Research on the Impact of Innovation on Regional Economic Growth

FeiFei Shang , ZhiYu Niu , SiYuan Zang

Shenyang University of Technology, Shenyang, 110870, China

*corresponding author Zhiyu Niu Email,17332098707@163.com

Abstract. The influence of innovation on regional economic development is a significant area of scholarly inquiry and holds paramount importance in the context of regional economic advancement. Innovation serves as a driving force for economic growth, bolstering competitive advantages, fostering job creation, enhancing productivity, and facilitating social progress. Presently, a confluence of factors, including technological advancements, global competition, market demands, and institutional frameworks, present both opportunities and impetus for innovation within regions, thereby propelling economic growth and prosperity. Governments, enterprises, and research institutions, among other stakeholders, are actively engaged in fostering innovation to infuse vigor and dynamism into regional economic development. The empirical analysis of panel data from 31 provinces and municipalities across the nation is adopted in the study, revealing a positive relationship between innovation and regional economic growth. Furthermore, the article presents insightful approaches on leveraging innovation to drive and facilitate regional economic development.

Keywords: innovation, regional economy, Panel Data, employment

1   Introduction

The paramount significance of innovation as a pivotal force driving economic growth and social advancement is acknowledged within the context of regional economic development. The acceleration of globalization and rapid technological progress has intensified competition among regions, leading to an incessant pursuit of innovation to enhance competitiveness and adaptability to dynamic changes[1]. Consequently, in-depth research on the influence of innovation on regional economic development proves indispensable for comprehending the multifaceted role and intricate mechanisms underlying innovation in regional economies. This research endeavor seeks to explore the intricacies surrounding the significance of innovation in regional economic development, alongside its underlying impact mechanisms[2].

To achieve this, the study undertakes a comprehensive review of pertinent literature, synthesizing existing research achievements, and conducting a systematic analysis of the pathways and effects through which innovation influences regional economies. Moreover, it delves into the diverse roles played by innovation in propelling economic

growth, augmenting competitive advantages, generating employment opportunities, heightening productivity, and fostering societal progress. Employing empirical analysis, the research endeavors to uncover the distinctive influencing factors and mechanisms through which innovation imparts its impact on regional economic development.

By delving deeply into this research inquiry, our intent is to provide novel insights and theoretical frameworks pertaining to the influence of innovation on regional economic development. These insights are poised to offer practical guidance and decision-making support to policymakers, furnish entrepreneurs with innovative strategies and developmental orientations, and furnish the academic community with a foundation for future research and inspiration. Ultimately, the study aspires to advance the sustainable development of regional economies and facilitate societal progress[3].

2   literature review

The investigation of the impact pathways and effects of innovation on regional economies constitutes a longstanding and dynamic research domain. In the early stages, particularly during the 1960s to 1970s, research primarily concentrated on comprehending the influence of innovation on national economies, specifically the contribution of technological advancements to overall economic growth. The regional dimension received relatively less attention, with scholarly focus predominantly centered on the national innovation system and policies.

However, with the emergence and recognition of regional innovation systems, research progressively shifted towards exploring the role of innovation within the context of regional economic development. Scholars initiated investigations into geographical agglomeration phenomena of innovation, such as industrial clusters and technology parks, thereby shedding light on the spill-over effects and externalities of innovation on regional economies[4]. Subsequently, the maturation of spatial econometrics enabled scholars to leverage spatial econometric models, which facilitated a more nuanced understanding of the interplay between innovation activities, spatial interactions, and spillover effects, thereby yielding research outcomes that are quantitatively robust and contextually specific.

In the new millennium, as innovation ecosystems and localized innovation policies gained prominence, scholarly attention towards understanding the impact mechanisms and effects of innovation at the local level surged. Consequently, researchers delved deeper into unraveling the intricate dynamics underlying the interrelationships between innovation and regional economies. Continuous advancements in research methodologies and the deepening of theoretical explorations have propelled our comprehension of the impact pathways and effects of innovation on regional economies to a more sophisticated level.

However, given the intricate nature and diverse characteristics of regional economies, further research endeavors are essential to unveil the nuanced relationships that exist among different regions, industries, and forms of innovation. By doing so, we can gain comprehensive insights that will contribute to our understanding of regional

economic development, facilitating evidence-based policymaking, fostering strategic directions for entrepreneurs, and inspiring future scholarly inquiries.

3   Theoretical mechanism and research hypothesis

The investigation into the influence of innovation on regional economic development has been a longstanding and pivotal research domain. Since the implementation of economic reform and opening-up policies in 1978, China has witnessed rapid economic growth and embarked on a trajectory of modernization. These transformative policies have offered development opportunities, engendering diverse regional economic progress. Subsequently, regional development strategies were instituted to foster balanced development across different regions. However, given the inherent disparities in resource endowments among regions, achieving equilibrium remains a formidable challenge. Thus, against the backdrop of simultaneous opportunities and challenges in regional development, innovation assumes a critical role as a key driver in propelling regional economic advancement. The impact and mechanisms of innovation on regional economic development encompass several salient dimensions:

(1)**Economic Growth Effect:**. Innovation emerges as a crucial propellant of economic growth. By introducing novel technologies, products, and production methods, innovation can heighten productivity, reduce costs, and generate new market opportunities, thereby fostering regional economic expansion. The impetus of innovation on regional economic growth is evidenced in various facets. Firstly, the application of novel technologies enables enterprises to attain heightened output levels relative to identical resource inputs, thereby bolstering regional economic growth. Secondly, innovation instigates the upgrading and transformation of industrial structures. By introducing novel products, services, and business models, innovation empowers enterprises to secure competitive advantages, facilitating the transition of traditional industries towards high value-added and knowledge-intensive sectors, thereby amplifying the overall competitiveness of regional economies. Moreover, innovation engenders the creation of new market demands and opportunities. By cultivating new products, services, and technologies, innovation caters to emerging consumer needs, expands market dimensions, and stimulates regional economic growth. Regions characterized by robust innovation capabilities typically attract greater investments and talent inflows[5]. The pursuit of innovation fortifies regional prominence and allure, enthralling domestic and foreign enterprises and talents, thus further propelling regional economic development. Lastly, the application and development of innovation within a particular industry frequently engenders progress within interrelated industry chains. For instance, the introduction of an innovative technology may precipitate heightened demand within associated sectors, thereby stimulating the development of entities along the supply chain and value chain, fostering a virtuous cluster effect, and propelling regional economic growth.

(2)Labor Multiplier Effect: The labor expenditure effect in regional economic growth pertains to the influence exerted by the heightened levels of employment and income of the labor force within a particular geographic area on the overall economic expansion experienced in that region. Innovation serves as a catalyst for creating employment opportunities. As businesses expand their scale or venture into novel product development through innovative practices, the demand for labor intensifies. Heightened levels of labor expenditure are often indicative of companies' willingness to hire additional personnel to meet the burgeoning requirements for production and service provision. Enhancing labor expenditures, such as augmenting wages, improving benefits, or offering more enticing incentives, bolsters the allure of employment opportunities, thereby enticing a greater pool of individuals to actively engage in the labor market. Elevated labor costs incentivize enterprises to bolster their recruitment efforts, culminating in a surge of job opportunities and fostering a trajectory of employment growth.As regional employment levels ascend, it reflects a burgeoning workforce participation, yielding positive ramifications for the region's overall employment rate and the prosperity of its residents[5].

Based on the above, we propose the following hypotheses:

Hypothesis 1a: Innovation fosters the development of regional economies.

Hypothesis 1b: Economic growth effect and Labor Multiplier Effect,are important channels through which innovation promotes regional economic development.

4   Study design

4.1   Variable description

(1) The variable to be explained. The explanatory variable here is the level of regional economic development, measured by the total annual GDP of each province and city.

(2) Core explanatory variables. The core explanatory variable here is innovation, measured by the amount of R&D spending in each province and city

(3) Control variables. The controlled variable in this study is labor expenditure, which is represented by the employment figures of various provinces and cities.

4.2   Model settings

Based on the preceding analysis, we set the econometric model to the following dynamic panel regression form (Equation 1):

$$Y_{it}=\beta_0+\beta_1x1_{it}+\beta_2x2_{it}+\zeta_{it} \tag{1}$$

Among them: i is the province, t is the year, and Yit represents the level of regional economic development. X1it stands for R&D expenditure and is the core variable that

the article focuses on. X2it represents the control variable, i.e. the number of employees, and ξ is the error term.

4.3 Basic assumptions for establishing the model

The level of regional economic development is influenced by various economic and policy factors, in addition to R&D expenditure and employment figures. We denote the combined impact of these factors, excluding R&D expenditure and employment figures, as ζ. Before establishing the model, we make the following fundamental assumptions:

(1) The null conditional mean assumes that E(U/X)=0.

(2) Same variance hypothesis: the influencing factors in U are not affected by the changes of the two main influencing factors, Var(ζ/X) = σ2.

(3) No multicollinearity: There is no multicollinearity between the two main influencing factors.

5 Empirical analysis

5.1 Parameter estimation of the model

Based on the collected economic data and the establishment of an economic model, scatter plots were generated using Stata software to depict the relationships between regional economic development and two key factors: R&D expenditure (Figure 1) and employment figures (Figure 2). These scatter plots reveal a positive correlation between regional economic development and both R&D expenditure and employment figures. The observed relationships in the scatter plots align with theoretical expectations and carry significant economic implications.

Based on the gathered economic data and the development of the economic model, a multivariate linear regression analysis was
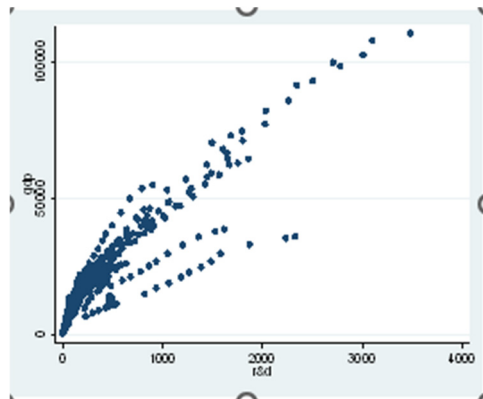

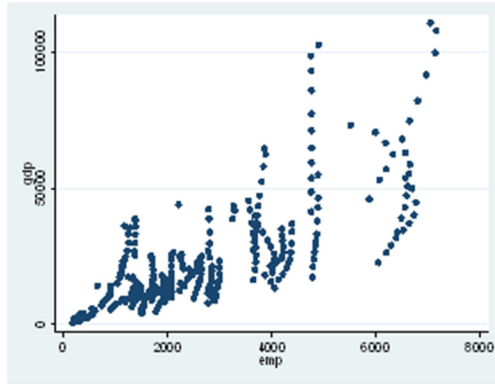**Fig. 1.** Scatter plot of GDP and R&D in 31 provinces/cities over a decade.

Fig. 2. Scatter plot of GDP and Employment in 31 provinces/cities over a decade.

Performed using Stata software to compute the parameter estimates of the regression equation. The findings are as follows((Figure 3):

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. regress gdp rd emp

      Source |       SS           df       MS        Number of obs   =       341
-------------+----------------------------------     F(2, 338)       =    2801.47
       Model |  1.3070e+11         2   6.5351e+10     Prob > F        =     0.0000
    Residual |  7.8847e+09       338   23327371.2     R-squared       =     0.9431
-------------+----------------------------------     Adj R-squared   =     0.9428
       Total |  1.3859e+11       340   407606764     Root MSE        =     4829.8


         gdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rd |   23.62976   .5279639    44.76   0.000     22.59125    24.66826
         emp |   4.448817   .1748377    25.45   0.000      4.10491    4.792724
       _cons |   33.17848   463.7767     0.07   0.943    -879.0737    945.4307
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Fig. 3. Regression results of GDP, R&D expenditure

Based on the statistical analysis, the parameter estimates are as follows:
β0 = 33.18
β1 = 23.63
β2 = 4.45

Therefore, the sample regression equation (Equation 2) can be written as:

$$Y_{it}=33.18+23.63X1_{it}+4.45x2_{it} \tag{2}$$

Based on the aforementioned econometric equation, it can be inferred that $\beta 1 > 0$, implying a positive relationship between R&D expenditure and GDP. This aligns with economic intuition, as an increase in R&D investment tends to stimulate economic growth and enhance productivity. Furthermore, the parameter estimate $\beta 2 > 0$ indicates a positive association between employment figures and GDP. This signifies that a growing labor force contributes to economic expansion and development, as higher employment levels often lead to increased consumer spending and production activities.

Hence, the established econometric equation demonstrates both theoretical and empirical coherence, with the selected explanatory variables deemed appropriate for analyzing the factors influencing regional economic development.

5.2   Model statistical test

(1)Goodness-of-fit test:.

Based on the regression findings, the presentation of the fitted curve reveals a discernible positive correlation among GDP levels, R&D expenditures(Figure 4), and labor force outlays (represented by employment figures)(Figure 5).Notably, within the context of the Stata analysis, the calculated adjusted coefficient of determination (R-squared) value, which stands at 0.9428, attests to the model's robust explanatory power, as evidenced by its convergence towards unity. This near-unity coefficient, substantiated by empirical testing, lends considerable credence to the assertion that variations in GDP are indeed contingent upon the extent of R&D financial allocation as well as labor force commitments. This analysis thereby underscores the methodological soundness underpinning the formulation of the econometric framework.
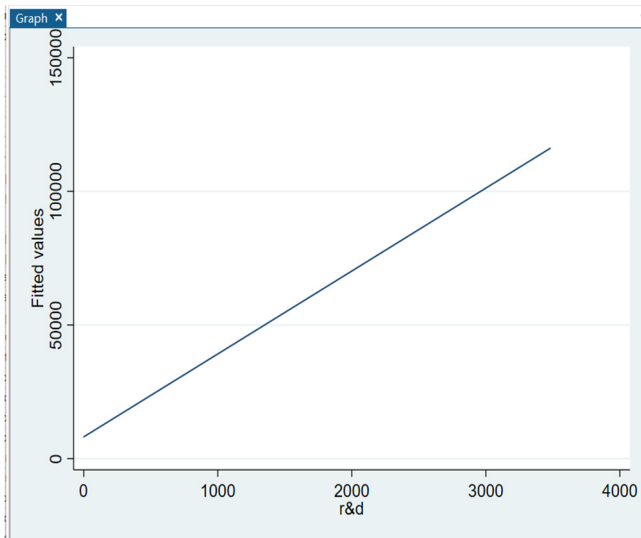

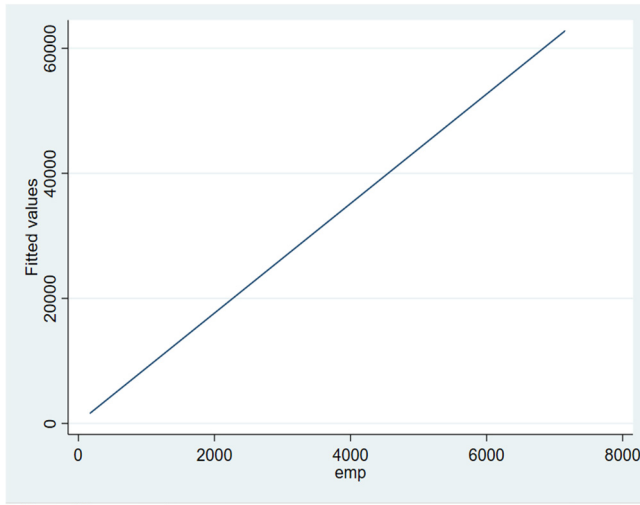**Fig. 4.** Fitting results of GDP and R&D expenditure levels.

Fig. 5. Fitting results of GDP and employment number

(2)F-statistic test:.

The computed F-statistic value is 2801.47 based on the regression analysis. Under the given significance level of $\alpha = 0.05$, the critical F-value $F_{0.05}(2, 338) = 3.022$ (where the number of explanatory variables is 2 and the sample size is 28). A comparison between the calculated F-statistic and the critical value reveals that the obtained F-statistic significantly surpasses the critical value of 3.022. Thus, at a 95% confidence level, the model's linear relationship is deemed statistically significant, indicating that the joint effects of R&D expenditure and employment figures have a substantial impact on the GDP.

(3)Statistical test:.

The t-statistic for variable X1 is calculated as 44.76, and the t-statistic for variable X2 is calculated as 25.45. Referring to the t-distribution table at a significance level of $\alpha = 0.05$, the critical t-value is determined as $T_{0.025}(338) = 1.9670$. Upon comparison, both t-statistics for X1 and X2 are found to be greater than the critical value, indicating that the explanatory variables exhibit significant effects on the dependent variable at a 95% confidence level. Consequently, it can be concluded that both R&D expenditure and employment levels exert statistically significant influences on GDP.

Furthermore, considering the regression results, the probability associated with the t-statistic for both X1 and X2, commonly referred to as the p-value, is found to be less than the predetermined significance level $\alpha = 0.05$. Thus, the null hypothesis H0: $\beta_1 = \beta_2 = 0$ is rejected, providing additional evidence that both R&D expenditure and employment levels have statistically significant impacts on GDP.

6   Conclusion

6.1   Perspective of Technological Investment

In order to foster regional economic development, a collaborative effort from both the government and enterprises is crucial. It is imperative for the government and businesses to increase their investment in research and development (R&D) and enhance their technological innovation capabilities. This entails augmenting R&D funding, establishing research institutions and laboratories, cultivating scientific research talent, and incentivizing enterprises to allocate more resources towards R&D activities. By intensifying technological investment, the output of innovation can be enhanced, thereby propelling the advancement of regional economic growth. Simultaneously, the government can establish technology innovation platforms, providing the necessary research and development facilities and resource support, which serve as collaborative spaces for enterprises and research institutions to foster cooperation, exchange ideas, and accelerate the conversion and application of scientific and technological achievements. Furthermore, policy measures such as tax incentives and financial subsidies can be implemented to encourage enterprises to bolster their investments in technological innovation. For instance, policies offering pre-tax deductions for R&D expenses, establishing innovation funds, and providing support for venture capital investments. These measures serve to stimulate enterprises to increase their commitment to technological innovation, thereby driving regional economic development[6]. Strengthening technological investment also necessitates a focus on technology transfer and the cultivation of scientific and technological talents. Establishing technology transfer institutions facilitates the effective conversion of research outcomes into tangible productivity by offering support in technology transfer, patent applications, market promotion, and licensing agreements. Additionally, relevant policies supporting education, training, and talent attraction in the field of technology should be implemented to foster a skilled workforce capable of driving innovation and contributing to regional economic progress[7].

6.2   Perspective of Labor Expenditure

Labor expenditure plays a crucial role in promoting employment, serving as the essential cost that businesses incur to hire employees. It serves as a primary driver for expanding employment opportunities. When companies plan to increase production scale or expand their operations, they typically need to augment their workforce, consequently fostering the growth of employment opportunities.Furthermore, labor expenditure has a direct and significant impact on the employment situation. In the context of a thriving economy and increasing market demands, companies are inclined to raise employee salaries, offer attractive benefits and incentive plans to attract exceptional talents and retain existing staff, thus elevating the employment rate.Indeed, augmenting labor expenditure not only serves as a means to drive employment growth but is also subject to a reciprocal influence on the employment rate. The achievement of high-

quality employment in a region contributes to enhancing the overall competitiveness and development level of the entire economy[8].

To facilitate rapid regional economic development, governments and educational institutions can intensify investments in cultivating and educating innovative talents. These talents can play a crucial role in innovative enterprises or entrepreneurial domains, driving innovative development and providing more employment opportunities for the regional economy. Additionally, providing support and policy incentives for the development of innovative enterprises, such as tax reductions, fiscal subsidies, and financing support, can lower operational costs and alleviate financing challenges, thus promoting their robust growth.Finally, through implementing measures like skill training, career transition guidance, and employment subsidies, efforts can be made to empower the workforce to undergo transformation and reemployment, thereby achieving a positive interaction between innovative development and employment. These measures effectively facilitate the sustainable development of the regional economy. These endeavors will grant the regional economy a broader development prospect, leading to economic structural optimization and comprehensive prosperity[8].

In conclusion, innovative development stands as a pivotal element in realizing the long-term and sustainable growth of regional economies. By intensifying investments in innovation, fostering a conducive environment for cultivating innovative talents, and actively promoting entrepreneurial endeavors, the region's innovative capacity can be significantly elevated. Consequently, this impetus engenders an augmented labor force expenditure, culminating in the generation of a multitude of employment opportunities. As a result, a dynamic cycle is set in motion, propelling the region's economic prosperity and facilitating a profound transformational evolution.

Acknowledgment

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