# The Mechanism of Technological Innovation in China's Regional Economic Development

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**Abstract.** Using panel data from 31 Chinese provinces covering 2014–2023, this study examines the driving effect of technological innovation (TI) on regional economic development (RED). Entropy weighting, fixed-effects models, the Spatial Durbin Model, and instrumental variable methods are employed to address endogeneity issues. The empirical results confirm that technological innovation has a significantly positive impact on regional economic development. The spatial spillover effects of technological innovation are relatively weak, mainly due to uneven distribution of innovation resources and barriers to technology diffusion. Moreover, the economic effects of technological innovation show pronounced regional heterogeneity: significantly positive in eastern and northeastern China, temporarily negative in central China, and insignificant in western China. This study enriches research on innovation-driven development and provides empirical support for formulating differentiated technological innovation policies to promote balanced, high-quality coordinated regional economic growth.

**Keywords:** Technological Innovation; Regional Economic Development; Regional Heterogeneity

## 1 Introduction

With intensifying global economic competition, technological innovation has become a core element through which countries enhance international competitiveness and a key driver of global economic growth [1]. For China, technological innovation serves as a crucial foundation for achieving economic structural transformation and high-quality development. The period from 2014 to 2023 marked a pivotal stage in China's economic trajectory, as the country transitioned from high-speed growth to high-quality development. During this process, multiple challenges emerged, including diminishing marginal returns from traditional factor-driven growth models, intensifying regional development imbalances, and the urgent need to optimize industrial structure. These challenges have elevated the strategic importance of technological innovation to an unprecedented level.


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From the perspective of actual economic demand, a growth model that relies primarily on inputs such as land is no longer sustainable, and resource and environmental constraints are becoming increasingly severe. According to the Series Report on the Achievements of Economic and Social Development since the 18th National Congress of the Communist Party of China released by the National Bureau of Statistics [2], from 2014 to 2023, China's energy consumption per unit of GDP decreased by about 26.4%. However, the excessively high proportion of energy-intensive industries and the predominance of medium- and low-end positions in the industrial chain have not been fundamentally resolved. Hong [3] emphasized that the Chinese economy is characterized as "big but not rich" and that the lack of core technology patents and brand premium capacity has constrained improvements in regional economic quality. Under such circumstances, technological innovation plays an increasingly vital role in enhancing total factor productivity, driving structural transformation in industry, and facilitating technological upgrading.

According to Schumpeter's [4] innovation theory, technological innovation reshapes the growth trajectory by reconfiguring production factors. It enables traditional industries to undergo green and intelligent transformations, guiding the industrial structure toward high-tech and high-value-added directions. The rapid diffusion of new-generation information technologies, including artificial intelligence, big data, and the Internet of Things, has fostered the emergence of industries such as intelligent manufacturing and digital finance, injecting new momentum into regional economies.

Numerous studies ([5]) have verified that technological innovation exerts both direct and indirect impacts on regional economic development, with pronounced regional heterogeneity across China. This study focuses on the driving effect of technological innovation on regional economic development, and empirically examines its overall impact, spatial characteristics, and regional heterogeneity, providing reliable empirical evidence for understanding how innovation drives high-quality regional economic development.

## 2 Theoretical Analysis and Research Hypotheses

### 2.1 The Direct Impact of Technological Innovation on Regional Economic Development

According to Schumpeter's [4] innovation theory, innovation — through intangible elements such as knowledge accumulation, technological progress, and organizational change — systematically reconfigures traditional production factors such as land, labor, and capital. This reconfiguration enables economies to break away from extensive growth paths that rely solely on factor inputs. Consequently, regional total factor productivity is significantly enhanced, improving the quality of economic growth while reducing material resource consumption.

China's economic predicament largely stems from its long-term position at the lower end of the global value chain, characterized by insufficient core technologies and weak brand premium capabilities. Technological innovation, by advancing key

technologies and increasing product value, drives the transformation from "Made in China" to "Created in China," thereby directly enhancing profitability and regional international competitiveness.

Technological innovation also generates strong spatial spillover effects, with achievements spreading to surrounding regions through technology diffusion, talent mobility, and industrial chain collaboration [7]. From 2014 to 2023, China's national R&D expenditure intensity rose from 2.05% to 2.55%, while the average annual growth rate of per capita GDP stabilized at about 6%. The top 10 provinces in terms of R&D investment accounted for more than 50% of the national economic output. Under the impetus of technological innovation, emerging industries such as artificial intelligence and new energy vehicles expanded rapidly. In 2023, China's production of new energy vehicles and photovoltaic components accounted for more than 60% and 80% of the global total, respectively. Between 2014 and 2022, China's total factor productivity increased at an average annual rate of 1.5%, with technological progress contributing more than 60%, particularly in eastern provinces [6], providing strong evidence of the positive correlation between technological innovation and economic growth.

From the perspective of innovation-driven development theory, technological innovation is the core driving force of regional economic growth. On the one hand, new technologies and methods optimize production processes, increase total factor productivity, and reduce factor input costs per unit of output, directly stimulating economic expansion. On the other hand, new products and services expand the boundaries of market demand, creating new sources of growth. Technological innovation not only drives economic expansion through efficiency gains and resource optimization [8] but also promotes industrial structure upgrading—supporting the rise of high-tech and strategic emerging industries while enabling the informatization and intelligent transformation of traditional industries [6].

Furthermore, according to innovation diffusion theory, the outcomes of technological innovation amplify its economic impact through technology spillover and cross-regional cooperation [9]. In summary, both the theoretical frameworks and the empirical findings strongly support the positive impact of technological innovation on regional economic development.

Hypothesis 1: Technological innovation has a significant positive effect on regional economic development.

## 2.2 The Heterogeneity of Technological Innovation's Impact on the Regional Economy

The theory of unbalanced regional development posits that differences in resource endowment, economic foundation, and innovation capacity across Chinese provinces create regional variations in the economic effects of technological innovation. The impact of technological innovation on regional economic development shows significant heterogeneity, reflected in differences in coordinated regional development [9].

At the industrial structure level, regions with higher shares of secondary and tertiary industries exhibit greater compatibility with technological innovation, leading to a stronger driving effect on economic development. In contrast, regions dominated by agriculture and traditional heavy industries face high substitution costs and long transformation cycles, resulting in weaker impacts [5]. Industrial complementarity among adjacent regions enhances the spatial spillover effect of technological innovation, whereas similarity in industrial structure decreases cross-regional linkage effects [10].

From a spatial correlation perspective, Kong et al.[11] reported that central cities, which benefit from the concentration of innovation resources, demonstrate strong direct effects of technological innovation. In contrast, peripheral cities depend more on diffusion from central cities. This diffusion, however, is constrained by geographical distance and transportation infrastructure.

Hypothesis 2: The impact of technological innovation on regional economic development is heterogeneous across regions.

# 3 Research Design

## 3.1 Variable Selection

(1) Dependent Variable: Regional Economic Development

The level of regional economic development is an important indicator of both a region's living standards and economic strength. In this study, the indicator system for regional economic development is constructed from four dimensions: economic scale, economic stability, economic structure, and economic openness. Eleven specific indicators are selected, as detailed in Table 1.

(2) Independent Variable: Technological Innovation

Innovation generally refers to creative thinking and practices that build on existing knowledge, products, or services to develop new products, improve product quality, and introduce new services. In this study, the technological innovation indicator system is constructed from four aspects: innovation input, innovation output, the innovation environment, and innovation synergy. Ten specific indicators are selected, as detailed in Table 1.

**Table 1.** Evaluation Index System of Technological Innovation and Regional Economic Development

| Primary indicators | Secondary indicators | Specific indicators | Indicator nature | Weights |
|---|---|---|---|---|
| Technological Innovation | Innovation input | XA1 | + | 0.097 |
| | | XA2 | + | 0.042 |
| | | XA3 | + | 0.098 |
| | Innovation output | XB1 | + | 0.054 |
| | | XB2 | + | 0.123 |
| | | XB3 | + | 0.125 |
| | Innovation environment | XC1 | + | 0.040 |

| | | | | |
|---|---|---|---|---|
| | | XC2 | + | 0.052 |
| | Innovation synergy | XD1 | + | 0.212 |
| | | XD2 | + | 0.159 |
| Regional Economic Development | Economic scale | YA1 | + | 0.081 |
| | | YA2 | + | 0.073 |
| | | YA3 | + | 0.144 |
| | | YA4 | + | 0.058 |
| | Economic stability | YB1 | + | 0.064 |
| | | YB2 | + | 0.058 |
| | Economic structure | YC1 | + | 0.015 |
| | | YC2 | + | 0.031 |
| | Degree of economic openness | YD1 | + | 0.137 |
| | | YD2 | + | 0.203 |
| | | YD3 | + | 0.136 |

(3) Control Variables

In this study, fixed asset investment, population size, consumption level, and residents' income are used as control variables.

(4) Instrumental Variable

To address endogeneity, we use the interaction term between the number of fixed-line telephones per 10,000 people in 1999 and the number of internet broadband accesses per 10,000 people during the observation period as the instrumental variable. This variable satisfies both the relevance and exclusion restrictions: historical communication infrastructure shaped the subsequent development of digital networks, which in turn affected technological innovation; meanwhile, telephone penetration in 1999 is unlikely to have directly influenced economic performance from 2014 to 2023.

### 3.2 Model Construction

Based on Hypothesis 1, to test the impact of technological innovation on regional economic development, the following benchmark regression model is used:

$$RED_{it}=\alpha_0+\alpha_1 TI_{it}+\alpha_2 X_{it}+\varepsilon_{it}$$

where i represents the province, t represents the year, α is the regression coefficient, REDit represents regional economic development, TIit represents technological innovation, Xit represents control variables, and εit is the error term. α1 denotes the total effect of TI onRED.

### 3.3 Data Sources

This study employs panel data for 31 provinces in Chinese mainland (excluding Hong Kong, Macao, and Taiwan) spanning 2014 – 2023. Data are obtained from the China Statistical Yearbook, China Statistical Yearbook on Science and Technology, the National Bureau of Statistics, and the Wind Database. Missing values for a small

number of indicators are imputed using interpolation and the mean values of adjacent years.

# 4 Empirical Results and Analysis

## 4.1 Baseline Regression

The Hausman test strongly rejects the null hypothesis of the random-effects model at the 1% significance level; therefore, the fixed-effects model is adopted. The regression results are as follows (Table 2):

When excluding control variables and fixed effects, the coefficient of technological innovation is 0.813 and significantly positive.

When including control variables but excluding fixed effects, the coefficient remains 0.495 and statistically significant.

After including control variables, time fixed effects, and individual fixed effects, the coefficient of technological innovation is 0.256 and significantly positive at the 5% level.

**Table 2.** Baseline Regression Results

| Variable | Regional Economic Development | | |
|---|---|---|---|
| | Without control variables, individual and time fixed effects | With control variables, without individual and time fixed effects | With control variables, individual and time fixed effects |
| Technological Innovation | 0.813*** | 0.495*** | 0.256** |
| | (0.0713) | (0.0978) | (0.104) |
| Control variables | × | √ | √ |
| Time fixed effects | × | × | √ |
| Individual Fixed Effects (Province-level) | | × | √ |
| Simple size/observations | 310 | | 310 |
| R-squared | | 310 | 0.791 |

The results indicate that after controlling for other factors, time fixed effects, and individual fixed effects, technological innovation significantly promotes regional economic development, and Hypothesis 1 is supported.

## 4.2 Endogeneity Test

To mitigate endogeneity bias caused by reverse causality and omitted variables, this study employs two approaches:

Lagged one-period regression: Using the one-period lag of technological innovation, the estimated coefficient is 0.2518 and significantly positive, confirming the robustness of the baseline results.

Instrumental variable 2SLS: Using the interaction term of historical telephone penetration as the instrumental variable, the second-stage coefficient is 0.691 and significantly positive.

The endogeneity tests confirm that the positive effect of technological innovation on regional economic development is robust and not driven by endogeneity concerns.

### 4.3 Spatial Effects and Robustness Checks

(1) Spatial Durbin Model Regression

The results of the Spatial Durbin Model are as follows: Without control variables, the coefficient of technological innovation is 0.4714; With control variables included, the coefficient is 0.2396.

Both coefficients are significantly positive and consistent with the baseline conclusion.

The coefficient of the spatial lag term of technological innovation (WTI) is negative and statistically insignificant, indicating weak cross-regional spatial spillover effects of technological innovation, which supports Hypothesis 3. The spatial autocorrelation coefficient (rho) is insignificant, suggesting weak spatial dependence in regional economic development.

### 4.4 Spatial Effects and Robustness Checks

(1) Spatial Durbin Model Regression

The results of the Spatial Durbin Model are as follows:

Without control variables, the coefficient of technological innovation is 0.4714;

With control variables included, the coefficient is 0.2396.

Both coefficients are significantly positive and consistent with the baseline findings.

The coefficient of the spatial lag term of technological innovation (WTI) is negative and statistically insignificant, indicating weak cross-regional spatial spillover effects of technological innovation, which supports Hypothesis 3. The spatial autocorrelation coefficient (rho) is insignificant, suggesting weak spatial dependence in regional economic development.

(2) Multidimensional Robustness Checks

To ensure the reliability of the results, this study conducts three types of robustness checks:

Replacing core variables: Using R&D investment intensity instead of the comprehensive technological innovation index, the coefficient is 0.231 and significantly positive.

Adjusting the sample range: After excluding municipalities directly under the central government and resource - based provinces, the coefficients are 0.248 and 0.262 respectively, confirming robustness.

System GMM estimation: Using a dynamic panel model, the coefficient of technological innovation is 0.229 and significantly positive.

All tests support the core conclusion: technological innovation significantly promotes regional economic development, and its spatial spillover effects are weak.

### 4.5 Regional Heterogeneity Analysis

Following the classification standard of the National Bureau of Statistics, the 31 provinces are divided into four groups: eastern, central, western, and northeastern China for subsample regression. The results are as follows (Table 3):

**Table 3.** Regional Heterogeneity Test

| VARIABLES | (1) Eastern Region | (2) Central Region | (3) Western Region | (4) Northeast Region |
|---|---|---|---|---|
| TI | 0.2634*** | -0.3461* | 0.2181 | 0.5862** |
| | (0.0743) | (0.1607) | (0.1256) | (0.1022) |
| Control Variables | √ | √ | √ | √ |
| Time Fixed Effects | √ | √ | √ | √ |
| Individual Fixed Effects (Province-level) | √ | √ | √ | √ |
| Observations | 100 | 60 | 120 | 30 |
| R-squared | 0.9169 | 0.8953 | 0.8854 | 0.8143 |
| Number of ID | 10 | 6 | 12 | 3 |

Eastern region: The coefficient of technological innovation is 0.2634 and significantly positive at the 1% level. The eastern region has concentrated innovation resources, sound industrial support systems, and a high degree of marketization, leading to high efficiency in innovation commercialization and a strong driving effect on the economy.

Central region: The coefficient is −0.3461 and significantly negative at the 10% level. The central region is undergoing industrial structural transformation, characterized by rapidly rising innovation investment costs and unrealized short-term returns, resulting in a temporary inhibitory effect.

Western region: The coefficient is 0.2181 and statistically insignificant. The western region suffers from a shortage of innovation resources, weak industrial transformation capacity, and backward infrastructure, so technological innovation has not yet generated a significant economic driving force.

Northeastern region: The coefficient is 0.5862 and significantly positive at the 5% level, showing the strongest effect magnitude among all regions. As a traditional industrial base, the northeastern region faces urgent demand for industrial upgrading. Technologies such as intelligent manufacturing and green innovation exert a pronounced boosting effect on the economy, further strengthened by revitalization policies, leading to an outstanding driving impact.

These findings confirm that the economic effects of technological innovation exhibit significant regional heterogeneity, and Hypothesis 2 is supported.

## 5 Conclusion

Using panel data from 31 provinces in China (2014 – 2023), this study systematically investigates the mechanism through which Technological Innovation (TI) influences Regional Economic Development (RED), and regional heterogeneity. The main conclusions are as follows:

(1) TI has a significant positive driving effect on RED.

Benchmark regression and endogeneity tests consistently show that TI significantly promotes RED. This conclusion remains valid in robustness tests controlling for spatial correlation effects. These results confirm the theoretical expectation that TI is a core engine of regional economic growth, indicating that in the stage of high-quality development, TI effectively enhances RED by improving total factor productivity, fostering new business models, and optimizing resource allocation.

(2) The impact of TI on RED exhibits marked regional heterogeneity.

The group regression results reveal that the economic effect of TI varies significantly across regions. In the eastern and northeastern regions, TI has a strong and significant positive effect, with the northeastern region showing the highest effect intensity because of its urgent need for industrial upgrading and strong leverage from innovation. In contrast, the central region experiences a short-term negative impact, likely because innovation investment costs outweigh immediate returns during structural transformation. In the western region, the effect of TI is not yet evident and is constrained by limited innovation resources, weak transformation capacity, and underdeveloped infrastructure.

(3) The spatial spillover effect of TI is weak, and its economic impact is mainly localized.

Spatial Durbin Model analysis reveals that the spatial lag coefficient of TI is negative but not significant, indicating that the spillover effect of TI across provinces is limited. These results align with the finding that the spatial correlation of TI in China remains low, which may be attributed to the uneven distribution of innovation resources, market segmentation, and restrictions on talent mobility.

In conclusion, TI has a robust positive influence on RED, but the mechanisms and effect intensities differ significantly across industrial structures, institutional environments, and regions. These findings provide empirical evidence for understanding the causes of unbalanced regional development in China and highlight the need to formulate differentiated innovation policies tailored to local conditions.

## 6 Policy Recommendations

(1) Eastern Region

The dual drive of innovation leadership and industrial upgrading should be strengthened. Increase investment in basic research; support the joint establishment of laboratories by universities, research institutes, and enterprises; focus on breakthroughs in core technologies in the fields of artificial intelligence and quantum information; and enhance original innovation capabilities. The clustering of high-tech

industries should be promoted; integrated circuit clusters in the Yangtze River Delta and new energy vehicle clusters in the Pearl River Delta should be cultivated; collaborative innovation platforms should be developed; and the efficiency of technology transfer should be improved. The institutional environment should be optimized, the process for recognizing high-tech enterprises should be simplified, an innovation tolerance mechanism should be established, intellectual property protection strengthened, and enterprise innovation enthusiasm stimulated.

(2) Central Region

Alleviate the contradiction between transformation challenges and innovation investment. Set up a special fund for industrial transformation, support the intelligent and green transformation of the steel and coal industries, and reduce short-term costs. Undertake the transfer of high-tech industries from the eastern region, develop an electronic component supporting industries, and build a service platform for industrial transfer. Enterprises should be encouraged to introduce, digest, absorb, and re-innovate, thereby enhancing their independent innovation capabilities. School-enterprise cooperation should be promoted to cultivate skilled talent in a targeted manner, a regional innovation cooperation platform should be developed, and development synergies should be formed.

(3) Western Region

Address innovation deficiencies and leverage resource advantages. Investment in innovation infrastructure should be increased, and regional science and technology innovation centers and incubators should be developed. Rely on energy and mineral resources to develop deep-processing industries, cultivate new energy industries, and transform resource advantages. Strengthen cross-regional scientific and technological cooperation and introduce advanced technologies and teams. Implement talent support plans, attract high-level professionals and encourage local talent to return, simplify policy application procedures, and ensure that support policies benefit innovation entities.

(4) Northeast Region

Revitalize traditional industries and foster emerging industries. Investment in science and technology innovation should be increased, the intelligent transformation of the steel and equipment manufacturing industries should be supported, and the application of industrial internet technology should be promoted. Special funds should be established to cultivate agricultural science and technology and the ice and snow economy, and to develop modern agriculture and ice and snow equipment manufacturing. Industry-university-research alliances should be established to address technical challenges, targeted talent cultivation should be pursued, the business environment should be optimized, administrative intervention should be reduced, and the internal vitality of enterprises should be strengthened.

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## References

1. Şener S, Sarıdoğan E. The Effects Of Science-Technology-Innovation On Competitiveness And Economic Growth. Procedia - Social and Behavioral Sciences. 2011;24:815-28.
2. National Bureau of Statistics. Series of Reports on the Achievements of Economic and Social Development since the 18th National Congress of the Communist Party of China. Beijing: National Bureau of Statistic; 2024.
3. Hong YX. On the innovation-driven economic development. Economist. 2013(01):5-11.
4. Schumpeter JA. The Theory of Economic Development. London: Routledge; 2021.
5. Chen T, Chen G. Study on the Spatial Spillover Effect of Technological Innovation on Industrial Structure Upgrading: Analysis Based on Provincial Spatial Panel Model. Journal of Yunnan University of Finance and Economics. 2020;36(01):21-31.
6. Zang YY, Luo CY. The Impact Mechanism of Technological Innovation on Regional Economic Development: An Empirical Analysis Based on Panel Data from the Guangdong-Hong Kong-Macao Greater Bay Area. Science and Technology Management Research. 2024;44(20):54-62.
7. Wang YX, Wu Q, Cao CS. How Scientific and Technological Innovation Drives Regional Modernization: Evidence from Yangtze River Delta Cities. East China Economic Management. 2025;39(07):35-46.
8. Williamson OE. The new institutional economics: taking stock, looking ahead. Journal of Economic Literature. 2000;38(3):595-613.
9. Xue Y, Gao W, Feng Y. Technological innovation, low-carbon energy consumption andregional coordinated development. Journal of Nanjing University of Posts and Telecommunications(Social Science Edition). 2025(8):1-11.
10. Wang LJ, Li F, Chen P. Utilizing Innovation Resources at Home and Abroad to Promote Regional Economic Development in China: Intrinsic Mechanisms and Implementation Paths. Price: Theory & Practice. 2024(03):194-9.
11. Kong LC, Chai ZY, Qiu DX. Research on the driving of regional integration to urban innovation capability—An empirical study of the Yangtze River Delta. Science Research Management. 2022;43(12):34-43.