Study on the Influence Mechanism of Technological Innovation Education Policy on Regional Economic Growth

Comprehensive Application of Cognitive Framework and Panel Measurement Method

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ABSTRACT
Under the background of global knowledge economy transformation and innovation-driven development strategy, it is of great significance to deeply explore the internal mechanism of technological innovation education policy driving regional economic growth. In order to solve the problem that the existing literature is separated from each other in theoretical mechanism interpretation and econometric logic design, this paper is committed to building a comprehensive analysis system that integrates cognitive framework and panel econometric methods. Based on endogenous growth theory and institutional economics, this paper systematically analyzes the coupling mechanism between human capital accumulation and technology spillover under policy intervention. Focus on the design of variable measurement scheme and model identification strategy based on panel data to solve potential endogenous errors. Policy effect presents nonlinear threshold characteristics in different development stages, and forms multiple intermediary transmission paths through the upgrading of industrial structure and knowledge diffusion. This paper clarifies the complete logical chain from micro-cognitive change to macro-performance output, provides scientific methodological reference and theoretical basis for the optimal allocation and differentiated management of regional innovation education policies, and realizes the effective connection from qualitative mechanism analysis to quantitative modeling logic.

Keywords: *Technological innovation, Regional economic growth, Conduction mechanism, Cognitive framework, Panel measurement method.*

1. INTRODUCTION

At present, the global economy is undergoing a profound transformation from factor-driven to innovation-driven, and technological innovation has become the core engine of regional economic growth. Under this macro background, education is no longer only the embodiment of social welfare, but also the infrastructure of human capital accumulation in the national innovation system [1]. Governments all over the world have introduced educational policies oriented to technological innovation, trying to release the regional development potential by optimizing the talent structure and strengthening the integration of Industry-University-Research. However, through what internal mechanism do these policies affect the regional economy? Does its effect have nonlinear characteristics or spatial spillover effect? Existing academic discussions often fall into the binary opposition of "emphasizing empirical data and neglecting theoretical mechanism" or "emphasizing normative analysis and lightweight verification" [2-3]. Many studies only stay in the simple description of input-output correlation, fail to reveal the path of micro-subject behavior change under policy intervention, and lack the standardized design of verification mechanism, which leads to the "black box" problem in policy effect evaluation [4].

This paper is devoted to constructing a comprehensive analysis system that integrates cognitive framework and panel measurement method logic. This paper focuses on the design of econometric identification strategy based on panel data, demonstrates the necessity of introducing dynamic lag term to capture the long-term policy lag, and expounds how to use instrumental variables to solve potential endogenous problems and how to control unobservable regional heterogeneity through fixed effect model. The study emphasizes the mapping process from micro-cognition to macro-performance, ensuring the rigor of logical chain at the methodological level. It is expected that through the double examination of this theory and method, this study will provide a new theoretical perspective for understanding the deep relationship between education and economic growth, and provide a reference for formulating differentiated and accurate regional innovative education policies.

2. THE CONSTRUCTION OF COGNITIVE FRAMEWORK FROM MULTI-DIMENSIONAL PERSPECTIVE

2.1 Endogenous Adaptation of Economic Growth Theory

Compared with the neoclassical growth model, which regards technological progress as exogenous, endogenous growth theory profoundly reveals the key role of human capital accumulation and knowledge spillover [5]. Based on this, this paper argues that the education policy of technological innovation is not only the supply side of human resources, but also the endogenous driving force for the improvement of TFP. This theoretical perspective defines the core position of education policy in breaking the law of diminishing marginal income and stimulating the long-term growth potential of the region.

2.2 The Institutional Economics Logic of Policy Intervention

Technological innovation involves high cost of information search and contract execution, and the education policy effectively reduces the institutional friction in innovation activities through standardization talent training and Industry-University-Research platform construction. In view of the quasi-public property of education, policy guidance can correct market failure, realize the internalization and regional sharing of innovation dividends, and optimize the efficiency of resource allocation.

2.3 The Conduction Path of "Cognition-behavior-result"

Construct a logical chain connecting micro-subjects and macro-economy. The policy signal first reshapes the innovation cognition and risk preference of individuals and enterprises, and drives R&D behavior to gather in high value-added fields; then, through the industrial correlation effect, it promotes the advanced transformation of regional industrial structure [6]. This framework system explains the complete mechanism from "policy input" to "cognitive change" and finally "economic output".

3. ANALYSIS OF NONLINEAR PATH AND INTERMEDIARY EFFECT

The influence mechanism of technological innovation education policy on regional economic growth is obviously complex and systematic. Its transmission process is not a single-dimensional linear response, but involves a multi-agent and multi-level dynamic feedback mechanism. From the micro-basis, the direct effect is mainly reflected in the substantial appreciation of human capital [7]. The implementation of education policy can significantly improve the professional skills and innovative literacy of the labor force in the region, and then enhance the absorption capacity of enterprises for advanced technology. This process of transforming human capital into economic output is restricted by the initial regional knowledge stock. Only when the accumulation of human capital breaks through a certain critical value can it effectively trigger the expansion of technological boundaries, otherwise it may face the risk of idle resources or inefficient transformation.

From the perspective of meso-industry, indirect effects constitute an important intermediary channel for economic growth. The gathering of high-quality educational resources will guide social capital to gather in high-tech industries, promote the technological transformation and digital transformation of traditional industries, and thus realize the advanced industrial structure. In this paper, a specific theoretical mechanism conduction path analysis table is designed (as shown in "Table 1").

Table 1. Theoretical Transmission Path Matrix of the Impact of Technological Innovation Education Policies

Transmission Path	Core Intermediary Variable	Functional Logic	Expected Nonlinear Characteristics
Talent Supply Path	Proportion of High-Skilled Labor Force	Reduces the cost of factor mismatch and enhances labor efficiency	There exists a minimum scale threshold; no effect below the threshold
Industrial Synergy Path	Value-Added Ratio of High-Tech Industries	Promotes coupling between upstream and downstream of the industrial chain and optimizes resource allocation	Inverted U-shaped convergence relationship; excessive transformation may lead to exhaustion
Knowledge Spillover Path	Regional Patent Application Density	Accelerates the explicitness of tacit knowledge and reduces marginal R&D costs	Diminishing marginal returns interval; requires combination with external introduction
Institutional Guarantee Path	Stability of Industry-University-Research Cooperation Contracts	Reduces transaction costs and protects the property rights of innovation achievements	Stepwise leap; depends on the overall improvement of the institutional environment

The threshold effect from the macro perspective cannot be ignored as well as regional heterogeneity, which is the key dimension to understand the difference of policy effects. The effectiveness of technological innovation education policy depends on the specific economic development stage and environmental conditions, which means that the policy effect is asymmetric in different regions [8]. In underdeveloped areas, the economic transformation rate of education policy may be low because of the weak supporting infrastructure and the underdeveloped financial market. In developed areas, perfect innovation ecology can further amplify the positive spillover effect of policies. At the same time, the spatial spillover effect of knowledge flow may lead to the differentiation of "center-periphery" pattern, and the siphon effect of adjacent areas may weaken the independence of local policies. Therefore, when constructing a cognitive framework, these nonlinear constraints must be taken into account, and the cumulative effect of policy with time lag and the attenuation with spatial diffusion must be recognized.

4. RECOGNITION STRATEGY AND MODEL CONSTRUCTION BASED ON PANEL DATA

Constructing a scientific and rigorous econometric analysis framework is a prerequisite to realize the verification of theoretical assumptions. The first core problem to be solved is how to transform abstract policy concepts into quantifiable theoretical indicators. For the explained variable regional economic output, we should not simply adopt the absolute value of GDP, but comprehensively consider the multi-dimensional index system such as per capita total factor productivity, and construct a weighted comprehensive score through principal component analysis to ensure the comprehensiveness and robustness of the measurement [9]. For the core explanatory variable, the policy intensity of technological innovation education, it is necessary to construct a policy intensity index including the proportion of special investment in education, the scale of Industry-University-Research cooperation fund and the number of innovative talents training projects. The design of control variable system must cover the key factors that may interfere with the estimation of policy effect.

In the logical framework of panel model setting, the choice of static panel regression and dynamic panel model depends on the theoretical judgment of policy lag effect. In view of the obvious long-term accumulation characteristics of the income realization of education investment, the accumulation process of policy effects cannot be fully captured by simply using the current lag term, so this paper tends to introduce the first or second lag dependent variable as the basic setting of the dynamic panel. According to the theoretical logic of houseman test, if individual heterogeneity is related to explanatory variables, fixed effect model should be adopted to eliminate the interference of unobservable regional characteristics; on the contrary, random effect model can be used to

improve the estimation efficiency. On this basis, in order to solve the potential reverse causality and endogenous problems, this study designed the implementation scheme of instrumental variable method. The penetration rate of historical higher education and geographical location characteristics in various regions are selected as exogenous instrumental variables, which satisfy exclusive constraints. They affect the current investment in education but theoretically do not directly affect the residual of current economic growth. At the same time, meeting the relevant requirements is significantly related to the policy intensity. Considering that the panel data may have sequence correlation and cross-section dependence, the generalized moment estimation method provides a better estimation framework. It can effectively deal with the endogenous and measurement errors in dynamic panels, especially when the sample period is short and the number of variables is large, showing good statistical properties. As shown in Figure 1, the system shows a complete theoretical chain from variable measurement to model identification to robustness test.

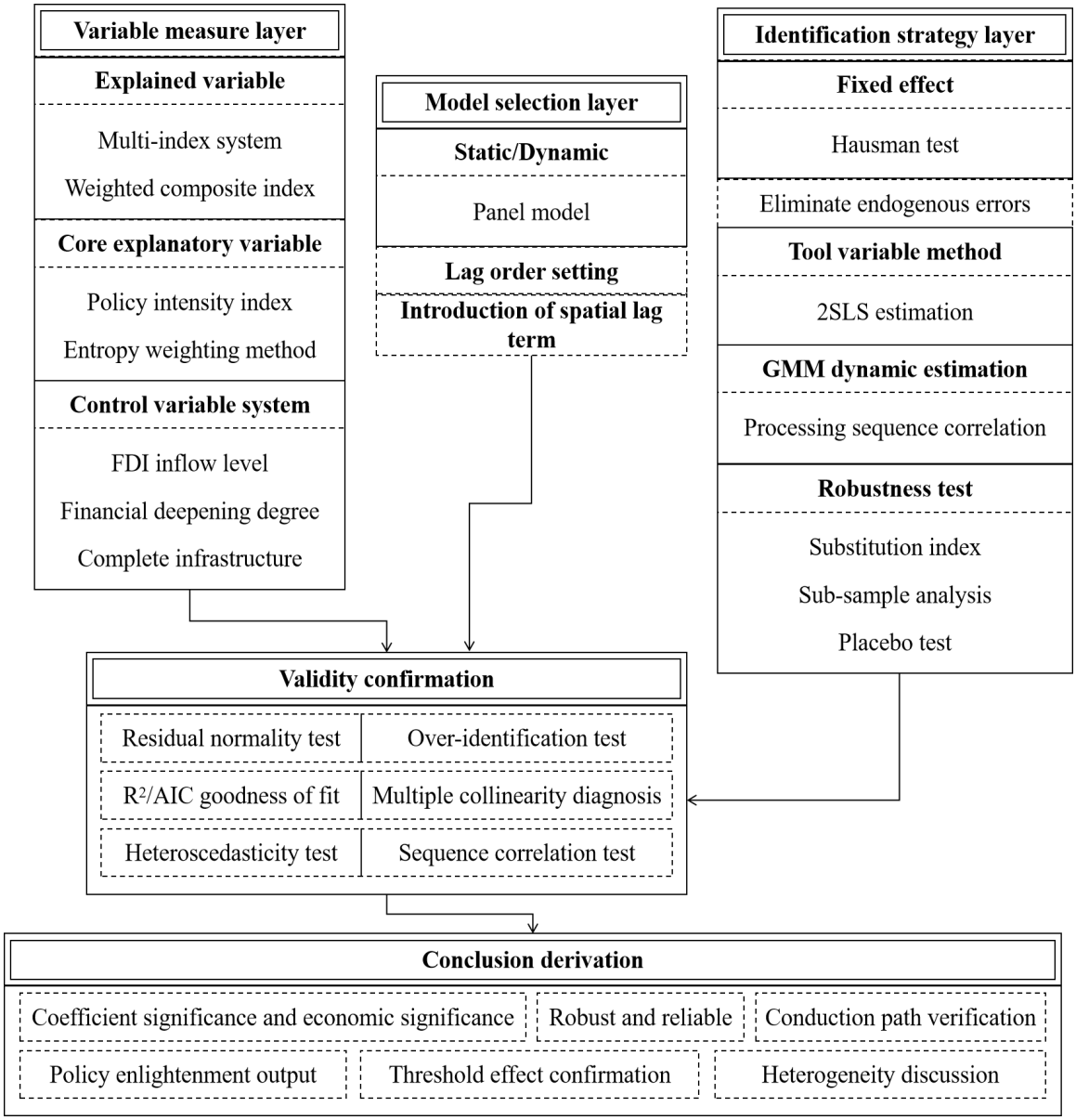


Figure 1 Process architecture of theoretical identification strategy based on panel data.

5. OPTIMIZATION PATH BASED ON THEORETICAL DEDUCTION

5.1 The Implementation of Differentiated Resource Allocation Strategy

According to the deduction of threshold effect, the marginal benefit of education policy has significant heterogeneity. The government should abandon the "one-size-fits-all" resource allocation model and set a differentiated input threshold according to the level of regional economic development. In underdeveloped areas, we should focus on consolidating the hardware facilities of basic education and vocational skills training and break through the initial threshold of human capital accumulation. In developed areas, we should focus on the cultivation of graduate students' innovative literacy and frontier interdisciplinary subjects to match the demand of high-end industries for high-intelligence elements. This classification guidance is helpful to overcome nonlinear constraints and improve the efficiency of resource use.

5.2 Building a Cross-regional Collaborative Linkage Mechanism

In view of the spatial imbalance of knowledge spillover, it is necessary to break the administrative division barrier. Theoretically, it is difficult to maximize the spillover effect by relying solely on local investment, so it is suggested to establish an education-innovation community across provinces and cities. By building training bases and sharing laboratories together, we can promote the optimal allocation of talents and technology in a wider range, avoid the imbalance of regional development caused by siphon effect, realize Pareto improvement of the overall economy, and give play to the positive externalities of spatial coupling.

5.3 Establishing a Dynamic Monitoring and Feedback System

In view of the long-term lag of policy effect, a long-term tracking mechanism must be established. Policymakers should pay attention to the lag effect rather than short-term fluctuation, and adjust the rhythm of fiscal expenditure according to the conduction cycle identified by the model to ensure the continuity and stability of education investment. Only through scientific dynamic evaluation and feedback can we maximize the long-term driving force of technological innovation education policy to regional economic growth and realize the accurate docking of theory and policy.

6. CONCLUSION

This study closely follows the main line of the relationship between technological innovation education policy and regional economic growth, and successfully constructs a comprehensive analysis system that integrates theoretical cognitive framework and econometric logic. It provides a new theoretical perspective for understanding the complex interaction between them. The driving effect of education policy on economy does not occur directly, but depends on the transmission of multiple intermediary mechanisms such as human capital appreciation, industrial structure upgrading and knowledge space spillover. This process shows significant stage threshold characteristics and asymmetric regional heterogeneity. This means that the release of policy effectiveness is highly dependent on specific initial conditions and development environment, and simple scale expansion is difficult to ensure the achievement of expected goals. In the contribution of methodology, this paper systematically plans the variable measurement standard and model identification strategy based on panel data, and provides operational ideas in index weighting and weighting. This paper demonstrates in detail the theoretical necessity of introducing dynamic lag term to capture investment lag effect, using instrumental variable method to overcome endogenous deviation and using generalized moment estimation to deal with sequence-related problems.

Based on deduction, policy makers should fully realize the nonlinear law of educational resources allocation and abandon the "one size fits all" administrative instructions and implement accurate differentiation strategies. Developed regions focus on the training of cutting-edge innovative talents, while underdeveloped regions give priority to breaking through the critical threshold of basic skills education in order to improve the efficiency of dividend release. This paper makes up for the lack of existing research in the mechanism black box through deep theoretical excavation and logical framework weaving, emphasizes the cornerstone role of theoretical model in policy evaluation first, and provides forward-looking theoretical support and decision-making reference for promoting the high-quality development of regional economy.

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