The nonlinear influence of education development on high economic quality in the Beijing-Tianjin-Hebei region

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Abstract. In this paper, we use panel data of 13 cities in the Beijing-Tianjin-Hebei region from 2012 to 2020 to analyses the economic level development adopting the entropy method, and then by a Tobit panel regression model to analyze the impact of education on the development of economic quality. It turns out that: (1) Relationship between education level and economic quality development in the Beijing-Tianjin-Hebei area is an inverted "U" shaped; (2) the overall distribution present a trend of rapid development of education and faster economic quality development in the Beijing-Tianjin region and slower development in the Hebei district; (3) finally, on the basis of the measured relationship between education and economic quality development , from the outcome of the modulation variables, the horizontal of transportation, the level of Internet advancement, the level of manufacturing employment on the level of economic mass development in the Beijing-Tianjin-Hebei region play a role in promoting. In view of the above, practical suggestions put forward to optimize the allocation of educational resources in the Beijing-Tianjin-Hebei region and to boost harmonized high-quality economic development.

Keywords: Beijing-Tianjin-Hebei, Economic quality, Education, Entropy Method, Tobit.

1. Introduction

Since the 18th Party Congress, our Party has further deepened its understanding of the regularity of economic development, and clearly put forward the important assertion that "China's economy has shifted from the stage of high-speed growth to the stage of high-quality development", and the Decision of the Fourth Plenary Session of the 19th Party Congress pointed out that "adhering to and improving the basic socialist economic system, promoting high-quality economic development". As a social activity to cultivate people, the knowledge and skills brought by education play a vital role in the cultivation of innovation ability. The high-quality talents cultivated by education will certainly have a cutting-edge research effect on the realization of social fairness and efficiency and green and innovative development. In this context, education level, as an important factor to enable regional development benefits, especially its contribution to scientific and technological innovation progress, has become increasingly obvious. Beijing-tianjin-hebei city cluster, as the capital city circle of China, is not only an important pole to drive China's economic growth, but also an important growth level for the development of urban clusters in the world. In view of this, this paper attempts to explore the impact of education level on high-quality economic development in the Beijing-Tianjin-Hebei region.

Education is the foundation of a strong country and the foundation of a nation. General Secretary Xi Jinping attaches great importance to the development of education, and in the report of the 20th Party Congress, he emphasized that "we should adhere to the priority development of education" and "accelerate the construction of a strong education country" and "run a good education to the satisfaction of the people". In some literature, scholars analyze the inextricable link between education and personal development, Zhao Wenlong and Dai Hongjuan [1] mention the mechanism of the role of education level and urban residents' happiness, and conclude that educational activities can achieve both material and spiritual rewards for individuals. When it comes to its relationship with

the economy, domestic and foreign scholars have conducted extensive and in-depth studies on the impact of education level on economic growth, and have achieved rich research results. From foreign studies, as early as the middle of the 20th century Schultz et al [2]. concluded in the context of the miraculous recovery of Germany and Japan from severe destruction after World War II that the high recovery rate was due to a healthy and well-educated population, that education promotes productivity, and that making investments in education can promote economic growth, Lucas, Romer et al [3] concluded that education is a source of human capital formation From the viewpoint of domestic scholars, Liu Hongwen [4] studied the interaction between education development and economic growth in China, thus concluding that economic growth can promote education development, and education development can in turn promote economic growth; Wang Dihai et al [5] concluded that without considering the effect of the allocation structure of human capital between the public and private sectors , the increase of education level has a significant effect on economic growth.

As our economic development has entered a new era, we must put our development foothold on promoting high-quality development. Since the concept of high-quality economic development is popular late in our country, many researches in practice are still in their infancy. The current economic high-quality development faces difficulties and challenges, and it is a long way to break through the predicament of growth economic quality. In order to effectively improve the level of economic quality development, many scholars have devoted themselves to studying the factors influencing the level of economic quality development. Ziyan Wang et al [6] concluded that a high degree of digital economy is conducive to improving the level of economic quality development; Yanyan Ren et al [7] concluded that scientific and reasonable environmental regulations play a significant positive influence role in economic quality development and other important conclusions. At the same time, there are many literatures on the measurement indicators and systems of the high quality economic development level of urban agglomeration, but there are few literatures on the impact of the development of education level on the high quality economic development of the Beijing-Tianjin-Hebei region. Therefore, this paper will study the relationship between education level and economic high quality development, and use the entropy value method to construct the economic high quality development index of Beijing-Tianjin-Hebei region. In order to explore the influence of education level on high quality development in Beijing-Tianjin-Hebei region, Tobit model is established for analyzing

2. Formula

2.1. Tobit formula

Tobit regression analysis was first proposed by Tobin as a regression model with restricted dependent variable, which can solve the problem of model construction with restricted or truncated dependent variable, and is used when the dependent variable is cut or fragmented, because when the dependent variable is partially continuously distributed or partially discrete distributed data, estimating the parameters of Tobit model using ordinary least squares (OLS) is biased, so The maximum likelihood estimation (MLE) method was used to estimate the model parameters.

The regression model takes the following form.

$$Y = \begin{cases} Y^* = \alpha + \beta X + \varepsilon & Y^* > 0 \\ Y^* > 0 & Y^* \le 0 \end{cases} \tag{1}$$

Where Y is the vector of truncated dependent variables; X is the vector of independent variables; α is the vector of intercept terms; β is the vector of regression parameters; ε is the perturbation term, ε~N(0,σ).

2.2. Entropy value method

In order to more objectively reflect the weights of the indicators related to the education level and high-quality economic development of the Beijing-Tianjin-Hebei city cluster, this paper adopts the entropy value method to exclude other artificial factors, the influence of the weights on the panel data containing years, cities and indicators to objectively assign the weights of each indicator, so as to obtain the comprehensive score of each city, the specific steps are as follows.

Indicator Selection:

With r years, n cities, and m indicators, $X_{\theta ij}$ denotes the value of the θth year, the i-th prefecture-level city, and the j-th indicator.

Standardization of indicators:

Since different metrics have different scales and units, they need to be standardized.

Positive indicators (larger values are better) are standardized.

$$X'_{\theta ij} = \frac{X_{\theta ij} - X_{\min}}{X_{\max} - X_{\min}} \tag{2}$$

Negative indicators (the smaller the value the better) are standardized.

$$X'_{\theta ij} = \frac{X_{\max} - X_{\theta ij}}{X_{\max} - X_{\min}} \tag{3}$$

Where, $X_{\max}$ and $X_{\min}$ denote the maximum and minimum values of the jth indicator in the rth year of the i city. After normalization, the value of $X'_{\theta ij}$ is in the range of [0,1], which indicates the relative size of $X'_{\theta ij}$ in r years in n cities.

Non-negative translations.

$$X'_{\theta ij} = X'_{\theta ij} + 0.001 \tag{4}$$

Calculation weights.

$$Y_{\theta ij} = X'_{\theta ij} / \sum_{\theta}^{r} \sum_{i}^{n} X'_{\theta ij} \tag{5}$$

Calculate the entropy value.

$$S_j = -k \sum_{\theta}^{r} \sum_{i}^{n} \left(Y_{\theta ij} \ln \left(Y_{\theta ij} \right) \right), k = 1 / \ln \left(rn \right) \tag{6}$$

Calculating the coefficient of variation

Coefficient of variation of the jth indicator.

$$E_j = 1 - S_j \tag{7}$$

Calculate the weight of the jth indicator.

$$W_j = E_j / \sum_j^m E_j \tag{8}$$

Calculate the product of the composite score indicator weights and the standardized indicator values under each year for each city.

$$H_{\theta i} = \sum_j^m \left(W_j \left(X'_{\theta ij} \right)^T \right) \tag{9}$$

2.3. Variable descriptions

2.3.1. Explained variables

This paper designs the index system of High quality level of economy in beijing-tianjin-hebei region, referring to the research methods of Qu Xiao'e and Liu Liu et al [8] and Cheng Xiang et al [9], and the degree of economic development in five directions of China's economic development: innovation, coordination, green, openness and sharing. It includes 17 basic indicators in 5 dimensions, as shown in Table 1. After establishing the above evaluation system, this paper further refers to the calculation method of Feng Xinghua [10] and others, and uses the entropy method to assign weights to the following indicators. The dispersion degree of the indicators is increasing with the increasing entropy value, i.e., the size of the weight value is positively correlated with the influence of the corresponding indicators on the evaluation system score. In this paper, based on the measurement method of entropy value method, the results of economic quality development index of Beijing, Tianjin and Hebei region including 13 cities of Beijing and Tianjin are measured.

Table 1. Economic high quality indicator system

Indicator System	Tier 1 Indicators	Secondary indicators	Secondary Indicator Metrics	Properties
Economic quality	Innovation	Science and technology expenditures	Science and technology expenditure as a proportion of local fiscal expenditure	+
		Number of R&D staff	Scientific Research Technicians	+
		R&D innovation intensity	Green utility models as a percentage of the total number of utility models obtained in the region in a year	+
	Coordination	Industrial structure optimization	Share of tertiary sector in GDP	+
		Financial Structure	Financial institutions deposit and loan balances as a percentage of GDP	+
		Urban and Rural Structure	Urban construction land as a proportion of urban area	+
		Employment Level	Registration of the unemployed at the end of the year	+
	Green	Ecological Environment Level	Industrial wastewater discharge	-
			Industrial sulfur dioxide emissions	-
			Greening coverage of built-up areas	+
		Green Development Level	Harmless disposal rate of domestic waste	+
	Open	Open to the public	Actual amount of foreign capital used in the year	+
		Open to the internal	Total retail sales of social consumer goods	+
	Share	Medical Facilities	Number of beds in hospitals and health centers	+
		Infrastructure	City maintenance and construction funds expenditure	+
		Social Security	Number of urban workers' basic pension insurance participants	+
		Cultural and educational facilities	Total Public Library Book Collection	+

2.3.2. Explanatory variables

Education level:Referring to relevant studies, the evaluation system of education level refers to the level of resource allocation layout within the education system in terms of teachers, financial resources, and materials. In this paper, the financial education expenditure of 13 municipal governments in Beijing-Tianjin-Hebei region is used as the explanatory variable, which in turn responds to the development level of education level in the region.

2.3.3. Control variables

With reference to the existing studies, this paper controls a series of relevant city characteristic level variables in the Tobit regression model, so as to reduce the bias of the variables and further improve the accuracy of the model results, which are: ①The level of transport development is expressed by summing up the actual number of buses (electric) and taxis in operation at the end of the year. ②the development level of green patents (UGRMGRT) indicates that the number of green utility models in the current year accounted for the percentage of the total number of utility models in the current year. ③Internet development level (Idl), expressed by the numerical value of the number of international Internet users in the region. ④the level of urban manufacturing employment (Mel), expressed by the numerical value of manufacturing employees.

2.4. Data sources

Based on the data of prefecture-level cities from 2012 to 2020, this paper studies the impact of education level on local high-quality economic development level in beijing-tianjin-hebei region.The relevant data in this paper are obtained from China City Statistical Yearbook, Hebei Statistical Yearbook, China Green Patent Statistical Report (2012-2020), and the relevant missing values are completed by China Economic and Social Data Research Platform.

3. Results

3.1. Regression results

Table 2 Regression results of education level in Beijing, Tianjin and Hebei on high quality economic development.

Table 2. Tobit regression result

ED	Tobit			
	(1)	(2)	(3)	(4)
El	0.2719**	0.5508***	0.5476**	0.7821***
	(0.1376)	(0.1556)	(0.2346)	(0.1703)
El^2	-0.1597*	-0.2765***	-0.2248*	-0.2115*
	(0.0918)	(0.0978)	(0.1344)	(0.1078)
Ptb		0.4906***		0.2050*
		(0.1113)		(0.1167)
Ugrmgrt		0.0094		-0.0827
		(0.1504)		(0.1635)
Idl		0.0009**		0.0020***
		(0.0004)		(0.0005)
Mel		-0.0914***		-0.2087***
		(0.0353)		(0.0274)
sigma_u	0.1887***	0.0542***	0.1400***	0.0504***
	(0.0396)	(0.0133)	(0.0384)	(0.0121)
sigma_e	0.0325***	0.0336***	0.0358***	0.0314***
	(0.0022)	(0.0024)	(0.0030)	(0.0026)
LR	136.69***	51.52***	52.67***	37.14***

Table 2 shows the results of the Tobit regression with a positive Jingjinji of education level and a negative square of education level in a model with a high-quality level of economic development as the explanatory variable, this shows that higher education contributes significantly to high-quality economic development in Jingjinji areas. However, with the further increase of education expenditure, the influence of education in economic development is gradually diminishing.

Through regression analysis of the control variables in the model, it was found that the level of transportation, the level of the Internet and the level of employment in the manufacturing industry played an important role in raising the level of economic quality and development in the Jingjinji regions, this further demonstrates that the continuous improvement of urban infrastructure, the rapid rise of the mobile internet industry and continuous progress in the domestic manufacturing industry play an important role in the development of economic quality in the Jingjinji regions.

In the level of traffic development, the developed and convenient urban transportatIn the level of traffic development, the developed and convenient urban transportation is the basic premise of creating a good business environment, trade environment, since China's reform and opening up, with the rapid development of the country's economy, in the process of industrialization and modernization on the road of development, a regional transportation industry is the cornerstone and bridge of regional economic development, therefore, the improvement of the level of transportation is an important prerequisite for the development of economy, and and play an important role at domestic and around the world. It plays a significant role in the economic development of the region.On the level of the Internet, with the rapid rise of the mobile Internet industry, it has greatly promoted the transaction efficiency of the Beijing-Tianjin-Hebei region. Compared with the traditional business model, the new e-commerce platform can quickly and accurately understand the sales situation of merchants and the supply and demand information with customers, and the rapid development of the Internet can fully promote the circulation efficiency of information flow and capital flow, which greatly promotes economic development and enhances Economic resilience and development momentum.

The employment level of manufacturing industry indirectly reflects the development level of manufacturing industry in the region. As an important part of the national economy, manufacturing industry not only provides a large number of employment opportunities for the talent market, but also is the basis of national economic activities. On the other hand, the development of manufacturing industry in a region further improves the economic level of the region, shortens the trade gap in international trade, and further improves the consumption level of consumers.

The regressive effect of the level of green patent development on Jingjinji high-quality economic development is not significant. This may be related to the low return on investment of green patents, indicating that the utilization rate of Jingjinji Green patents is low, high rate of return on investment is low, the promotion of high-quality economic development from the overall point of view is not obvious.

3.2. Robustness test

In this paper, the robustness analysis is conducted by shortening the time scale to 2014-2020, and the results are shown in model (3) and model (4) in Table 2, and the regression results do not change much in terms of positivity, negativity and significance, so the results are robust.

4. Conclusion

This paper takes the panel data of 13 urban areas in the Beijing-Tianjin-Hebei district from 2012 to 2020 as sample, this study adopted the entropy manner to calculate the index coefficients of economic quality development in 13 cities and analyze the nexus between education level and economic mass advancement employing the Tobit panel regression model.

Education expenditure has a important "inverted U" influence on the economic quality development of the Beijing-Tianjin-Hebei region, indicating that as education expenditure increases the economic

quality development of the Beijing-Tianjin-Hebei area accelerates, which has a significant positive effect on the economic quality advancement, and after reaching the peak, the economic quality development starts to decline, which has a prominent bad effect on the education expenditure. After reaching a peak, the economic high quality development starts to decline, then education expenditure has a important negative effect on the economic high mass development. From the control variables, the standard of local transportation advancement, the level of Internet development and the standard of urban manufacturing employment play a significant role in boosting the economic high mass development of Beijing-Tianjin-Hebei area, while the regression outcome of the level of green patent development are not significant, indicating that the efficiency of the use of green patents in Beijing-Tianjin-Hebei region is low, with high investment and small returns, and therefore does not have a important influence in promoting the economic high quality advancement.

From the perspective of talent input. Therefore, Tianjin and Henan should introduce more education talents, implement corresponding policies, subsidies and preferences, reduce the overflow of education investment talents from Beijing, and guide the investment talents to the "Tianjin-Hebei" region, so as to reasonably optimize education talent resources.

In terms of financial expenditure, the government should increase financial support for the optimization of educational resources in remote areas to reduce the gap between the economic development of Beijing, Tianjin and Hebei regions and increase the space for remote economic advancement. The government should improve educational facilities in remote areas and expand shared resources for education.

The Beijing-Tianjin-Hebei district needs to adjust and optimize the structure of education levels. If you want to make long-term high-mass economic development, you ought to not just invest in education resources, but make a reasonable allocation of education resources. Education has a lagging effect on high quality economic advancement and there should not be too much focus on the current returns to education. The balance of educational resources in the Beijing-Tianjin-Hebei area should be coordinated to promote the accelerated advancement of economically underdeveloped areas and optimize the structure of educational resources, not only in one region alone, but also from several regions to boost the economic development of education in an integrated and comprehensive manner and to improve the efficient use of educational resources.

The article only focuses on the Beijing-Tianjin-Hebei area and the study has few relevant indicators, so this study is still inadequate, and further development of relevant research can consider increasing relevant indicators while starting from the quality development of education.

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