

An Empirical Study on the Effectiveness of Technology Market Promoting Technological Innovation Capability

— Based on panel data in the Yangtze River Delta

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Abstract

Based on panel data such as 2009-2018 R&D expenditures, full-time equivalent of R&D personnel, Number of valid invention patents, and technology market turnover in China's Shanghai, Jiangsu, Zhejiang, and Anhui provinces (cities), using Griliches-Jaffe knowledge to produce Function, construct Time fixed effects model, conduct empirical research on the main factors affecting the technological innovation capability of the Yangtze River Delta, focusing on the relationship between the technological market and technological innovation capability. The results show that human capital and R&D expenditures have a significant and positive impact on the technological innovation capacity of the Yangtze River Delta. Although the technology market has a positive effect on the scientific and technological innovation capacity of the Yangtze River Delta, the effect is not significant. Propose countermeasures and suggestions to strengthen the influence of the technology market on technological innovation.

Keywords: *Technology Market; Technological Innovation Capability; Yangtze River Delta Region; Fixed Effects Model*

1 INTRODUCTION

A developed technology market can promote the diffusion and efficient use of the latest technology, and it can accelerate the speed of technological progress by increasing the incentives for research and development investment, and improve the country's innovation and competitiveness. At present, developed industrialized countries are gestating a technological and economic system that replaces traditional industrialization, forming a new technological and economic model, and forming a new innovation integration model and innovation organization network through the establishment of a technological market collaborative innovation mechanism between different subjects and different regions. "Technology trading and technological innovation platform", "innovation strategic alliance", etc. that can maximize the integration of national and global resources. Chen Jin (2019) All countries have promulgated a series of major strategies and decisions in the field of technological innovation and technology market. These policies and strategies have formed a new layout of technology market and technology transfer.^[1]

From a Chinese perspective, innovation-driven, especially technological innovation capabilities, have been raised to an unprecedented strategic height. The comprehensive construction of the National Science and Technology Innovation System (NIS) and the Regional Science and Technology Innovation System (RIS) will rise to a long-term national will. The technology market is a key link that constitutes the national independent innovation system. How to use technology management methods to break through many bottlenecks in the process of technology transfer and speed up the technology transfer of scientific research results has become a major issue facing China's technology and economic policies.^[2]

Technology market failure is a common phenomenon all over the world. China's technology market is not yet mature, causing technology market failures to be more serious than in developed countries. The Yangtze River Delta

is a very strategic pole among the three major economic regions of China's regional growth poles. One of the development's strategic goals is to coordinate the construction of a global innovation center. However, there are still many problems in the technology market, which limit the improvement of regional scientific and technological innovation capabilities to a certain extent. The innovation and transformation trend of the four provinces in the Yangtze River Delta is similar to the overall trend in China. Through the research on the technology market in the Yangtze River Delta region, it can solve the problem of the ability of the Chinese technology market to effectively promote technological innovation and play a reference role for the further development and improvement of the Chinese technology market in the future. [3]

Based on the above background, this paper uses the inter-provincial panel data of the four provinces (cities) in the Yangtze River Delta from 2009 to 2018 to conduct an empirical analysis of the factors affecting the technological innovation capacity of the Yangtze River Delta, focusing on the analysis of the technology market and technological innovation capabilities of the Yangtze River Delta. Research from this key and hot issue should have certain theoretical value and practical significance. Previous related studies only used the full-time equivalent of R&D personnel and R&D expenditures as indicators to measure technological innovation capabilities. This research has added the new variable of technology market, and the conclusions obtained may be more comprehensive and objective.

2 RELATED CONCEPTS AND LITERATURE REVIEW

2.1 Technology Market

The concept of "technology market" has Chinese characteristics, and it is more accurately called technology transfer. Gu Zhenrong, Jiang Fuxin (2019), the technology transaction market is generally divided into narrow and broad concepts. The technology property rights transaction market in the broad sense refers to the sum of the venues and relationships of technology property rights transactions, while the technology property rights transaction market in the narrow sense refers to the sum of technical property rights trading venues. [4]Based on the limitations of China's technology trading system and the feasibility of research, this article will take a narrowly defined technology market perspective as an entry point for research, that is, the concept of technology market used in this article is defined as the collection of all technology markets in China.

2.2 Technological Innovation Capability

Lu Jitong (2016) believes that technological innovation ability can be decomposed into technological potential energy, technological transformation ability and technological potential. From the perspective of the technology market. [5] this study defines technological innovation capability as a comprehensive force of technological innovation such as technological creation capability, technology acquisition capability, technology transfer application capability, etc. possessed by a region. Comprehensive evaluation by indicators such as R&D expenditures, full-time equivalent of R&D personnel, Number of valid invention patents, and technology market turnover. Number of valid invention patents, that is, the direct output of scientific and technological achievements, is a general yardstick for evaluating a region's scientific and technological innovation capabilities; the technology market turnover reflects an important indicator of technology application and transformation.

2.3 Yangtze River Delta

The Yangtze River Delta, the industrial economy concept is called the "Yangtze River Delta Economic Zone"; the urban economic concept is called the "Yangtze River Delta Urban Agglomerations". With the official release of the "Outline of the Yangtze River Delta Regional Integration Development Plan" in 2019, academics and industry A consensus has been gradually reached on the division of the Yangtze River Delta space. Based on the purpose of the research, this thesis defines the spatial scope of the "Yangtze River Delta" as the whole area of Shanghai, Jiangsu, Zhejiang, and Anhui. This paper is abbreviated as "Yangtze River Delta". Abbreviated as "YRD".

3 MODEL CONSTRUCTION AND DATA DESCRIPTION

3.1 Model Selection

Griliches (1979) put forward the concept of knowledge production function for the first time. The theoretical basis of the knowledge production function is the endogenous growth theory. From this theory, scholars have concluded that the core element of technological progress is knowledge. In order to have a more comprehensive understanding of the law of knowledge development, researchers have begun to pay attention to the effect of knowledge production on economic development. Influence, understand the relationship between technological output and the input of independent innovation. With the deepening of research, the research has evolved to the current use of knowledge production function to study the relationship between knowledge production and economic development in a certain technological market.

Knowledge production is the evolution of knowledge from funding and R&D personnel input to patent generation. It is also a process of knowledge accumulation. However, how to measure the internal changes in the process of knowledge production, most scholars now adopt the knowledge production function constructed by the framework of knowledge production is studied. The following is the basic form of the Cobb-Douglas production function:

$$R\&D_{output} = \alpha(R\&D_{output})^\beta \quad (1)$$

Among them is a constant, which is the elasticity of R&D output relative to changes in the R&D process input. Similar to the Cobb-Douglas production function of Griliches, in Jaffe's knowledge production function, the knowledge production function has a very wide range of applications. It can not only study the micro-individual R&D input and output process, but also study the macro level. He further divided the production factors into R&D funding input and corresponding human capital input. The following is the basic form of Jaffe's production function:

$$Q_i = AL_i^\alpha K_i^\beta \varepsilon \quad (2)$$

In Jaffe's knowledge production function, Q represents the intensity of R&D activities, L represents the human resource investment in scientific research and development, K represents the capital investment in the R&D process, and respectively represents the output of R&D human investment and R&D capital investment. The coefficient of elasticity is a random perturbation item that represents individuals in different categories. ^[6]Based on the above considerations, this article will study the innovation ability of the Yangtze River Delta urban agglomeration, so it adopts the improved Griliches-Jaffe knowledge production function for analysis. As follows:

$$F_i = A_i RD^{\delta_i} V_i^{\theta_i} \quad (3)$$

Among them, F stands for technological innovation capability; RD stands for R&D expenditure or human capital, V stands for technology market development index, and i stands for observation unit. This paper mainly studies the relationship between technology market and technological innovation capability.

3.2 Data and Index Selection

3.2.1 Data Selection

Based on the availability of sample data, the fit with the topic of the article, and the consistency with the knowledge production function of the theoretical model. The data range selection of this article includes: mainly select data from China Statistical Yearbook (2009-2018), China Statistics Yearbook of Science and Technology (2009-2018) and Yangtze River Delta (2009-2018) for empirical model testing; the data in this paper covers the regional scope includes: mainly refers to the "three provinces and one city" in the Yangtze River Delta, including Shanghai, Jiangsu, Zhejiang and Anhui. Some data not included or covered by the statistical yearbook of the year or the current year will be filled by interpolation. The overall descriptive statistical analysis table of the data is as follows. It mainly presents the sample size, arithmetic mean, standard deviation, minimum and maximum values of several variables.

TABLE 1 DESCRIPTIVE STATISTICS OF THE PANEL DATA OF THE YANGTZE RIVER DELTA FROM 2009-2018

	(1)	(2)	(3)	(4)	(5)
Variable	Sample size	Arithmetic mean	Standard Error	Min	Max

year	44	2,013	3.199	2,008	2,018
y	44	3.449	3.702	0.149	17.61
p	44	18.38	13.98	2.769	45.55
m	44	628.8	484.2	61.23	2,025
t	44	348.8	289.9	32.49	1,225
provi	44	2.500	1.131	1	4
lny	44	0.688	1.156	-1.906	2.869
lnp	44	2.611	0.806	1.019	3.819
lnm	44	6.148	0.819	4.115	7.613
lnt	44	5.429	1.017	3.481	7.111
Number of provi	4	4	4	4	4

3.2.2 Index Selection

Based on the basic framework of the Griliches-Jaffe knowledge production function, this paper studies the impact of the technology market on the ability of technological innovation, mainly using the Number of valid patent grants as the explanatory variable, Full-time Equivalent of R&D Personnel and R&D expenditures as the explanatory variable, and then the technology market turnover as a new explanatory variable for further study. The following is the basic connotation explanation and variable definition of each variable (Table 2):

TABLE 2 TYPES, DEFINITIONS AND MEASUREMENT METHODS OF VARIABLE

Variable	types	Definitions	measurement methods
year	Time variable	Year	The year of this article is (2009-2018)
y	Explained variable	Technological innovation ability	Number of valid patent grants
p	Explanatory variables	human capital	Full-time Equivalent of R&D Personnel
m	Explanatory variables	R&D expenditures	Current R&D expenditures
t	Explanatory variables	Technology market	Technology market turnover
provi	virtual variable	Province variable	Shanghai, Jiangsu Province, Zhejiang Province, Anhui Province
lnp	Logarithmization	Logarithmic human capital	Logarithm
lnm	Logarithmization	Logarithmic funding capital	Logarithm
lnt	Logarithmization	Logarithmic technology market	Logarithm

(1) Technological innovation capability. This paper selects the number of valid invention patents (2009-2018) in the statistical yearbooks of Shanghai, Jiangsu, Zhejiang and Anhui provinces in the Yangtze River Delta region as a measure of technological innovation capability.

(2) Human capital. Personnel input is also one of the important independent variables in the knowledge production function.^[7] This article uses the full-time equivalent of R&D personnel to measure human capital input.

(3) R&D expenditures. Expenditure investment is also one of the important independent variables in the knowledge production function. This paper uses R&D expenditure to measure the expenditure of capital investment.

(4) Technology market. The most commonly used variable to measure the size of the technology market in domestic and foreign research is the technology market transaction volume or technology contract transaction volume. This paper chooses technology market turnover as the new explanatory variable.

4 EMPIRICAL ANALYSIS

4.1 Model Selection-1: Random Effects Model or Fixed Effects Model

4.1.1 Stationarity Test

Since the panel data includes the characteristics of time series data and cross-sectional data, the stationarity of the data must be verified before regression. Common stationarity tests include LLC, ADF, PP, HT, IPS, HADRI, etc.^[8] Considering various methods, the applicability of this paper selects HT to test. From the HT test results in Table 3, it

can be seen that the four variables of lny, lnp, lnm and lnt are all stable. It can be considered that the data selected in this paper have a stable trend and do not have unit roots. Suitable for panel data inspection. The results are shown in Table 3.

TABLE 3 HT TEST

Variable	Statistic	z	p-value	Stationary Judgment
lny	-0.1499	-3.4287	0.0003	Stationary
lnp	-0.0160	-2.6276	0.0043	Stationary
lnm	-0.0744	-2.9771	0.0015	Stationary
lnt	-0.1993	-3.7241	0.0001	Stationary

4.1.2 Hausman Test

The fixed effects model (FEM) assumes that all included studies have a common true effect size, or that except for random errors, the observed effect size is the true effect size. The real effects in the random effects model (REM) vary with different researches. The formula is as follows. The first formula is a fixed effects model, and the second formula is a random effects model.

$$Y_{it} = \beta_0 + \beta_1 P_{i,t} + \beta_2 M_{i,t} + \beta_3 T_{i,t} + \varepsilon_i \quad (4)$$

Among them, the β_0 -intercept item means that for different section members, there are different intercept items, and the changes are related to $P_{i,t}$, $M_{i,t}$ and $T_{i,t}$.

$$Y_{it} = \beta_0 + \beta_1 P_{i,t} + \beta_2 M_{i,t} + \beta_3 T_{i,t} + \varepsilon_i \quad (5)$$

The random effects model and the fixed effects model are the same in terms of structure. The difference is that the random variable β_0 has nothing to do with each of the explanatory variables $P_{i,t}$, $M_{i,t}$, and $T_{i,t}$.

In order to determine whether the regression equation is a fixed effect or a random effect, the equation needs to be tested by Hausman, and the form of the model needs to be tested. The null hypothesis and alternative hypothesis are:

H0: Establish a random effects model.

H1: Establish a fixed effects model.

The results show that the test value p value is less than 0.001, which means that the null hypothesis is rejected. The null hypothesis is to use a random effects model, so the fixed effects model is more appropriate. The regression fitting degree of the model is relatively high, the adjusted R2 within the group is 0.9417, and the test results are shown in the following table.

TABLE 4 HAUSMAN TEST RANDOM EFFECTS MODEL AND FIXED EFFECTS MODEL

	(b) Fixed effects model	(B) Random effects model	(b-B) The difference between the two	sqrt(diag(V_b-V_B)) Standard Error
Lnp	1.566279	-.5366399	2.102919	.5351466
Lnm	.6639808	1.732481	-1.0685	.34812
Lnt	.0542217	-.0199473	.074169	.0160238
_cons	-7.857366	-8.425611	.5682448	.8755935

Get a statistical value that conforms to the chi-square distribution:

$$\chi^2(3) = (b-B)'[(V_B)^{-1}](b-B) = 24.08$$

Finally, it is concluded that $\text{Prob} > \chi^2 = 0.0000$, and it is believed that the fixed-effects model analysis should be used to reject the null hypothesis.

4.1.3 Comparison of Regression Results between Fixed Effects Model and Random Effects Model

The regression results of the fixed effects model and the random effects model are shown in the following table.

Among them, model (1) is a fixed-effect model. It can be seen from the fixed-effects model that the result is more consistent with the expected result of the hypothesis. The impact of Human capital investment on technological innovation capability is positive, and the impact of R&D expenditures on technological innovation capability is also positive, the technology market turnover and technological innovation capability are also positively correlated. The results of the overall regression model basically pass the test at a significance level of 1%, indicating that it is more appropriate to use the fixed effects model to explain the impact of the technology market on technological innovation capabilities. The fixed-effects model also shows that as human capital investment increases by 1%, the flexibility of technological innovation capabilities will increase by 1.566%; every 1% increase in R&D expenditures will promote technological innovation capabilities by 0.664%; every increase in technology market turnover 1%, will promote an increase of 0.0542% in technological innovation capabilities.

Model (2) is a random effect model. From the results of the random effect model, it can be seen that the technology market turnover is significant at the level of 10%, and the significance is low. However, both human capital investment and R&D expenditures contribute to technological innovation. Ability significantly affects. In summary, the conclusions of these two models have verified the original hypothesis, but according to the results of Hausman's test, this article should apply the fixed-effects model for analysis.

TABLE 5 COMPARATIVE OUTPUT RESULTS OF FIXED EFFECTS MODEL AND RANDOM EFFECTS MODEL

	(1)	(2)
VARIABLES	Fixed effects model	Random effects model
Lnp(Human capital)	1.566*** (0.391)	0.537** (0.263)
Lnm(Funding capital)	0.664** (0.285)	1.732*** (0.260)
Lnt(Technology market turnover)	0.0542*** (0.0199)	0.0199* (0.0258)
Constant (Constant term)	7.857*** (0.896)	8.426*** (1.049)
Observations(Number of variables)	44	44
Number of provi(province)	4	4

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

4.2 Model Selection-2: Mixed Fixed-effects Model or Time-point Fixed-effects Model

4.2.1 Hypothetical Construction

The model was constructed using the 10-year panel data of the above three indicators in the Yangtze River Delta. For the selection of the panel data model, it is necessary to consider whether to create a mixed model or a fixed-effect model.

For the original model form: take the logarithm of two-sided of $Q_i = AL_i^\alpha K_i^\beta \varepsilon$, and the form of the estimated model becomes:

$$\ln Q_i = \ln A + \alpha \ln L_i + \beta \ln K_i + \ln \varepsilon \quad (6)$$

Converted to the following form:

$$\ln Q_{it} = c + \alpha \ln L_{it} + \beta \ln K_{it} + u_{it} \quad (7)$$

$i=1.2\dots N$; $t=1.2\dots T$

Among them, c is the intercept term, i is the regional individual, N is the number of individuals in the panel data (N=4), t is the time, which is the length of time in the panel data (T=10), and U is the random disturbance term. Shanghai,

Jiangsu, Zhejiang, and Anhui are represented by sh, js, zj, and ah respectively.

To test the form of the model, the original hypothesis and alternative hypothesis are:

H0: Establish a mixed model.

H1: Establish a point-in-time fixed-effect model.

4.2.2 Comparison of Mixed Effects Model and Time Fixed Effects Model

Judging from the results of Time fixed effects model, the significance and goodness of fit of several variables are relatively high. However, according to the results of the mixed-effects model, the goodness of fit is very low, so this paper chooses the Time fixed effects model. The output results of the Time fixed effects model are shown in the following table.

TABLE 6 OUTPUT RESULTS OF TIME FIXED EFFECTS MODEL

	(1)	(2)
VARIABLES	Time fixed effects model	Time fixed effects model
Lnp(Human capital)	0.179** (0.0792)	0.174* (0.111)
Ln(Funding capital)	0.0110** (0.00289)	0.0111*** (0.00398)
Lnt(Technology market turnover)	1.58e-07* (1.21e-07)	
2009.year	0.366 (0.387)	0.343 (0.425)
2010.year	0.000378* (0.218)	0.0479** (0.233)
2011.year	-0.144* (0.322)	-0.140* (0.354)
2012.year	0.0368 (0.0447)	0.0204 (0.127)
2013.year	-1.140* (1.046)	-1.187* (0.897)
2014.year	0.569* (0.321)	0.517 (0.333)
2015.year	0.663 (0.490)	0.599 (0.543)
2016.year	1.429** (0.883)	1.354** (0.903)
2017.year	1.904** (1.219)	1.500* (1.165)
2018.year	2.310** (0.965)	2.209** (1.108)
Constant	-0.676 (0.601)	-0.801 (0.673)
Observations	44	44
Numberofprovi	4	4
CountryFE	YES	YES

Standard errors in parentheses; ***p<0.01,**p<0.05,*p<0.1

In order to study the effect of technological market turnover on technological innovation capabilities, this article compares the models with and without introducing technological market turnover variables, forming two models.

From the output results of model (1), it can be seen that at the significance levels of 0.05 and 0.1, the full-time equivalent of R&D personnel and R&D expenditures have significant effects on technological innovation, and the overall goodness of the model is very high. According to the least squares estimate, the output elasticity of R&D human capital input to the Number of valid invention patents is 0.179, which means that for every one percentage point increase in the full-time equivalent of R&D personnel, the Number of valid invention patents increases by an average of 0.179 percentage points; R&D expenditures investment affects the Number of valid invention patent The output elasticity is 0.0110, indicating that for every one percentage point increase in R&D expenditures, the Number of valid invention patents increases by 0.0110 percentage points on average; and the technology market also has a positive impact on the output of the Number of valid invention patents, but However, the degree of impact is lower than human capital investment and R&D expenditures investment, and is significant at the 10% level.

From the output of model (2), both human capital investment and R&D expenditures investment have a positive and significant impact on the Number of valid invention patents. It can be seen that the conclusions of Time fixed effects model are also consistent with the above.

4.2.3 Formula of Time Fixed Effects Model

Based on the above analysis, the following is the formula to determine the Time fixed effects model.

Therefore, this paper expresses the expansion formula for the relationship between technology market and technological innovation capability as follows.

$$A_{it} = P_{it}^{\beta} \cdot M_{it}^{\beta_1} \cdot T_{it}^{\beta_2} \quad (8)$$

Among them, A represents technological innovation capability, and this paper uses the number of Number of valid invention patents to represent; P represents human capital investment, and this page uses the number of R&D personnel in the current period; M represents R&D expenditure, which is represented by R&D expenditure investment in this paper; T represents technology market development, this paper uses technology Market turnover is expressed. i represents the observation unit, and t represents the current time. Represents the output elasticity coefficient of R&D human investment and R&D expenditure investment.

Since it takes a long process from R&D investment to patent output, there is a hysteresis effect. Patent output itself also has inertia, which is a continuous dynamic adjustment process. Therefore, when studying the impact of knowledge stock on patent output. The use of dynamic models should be considered. [9] Considering this inertial feature and path dependence, this paper adds the lag term of the explained variable to the static panel model to construct a dynamic panel model as a benchmark model. The specific formula is as follows:

Take the logarithm of both sides of the above formula to obtain Timet fixed-effect model of this paper:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln P_{i,t} + \beta_2 \ln M_{i,t} + \beta_3 \ln T_{i,t} + \varepsilon_i \quad (9)$$

$$\ln Y_{i1} = \beta_0 + \beta_1 \ln P_{i,1} + \beta_2 \ln M_{i,1} + \beta_3 \ln T_{i,1} + \varepsilon_i, t=1, \text{First cross-sectional} \quad (10)$$

$$\ln Y_{i2} = \beta_0 + \beta_1 \ln P_{i,2} + \beta_2 \ln M_{i,2} + \beta_3 \ln T_{i,2} + \varepsilon_i, t=2, \text{Second cross section} \quad (11)$$

...

$$\ln Y_{in} = \beta_0 + \beta_1 \ln P_{i,n} + \beta_2 \ln M_{i,n} + \beta_3 \ln T_{i,n} + \varepsilon_i, t=n, \text{Nth cross section} \quad (12)$$

Based on the internationally accepted practice, R&D expenditure is used as a substitute variable for knowledge stock, and in order to further examine the role of patents and human capital, which are two knowledge stock indicators, on regional economic growth, patents and human capital are added on the basis of the 10 formula. Index variables are used as substitute variables for the stock of knowledge. Taking into account the endogenous problems caused by mutual causality in the current value, the key variables and all control variables are taken to be one period lagging, and the following fixed-effects model with one period lagging can be obtained as follows.

$$\ln Y_{it} = \beta_0 + \beta_1 \ln P_{i,t-1} + \beta_2 \ln M_{i,t-1} + \beta_3 \ln T_{i,t-1} + \varepsilon_i \quad (13)$$

4.3 Regression Analysis and Robustness Test

In order to verify the robustness and accuracy of the results obtained from the empirical analysis of panel data used in this paper, further verify the robustness of the fixed effects model. In this paper, the three key explanatory variables-human capital, R&D expenditure, and technology market turnover are quadratic term squared, which is to re-regress in the form of replacement variables. The regression results show that human capital and funding have a positive and significant impact on the technological innovation capability of the Yangtze River Delta. Although the technology market has a positive effect on the technological innovation capability of the Yangtze River Delta, the effect is not significant. The main point of view is the same as the previous conclusion, which further reflects that the data of the Yangtze River Delta region used in this research is robust.

The data time interval of this paper is 2009-2018. Since time series data and panel data are used as the data of this paper at the same time, due to the lag of time series data, the relevant data of the Yangtze River Delta in this paper has a one-year lag. The term is introduced into the model, thereby reducing the collinearity and correlation of the model. From the results of the quadratic term of Time fixed effects model, the models (3) and (4) of this paper are formed.

TABLE 7 ROBUSTNESS TEST OF REGRESSION RESULTS

VARIABLES	(3) Time fixed effects model	(4) Time fixed effects model
p ² (Human capital)	0.00179** (0.000707)	0.00180*** (0.000698)
m ² (R&D expenditure)	4.29e-06*** (5.39e-07)	4.29e-06*** (5.49e-07)
t ² (technology market turnover)		1.31e-03** (1.311e-03)
2009.year	0.211 (0.165)	0.211 (0.167)
2010.year	0.242** (0.121)	0.242* (0.124)
2011.year	0.651** (0.300)	0.652** (0.302)
2012.year	1.050*** (0.198)	1.052*** (0.193)
2013.year	0.737 (0.567)	0.739 (0.565)
2014.year	1.820*** (0.0658)	1.823*** (0.0684)
2015.year	2.011*** (0.191)	2.015*** (0.212)
2016.year	2.835*** (0.503)	2.839*** (0.528)
2017.year	3.080*** (0.645)	3.113*** (0.855)
2018.year	3.638*** (0.598)	3.642*** (0.630)
Constant	0.238*** (0.0916)	0.239*** (0.0913)
Observations	44	44
Numberofprovi	4	4
CountryFE	YES	YES

Robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1

It can be seen from the model (4) that the quadratic term of human capital investment in the current period is positively correlated, which means that with the increase of human capital investment, within the 5% confidence interval, it will promote the improvement of technological innovation capabilities, and the elasticity will increase by 0.179%. The current increase in R&D expenditure will promote the improvement of technological innovation

capabilities within the 1% confidence interval. However, it can also be seen that neither the quadratic terms of the technical market indicators (technology market turnover) nor the individual indicators have a significant impact on the technological innovation capability, that is, the impact is not very large. This means that the current development of the technology market in China's Yangtze River Delta cannot fully promote the improvement of technological innovation capabilities, and the positive correlation between the two is limited. Therefore, it can better reflect the urgency of the development of the efficiency of the technology market.

It can be seen from the model (3) that when the technology market variables are not introduced, the significance of human capital investment and R&D expenditure is. Comparing model (3) with model (4), it is not difficult to see that the introduction of the secondary term of the technology market will affect the significance of human capital investment to a certain extent. When the secondary indicators of the technology market are not invested, the human capital investment is significant in the 5% confidence interval, but when the indicator is introduced, the human capital investment is significant in the 1% confidence interval. It can be seen that the technology market turnover will increase the efficiency of the impact of human capital indicators, which has certain positive significance. On the whole, the fixed effects model is more robust.

5 CONCLUSIONS AND COUNTERMEASURES

The development of the technology market in the Yangtze River Delta has a positive impact on the region's technological innovation capabilities, but a series of problems in the technology market restrict the significance of the positive impact. The imperfect operating mechanism of the technology market is the underlying cause of these problems.

From the perspective of the Yangtze River Delta, there are no statistics on technology transactions across provinces and cities in the region, and a unified market supervision system is lacking. technology intermediary agencies have not been able to fully play the role of ties. The strength of the links between provinces and cities is not enough, the information resources have not formed a system, and there are barriers to the exchange of talents. It is difficult to fully realize the potential of knowledge sharing and technology learning. This is precisely the most important prerequisite for building an innovation system. To solve this problem, it is necessary to explore a diversified technology market model and commercial organization mechanism that adapt to regional integration. ^[10]Coordinated development is an advanced stage of regional development. Through technological innovation, collaborative innovation, and promotion of exchanges and cooperation between different innovation subjects, the promotion of market element reorganization, structural optimization and integration of scientific and technological resources, building a complete new innovation network in the Yangtze River Delta, is also optimizing regional technology Market, promote the transfer and transformation of scientific and technological achievements, and promote the practical choice of the Yangtze River Delta's collaborative innovation development.

The innovation transformation trend of the four provinces in the Yangtze River Delta is similar to that of the whole country, indicating that the existing technology market has not yet formed a mechanism that positively and significantly affects the level of technological innovation capabilities, which has led to market failure. The conclusions drawn by the research also have a certain reference for the further development and improvement of China's technology market in the future. The technology market in developed countries has formed a relatively complete technology market operation system and management system.^[11] We should make full use of China's actual conditions and formulate technology market development strategies that are consistent with the actual conditions.

Countermeasure 1: Solve the relationship between the government and the market

The government focuses on the construction of the supply of scientific and technological achievements, the rules of technology trading platforms, the technology transfer service system and mechanism, and the environment for scientific and technological innovation and entrepreneurship to expand market demand, effectively linking technological supply, market demand and scientific and technological services. The market must give full play to the role of resource allocation, through the market mechanism, under the premise of respecting the particularity of

technology as a commodity, to achieve the optimal allocation of technical resources. Achieve a combination of effective market and effective government.

Countermeasure 2: Build an effective technology trading platform and network

Focus on the construction of online and offline technology markets to create a diversified technology market system. Promote the upgrade of the technology market operation model, provide a complete supply and demand information standardization system, big data application solutions, and an information push mechanism based on artificial intelligence technology for the technology transaction network, and realize the data description of technology supply and demand, accurate portraits of technology transaction participants, etc., At the same time, blockchain and other technologies are used to ensure the confidentiality of information and the matching of contribution-benefits, so as to stimulate the enthusiasm of all parties to participate, and to realize the coordination mechanism that each exhibits its strengths and takes each one's needs.

Countermeasure 3: Optimize the technology transfer talent training system

The key to the development of the technology market is people rather than technical documents. Vigorously cultivate technology transfer service agencies, cultivate technology brokerage service personnel and technology market management service personnel, develop a technology broker system; enterprises and university scientific research institutions exchange personnel for visits or study and work, Technological knowledge is transferred with the exchange of such personnel, and scientific research personnel are given ownership or long-term use right of the scientific and technological achievements of the post; ^[12]strengthen the protection of intellectual property rights, and vigorously train patent analysts and patent lawyers.

Countermeasure 4: Strengthen financial capital support

The Venture Capital and financing mechanism of the technology market should be improved, and the financing threshold for small and medium-sized enterprises should be lowered. The synergy of technology and capital is the key to promoting the country's high-quality development, and it is also the prerequisite for giving play to the capital market hub function. ^[13] VC/PE has played a very important role in the early stage of enterprise development, all the way to the process of landing on the capital market. Through the reform of the capital market, the stock market Sci-Tech innovation board will be built into a mature market. STAR MARKET will continue to grow bigger and stronger and support a number of high-tech companies, form a synergistic linkage with the technology factor market, and guide capital to support core technology companies.

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