation and method innovation, which are not easily obtained by competitors through confidentiality measures, product innovation of enterprises is more likely to enter the market through the authorization of patents. The successful sale of product innovation is closely related to patents, and patents encourage further innovation of enterprises, that is, the emergence of new products. In the face of fierce domestic competition, they are more inclined to apply for patents to prevent copying and shield competitors. In the early stage of the development of the patent system, technology transfer is mainly encouraged. Only in the more advanced development stage, the patent system can better promote domestic innovation.

# 4 Construction of econometric model and selection of variables

## 4.1 Econometric model

In order to investigate the impact of the development of technology market on the heterogeneity innovation performance of Chinese enterprises, this paper sets the following

measurement equations:

$$\mathrm{LNEIP}_{it} = LNA_{it} + \alpha \mathrm{LNTMD}_{it} + \beta \mathrm{LNRDP}_{it} + \gamma \mathrm{LNINS}_{it} + \varphi EL_{it} + \varepsilon_{it} \quad (1)$$

In the above formula (1), i represents the province and t represents the period. The data from 2011 to 2017 of 29 provinces, municipalities and autonomous regions in China except Tibet and Qinghai were selected. $EIP_{it}$ refers to the innovation performance of enterprises in each province of China in each year; $TMD_{it}$ refers to the development of technology market in each province of China in each year; $RDP_{it}$ refers to the R&D personnel of enterprises in each province of society in each year; $INS_{it}$ refers to the industrial structure of industries in each province in each year; $EL_{it}$ refers to other factors affecting innovation performance; $A_{it}$ refers to constant term. Among them, $EL_{it}$ includes regional financial expenditure on science and technology $LNCAIZ_{it}$ and regional export volume $LNIT_{it}$.

**4.2 Variable selection**

Firstly, industrial innovation performance ($LNEIP_{it}$). According to literature review, large and medium-sized industrial enterprises are gradually becoming the main body of technological innovation in China. The performance of industrial innovation is divided into two categories: technological innovation and product innovation, which fully reflects the performance of industrial innovation. Among them, the number of effective invention patents of industrial enterprises above scale is selected as the substitution variable for technological innovation, represented by Famit. Previous studies mostly use the number of patent applications or authorization to reflect the level of innovation performance of a region or industry. Product innovation selects new product sales revenue ($NEW_{it}$) of industrial enterprises above scale, so as to avoid that technological innovation cannot fully reflect the performance of industrial innovation. Take logarithms respectively, and denote by $LNFAM_{it}$ and $LNNEW_{it}$.

Secondy, technology Market Development ($LNTMD_{it}$). About the development of the technology market index and the current domestic scholars, there is no consensus measure index. Technical market turnover is one of the important indicators to measure technology market development, and it reflects the transformation of scientific and technological innovation and capacity of a region, which technology market turnover can reflect the status of each province technology commodity trading. Therefore, this paper selected the technology market turnover used by many scholars to measure the development of the technology market, and took the logarithm of this index and expressed it as $LNTMD_{it}$.

Thirdly, control variables and regional characteristic variables. Control variables :(1) R&D human capital ($RDP_{it}$). It represents the annual investment of R&D personnel in enterprises in each province of the society, which is measured by the full-time equivalent (person-year) of R&D personnel in industrial enterprises above designated size. (2) Structure of secondary industry ($INS_{it}$). It represents the proportion of secondary industry GDP in regional GDP of each province in each year to represent. (3) regional export degree ($IT_{it}$), which is reflected by the total export volume of each region and converted into RMB according to the annual average exchange rate of RMB against US dollar in that year, and is deflated.

## 5. Empirical analysis

### 5.1 Spatial spillover effect

Considering that the closer the geographical distance is, the closer the relationship between patents is, it is necessary to introduce the geospatial distance into the statistical analysis and establish the spatial autoregressive model by combining the spatial geographical weight matrix:

$$Y = \lambda W Y + \beta X + \varepsilon, \left\{ \varepsilon \sim N(0, \sigma^2 I_n) \right\} \tag{2}$$

Where W is the adjacency matrix generated according to regional longitude and latitude, namely the space weight matrix; Y is $LNFAM_{it}$; X includes $LNRDP_{it}$, $LNTMD_{it}$, $CAIZ_{it}$, $IT_{it}$, and INSit. Spatial autoregressive test was carried out on the patent variables, and global Moran value was adopted, which basically passed the significance test. The estimated value of spatial autoregressive coefficient (Rho) was 0.142, which was significant at the 1% level. Therefore, there was a spatial autoregressive effect: Clustering mode, discrete mode and random mode. When the Moran index is greater than 0, as shown in Table 1, it indicates that China's industrial invention patents present a trend of spatial aggregation.

**Table 1.** Global Moran's I for patent variables

| year | | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| $LNFAM_{it}$ | Moran's I | 0.097 | 0.088 | 0.095 | 0.098 |
| | P-valve* | 0.033 | 0.044 | 0.035 | 0.033 |
| year | | 2015 | 2016 | 2017 | |
| $LNFAM_{it}$ | Moran's I | 0.093 | 0.076 | 0.072 | |
| | P-valve* | 0.038 | 0.061 | 0.068 | |

According to table 2, it shows that the total effect of patent is decomposed into direct effect and indirect effect, which directly effect refers to the local technology market development's contribution to the local invention patent value of 0.078, indirect effect refers to the local technology market development contribution value of 0.013 for a patent for invention in adjacent areas, and thus to develop the technology market, speed up the efficiency of technology transfer, Have remarkable effect to each area innovation.

**Table 2.** decomposition of direct effect and spillover effect in spatial autoregressive model

| variable | Direct effect | Indirect effect | Total effect |
|---|---|---|---|
| | coefficient<br>(t value) | coefficient<br>(t value) | coefficient<br>(t value) |
| $LNRDP_{it}$ | $0.604^{***}$<br>(12.35) | $0.100^{***}$<br>(3.26) | $0.704^{***}$<br>(11.31) |

| | | | |
|---|---|---|---|
| $LNTMD_{it}$ | $0.078^{***}$ | $0.013^{**}$ | $0.091^{***}$ |
| | (3.62) | (2.25) | (3.49) |
| $CAIZ_{it}$ | $0.418^{***}$ | $0.069^{***}$ | $0.486^{***}$ |
| | (6.36) | (3.06) | (6.31) |
| $IT_{it}$ | $-1.460^{***}$ | $-0.245^{**}$ | $-0.705^{***}$ |
| | (-4.14) | (-2.34) | (-3.95) |
| $INS_{it}$ | $0.067^{***}$ | $0.011^{**}$ | $0.079^{***}$ |
| | (3.17) | (2.04) | (3.04) |

Similarly, the contribution value of the input of local R&D personnel to the local invention patent output is 0.604, and the contribution value to the invention patent output of neighboring areas is 0.1. Similarly, the contribution value of local financial science and technology support funds to local invention patent output is 0.418, and the contribution value of invention patent to adjacent areas is 0.069. State of industrial spatial agglomeration distribution of invention patent, the influence of geographical space distance, produces spatial spillover effect and the spatial spillover effect in perfecting the technology market development to promote the region, the region of industrial innovation performance has 0.078 direct effects, industrial innovation performance is 0.013 in adjacent regions of indirect positive effect.

# 6 Research conclusions and policy implications

## 6.1 Research conclusion

Based on the panel data of 29 provinces in China from 2011 to 2017, this paper analyses the spatial spillover characteristic effects of China's technology market development on industrial innovation performance from the perspective of product innovation and invention patent innovation performance by using spatial autoregression models. The results show that there is a spatial spillover effect on industrial invention patents. The contribution value of the development of local technology market to the local industrial invention patents is 0.078, and the contribution value of the development of local technology market to the industrial invention patents in neighboring areas is 0.013.

## 6.2 Policy implications

Local governments at all levels should actively guide technology market participants to construct network reciprocity mechanisms through various forms. The establishment of network reciprocity mechanism promotes the formation of national technology market service network more effectively. The development of technology market is limited by geographical distance. Local governments at all levels should implement the technology market development plan according to local conditions, optimize the regional factor endowment structure, and vigorously promote the healthy development of technology market. Actively the government can study and formulate demand-side innovation policies in combination with the development of technology market, and form a positive feedback mechanism between industrial innovation and demand.

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