ISSN 2229-5518

IMPACT OF HIGHER EDUCATION AND TECHNOLOGY IN DEVELOPMENT OF ECONOMIC GROWTH IN CHINA

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Abstract: Education positively affects economic growth. The growth and progress of education increaseknowledge and information, which is reflected in improved factors of production. Education and technology increase human capacity to increase production and achieve high rates of economic growth. The theoretical analysis of the relationship between Chinese investments in higher education, technological innovation, and economic growth, selected data from China (1995–2018) were selected and the autoregressive vector (VAR) model was used between three. The results show that investment in education, technological innovation, and economic growth form a dynamic cycle of interaction. Investment in higher education and technological innovation are two important factors affecting economic growth. At the same time, investment in higher education is an important source and driving force for technological innovation, and technological innovation will contribute to further economic growth. However, technological innovations have a positive impact on economic growth, therefore, investment in higher education requires a long-term perspective, fast and successful thinking, and should avoid immediate benefits.

Keywords: economic growth; VAR model, autoregression, higher education, education input, technological innovation.

1. INTRODUCTION

Education and technology are fundamental to development and growth. The human mind makes possible all development achievements, from health advances and agricultural innovations to efficient public administration and private sector growth. ... And there is no better tool for doing so than education. For a long time, exploring the relationship between educational contribution and economic growth is a recurring theme in the theoretical world, often generating new ideas. Classical economic theory holds that a country's economic growth depends mainly on capital growth, employment growth, human capital growth, and technological progress, while higher education is an important way to increase human capital. It is believed that higher education and economic development interact and promote each other. Therefore, it effectively increases economic growth. On the other hand, economic growth is the material basis and condition for the development of education. With the increase in social needs and human capital, economic growth can also stimulate the development of higher education. Lewis, the American economist who won the Nobel Prize in Economics, concluded that "growth of knowledge through education" is one of the three main reasons for economic growth. Vector autoregressive (VAR) methods provide us with an efficient way to study the dynamic relationship between them from an empirical perspective.

How economic growth supports the development of higher education.

The roles of higher education in sustainable economic and social development increase year by year, and this will continue over the next decades. Higher education can be seen as a focal point of knowledge and its application, an institution which makes a great contribution to the economic growth and development through fostering innovation and increasing higher skills. It is looked like a way to improve the quality of life and address major social and global challenges. Based on the theoretical analysis of the relationship between the three, we select the corresponding data from China to construct the VAR model. Granger validated the bilateral causal relationship between higher education, technological innovation, and economic growth.

ISSN 2229-5518

The main differences between this paper and the existing researches are as follows:

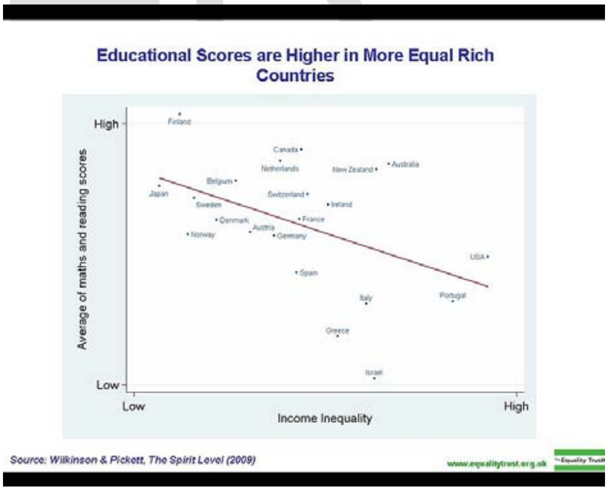
The viewpoint is unique. This paper analyzes economic growth from the perspective of higher education and technological innovation;

attempts to theoretically explore the relationship between higher education, technological innovation, economic growth, and memory mechanisms;
using China's actual data to test higher education, The link between technological innovation and economic growth. Provide relevant policies and recommendations based on the abstract.

2. LITERATURE REVIEW

Foreign scientists have long been studying the relationship between education and economic growth. There are many relevant studies, but there is a clear contradiction about whether education contributes to economic growth. Schulz (1956) [1] found that education played an important role in the development of American agricultural production after the war, and then proposed the theory of human capital. Denison (1996) used growth accounting methods to evaluate the contribution of education to economic growth in the United States. And he found out that the contribution of educational expenses to the increase in national income for the period 1929-1982. Was 13.7%. Lucas (1988) [3] created a model of endogenous growth that illustrates the mechanism of the role of education in economic growth. He believes that people should be encouraged to invest in education and training in order to gain more human capital to promote sustainable economic growth. On this basis, investments in human capital affect technological progress and have a long-term impact on economic growth in many endogenous growth models. For example, Glomm and Ravikumar (1998) [4] and Blankenau and Simpson (2004) [5] explained the internal operational mechanisms of public spending on education, human capital and economic growth in terms of investments in public education. Barro (1991) [6] showed that economic growth in 98 countries from 1960 to 1985 was largely dependent on the initial level of human capital, as measured by the number of students and gross national product per capita. Mankiw et al. (1992) [7] further expanded the Solow model by including human capital in education as a standard, and found that human capital is an important contribution to economic growth. Gylfason and Zoega (2003) [8] found that education not only contributes to the development of human capital, but also contributes to economic growth by increasing physical and social capital. Blankenau and Simpson (2004) [5] created an endogenous model of economic growth governed by human capital. Studies have shown that the impact of spending on public education on economic growth is not reasonable within certain limits, depending on public investment and construction, levels of spending, tax structure and technical parameters of production. Chanushek and Wessmann (2012) [9], based on data from the Organization for Economic Cooperation and Development (OECD) group, show that education can significantly contribute to economic growth. Barlow and Lee (2013) [10], based on panel data from 146 countries, show that education plays an important role in promoting economic growth.

Crespo Cuaresma, Doppelhofer and Feldkircher (2014) [11] used the average Bayesian model (BMA) to find reliable determinants of economic growth between 1995 and 2005 in a new data set from 255 European regions. Districts with capitals grew faster, especially in the countries of Central and Eastern Europe, as well as in areas with many highly educated workers. When the space between the European regions is allowed to overflow, the result is sustainable. Pustovrh and Jaklic (2014) [12] argue that innovation policy research can benefit from the use of new research methods, since they can lead to different policy recommendations. comparative analysis.



Ferreira and Dionísio (2016) [14] used a clear and qualitative comparative analysis of data from the countries of the European Union to establish what conditions could be considered necessary and sufficient to bring these countries closer together. Based on six different conditions (GDP, secondary education, life expectancy, fertility rate, government consumption, and inflation rate), this study showed that the main conditions that affect convergence are the government consumption ratio (the highest levels). low increase convergence). Education, and life expectancy (as a positive effect on convergence). The first two conditions show quite interesting results: in fact, reducing government spending and budget constraints is an open discussion; and the European Union's goal of becoming a more competitive economy can only be achieved with a higher level of education. Walheer (2016) [15] extended the previous approach, considering a multisectoral environment.

The results confirmed the non-neutrality of technological changes. It was also found that capital accumulation plays an important role in increasing labor productivity, while technological change and the accumulation of human capital also play an important role, but it is half the size of capital accumulation. A study conducted by Barro (2016) [16] showed that China can not deviate forever from world historical experience and that the per capita growth rate will soon fall from about 8% per year to a range of 3-4%. In contrast, Benhabib and Spiegel (1994) [17] argued that human capital, as measured by years of worker education, cannot effectively explain the increase in per capita production. Browninger and Vidal (1999) [18] found that, on the one hand, spending on education improves the average skills of individuals, thus contributing to economic growth, but, on the other hand, spending on education displaces the accumulation of tangible capital and weakens the effect of learning In practice, what is not conducive to growth. Beals and Klenov (1996) argued that, in any case, the positive correlation between education and growth of production can not indicate that education affects economic growth. On the contrary, the general growth of factors that we neglect in this study can contribute to the formation and growth of production. Coincidentally, Pritchett (2000) [20] also showed that the duration of learning as a variable has little effect on the explanation of cross-border economic growth. Temple (1999) [21] argued that human capital can not explain very well its significant relationship with growth due to the presence of many outsiders. Horia et al. (2008) [22] showed that a higher level of education increases personal income, but its long-term effect on economic growth is not so obvious. Blankenau et al. (2007) [23] argued that, based on panel data from 23 developed countries and 57 developing countries, spending on education has a strong catalytic effect on the economic growth of developed countries, but does not have a significant effect on the economic growth of developing countries. In China, research on contributions to education, technological innovation, and economic growth also attracted the attention of scientists. According to the principle of knowledge dissemination, Huang Yanping (2013) [24] used a metrological regression model to analyze the various effects of education at different levels on China's economic growth and argued that both higher education and primary education contribute to economic growth, and in the current, primary stage. Education plays a more important role than higher education in economic growth. Second, the impact of education spending on GDP is a long-term saving process, since the Chinese government's spending on education is low and its positive effect on economic growth has not yet been demonstrated. Tang Weibing et al. (2014) [25] indicated that the effect of the imitation of foreign capital and the diffusion of technology are beneficial to improve the intensification of economic growth, and that technological innovations are negatively related to the level of intensification of economic growth due to the capacity of digestion and absorption, technical gap, etc. In addition, the role of technological innovation and economic growth is not clear according to the specific samples. Lee Miaomiao et al. (2018) [26] found that there is a with both positively promoting economic growth in the long term, and technological innovation being the driving force of economic growth. However, there is a certain lag. To sum up, the impact of education input and technological innovation on economic growth is still controversial.

3. THEORETICAL ANALYSIS

The interaction between educational input, technological innovation, and economic growth can be analyzed from the following three levels.

3.1. The Relationship Between Education Input and Technological Innovation

Technological innovation is the driving force of social and economic development, while education is an important way for knowledge precipitation and accumulation in technological innovation. The first step is to improve the quality of personnel through education input, gradually increasing the accumulation of human capital, and, thus, promoting technological innovation and progress (Figure 1).

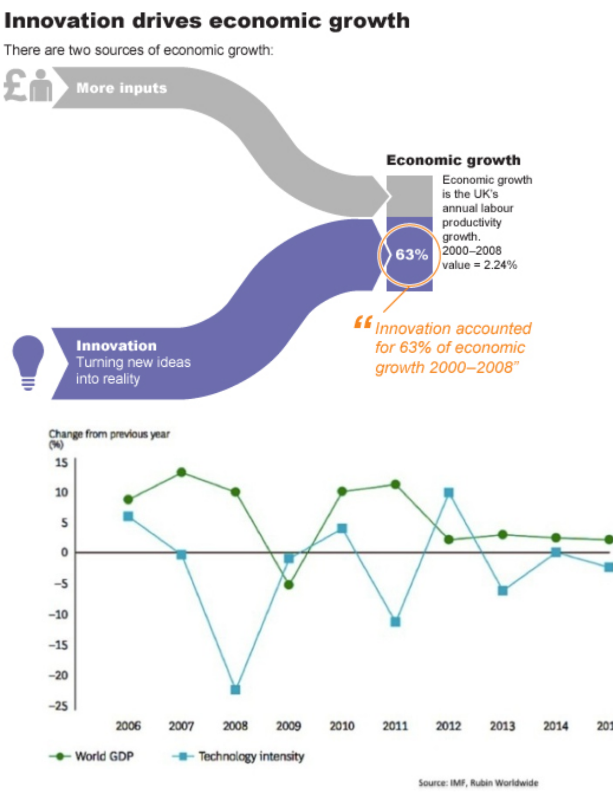


Figure 1. The relationship between education input and technological innovation.

3.2. Interaction Between Education Input, Technological Innovation, and Economic Growth

Figure 2. Innovation drives mechanisms between educational input, technological innovation, and economic growth.

From the above analysis, it can be seen that the contribution to education does not directly lead to economic growth, but will significantly affect the accumulation of human capital, and then create technological innovation, and the impact process is a dynamic cycle. Therefore, the relationship between education, technological innovation, and economic growth is relatively complex. For a more intuitive effect, Figure 2 is used to illustrate the relationship between them.

It can be seen from Figure 2 that, first, the accumulation of human capital can be increased through education input. Secondly, human capital accumulation, to a certain extent, will bring technological innovation and progress. Furthermore, technological innovation and technological progress will further promote economic growth. Finally, economic growth makes more education input possible. A further increase in education input will begin a new round of circulation, promoting technological innovation once again through the accumulation of human capital, and, thus, promoting economic growth. This is a spiral escalating, self-strengthening process. Thus, education input, technological innovation, and economic growth form an interaction mechanism, featuring dynamic circulation.

4. METHODOLOGY, VARIABLES, AND DATA

4.1. Methodology

Vector autoregressive (VAR) is a typical econometric model created by Christopher Sims in 1980 (Christopher, S., 1980) [28]. In the economic system, each endogenous variable is considered a function of the entire system. The hysteresis value of the endogenous variable is used to construct the model through VAR, predict the time series system and analyze the dynamic influence caused by the random variable. Interference with variable systems explains several economic effects on the formation of economic variables (Tiemei, G., 2009) [29]. It is a generalization of the AR model and is now widely used. The basic mathematical expressions for the VAR (p) model are:

$$y_t = \Phi_1 y_{t-1} + \ldots + \Phi_p y_{t-p} + \mathrm{H} x_t + \varepsilon_t,\ t = 1,2,\ldots,T$$

The autoregressive vector (VAR) is a model based on the statistical properties of the data; constructs a model by treating each endogenous variable in the system as a function of the hysteresis of all the endogenous variables in the system, and then an autoregressive autoguider. The model is generalized to an autoregressive "vector" model that consists of series variables of multivariate time. The VAR is one of the simplest models for the analysis and prediction of multiple relative economic indicators. Under certain conditions, it is formulated by the multivariable model of moving average (MA) and the autoregressive model and moving average (ARMA).). In recent years, it has attracted more and more attention from business managers, so this document chooses the VAR model as the object of research.

The basic mathematical expressions for the VAR (p) model are:

Compared to common simultaneous equations, the VAR model treats all variables as endogenous variables, reduces the uncertainty of the simultaneous equations model due to subjective errors and eliminates the prediction of endogenous variables in the process of establishing simultaneous public equations. In addition, VAR also demonstrates its unique advantages in the following aspects: (1) the estimation of the parameters is relatively easy;

(2) the model has a wide range of applications, since the VAR model is not based on the theory of financial economics, it can be largely added other explanatory variables; (3) The advantage of prediction as a small VAR model of reasonable configuration is generally better than the larger structured synchronization system, especially for short-term prediction. This is because the AR model generally avoids the effects of applying restrictions to ensure the identification of the structural model. On the other hand, it only describes the interaction between the variable of the delay period and the current period, ignoring the structural relationship between them, and the structural relationship between hidden relative economic variables affects the investigation to some extent. Accuracy In the element of random disturbance. However, their predictions do have advantages.

4.2. Variables and Data

This paper focuses on the relationship between investment in higher education, technological innovation, and economic growth, and empirical research on its causal relationship and its dynamic impact. The number of grants and patent applications are the two most common indicators that reflect the level of technological innovation. Since the number of patent grants is influenced by human factors such as government organizations, the number of patent applications granted for authorization is used as a proxy variable to measure technological innovation. The agency index for economic growth and investment in higher education will be expressed by the current measured gross domestic product and the national financial education fund.

Based on the above considerations, data from 1991 to 2016 were selected as a sample for this study. They come from the corresponding years of books such as "China Statistical Yearbook", "Chinese Education Fund Statistical Yearbook" and "China Education Statistics Yearbook", and conduct empirical research based on a unified resolution of the rate of annual growth. The variables, represented by GDP, budget and patents, represent the current annual growth rate of GDP, the annual growth rate of the National Financial Education Fund and the annual growth rate of the patent application authorization.
The variation trend of the above variables is expressed in Figure 3.

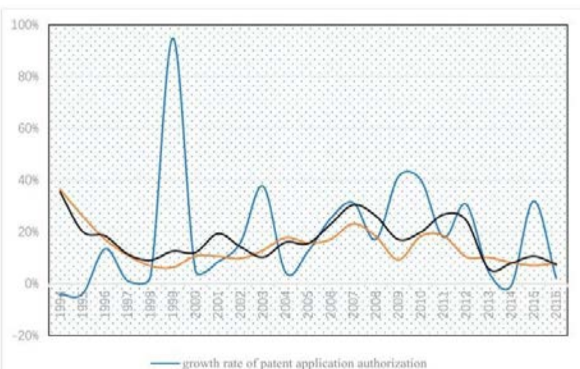


Figure 3. Vibration trend of variables.

From the analysis of Figure 3, we can simply see that over the years from 1998 to 2008 the annual growth rate of the GDP, as measured by the current price, is rising, with some fluctuations. In the meantime, the national financial education fund growth rate also appears to be increasing, but there is a slight uplift in the fluctuation range of the growth rate of the patent application quantity. It is noteworthy that the annual growth rate of the GDP, the growth rate of the national financial education fund, and the growth rate of patent application authorizations have shown the same fluctuation trend, while in a downward trend since 2009.

5. ANALYSIS OF TEST RESULTS

5.1. Variable Unit Root Test

Time series were employed for the paper's empirical test, which must be checked prior to the model establishment and analysis to avoid pseudo regression between variables. If the sequence is stable or is a stationary sequence, that is, the same order single integer sequence, that can be acquired after the same difference operation, then the subsequent modeling analysis begins. In this paper, we used the common unit root test method, Augment Dickey-Fuller (ADF), to test the time series and implemented this with the operation of the Eviews7.2 software. The results are shown in Table 1.

Table 1. Augment Dickey-Fuller (ADF) Variable unit root test results.

Variable	Test Form (I,T,P)	ADF Test Value (t Statistics)	Probability	Test Results (the Data Showed Significant at 5%)	Test Results (the Data Showed Significant at 10%)
GDP	(I,N,0)	−2.335673	0.0046	Stable	Stable
ΔGDP	(I,N,0)	−4.266645	0.0503	Unstable	Stable
Budget	(I,N,2)	−2.127141	0.0644	Unstable	Stable
ΔBudget	(I,N,1)	−4.258338	0.0004	Stable	Stable
Patent	(I,N,1)	−4.440905	0.0003	Stable	Stable
ΔPatent	(I,N,1)	−4.181977	0.0000	Stable	Stable

Note: (1) I and T in the teaching and research form represent the constant term and the trend term, N means that the test equation does not have the

ISSN 2229-5518

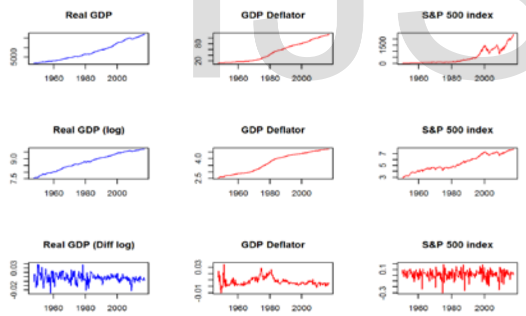
term, and p represents the lag order determined by the AIC (Akaike Info criterion);

(2) D represents a first-order difference calculation for a variable.

Based on the ADF unit root test, we found that the sequence of this empirical test under the 10% confidence level satisfies the single integer serial or the first order serial. As per the requirements for series stability, the original sequence or the first order difference sequence can all be used to formulate the Vector Autoregression (VAR model.

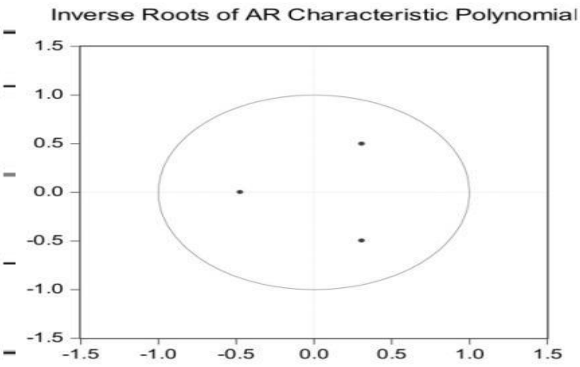
5.2. Estimation of VAR Model To study the interaction among higher education investment, technological innovation (progress), and economic growth, and further decomposition of the impact of various factors, as well as the changes in the short-term and long-term influences, we used the first-order difference of the annual growth rate of the GDP as well as the authorized number of patent applications and the original value of the national financial education funding growth rate as endogenous variables to construct the three-factor VAR model, with the parameters estimated by the Eviews7.2. software.

The consequences are as follows:



Since the VAR model establishes a dynamic system and does not make a strict distinction between the dependent variable and the independent variable, we do not focus on the significance of the unilateral process. However, the estimated results still show that the equations in the model have good significance (see Table 2). The results of the stationary test of the VAR model show that all the characteristic roots of the model are in the unit circle (Figure 4), so the model is a stationary VAR model. Combining the internal relationship of the economic system, the VAR model we selected is a model with a lag order of 1. Therefore, we can further analyze the relationship between variables based on the VAR model.

Table 2.Vector auto-regression (VAR) Variables statistical characteristics and model significance.



Note: The first row is the standard deviation of the estimating coefficient. The square brackets ([ ]) contain the statistics of the estimating coefficient.

Equation	Primary Hypothesis	χ^2 Statistics	Degree of Freedom	P Value	Testing Results
dGDP	dPatent cannot Granger cause DGDP	5.114158	1	0.0237	Reject **
	Budget cannot Granger cause DGDP	7.276193	1	0.0070	Reject **
	ddPatent, Budget both cannot Granger cause dGDP	12.26413	2	0.0022	Reject **
dPatent	[illegible]	3.683571	1	0.0550	Reject *
	Budget cannot Granger cause dpatent	0.028634	1	0.8656	Accept
	ddGDP, Budget both cannot Granger [illegible]	3.875851	2	0.1440	Accept
Budget	dGDP cannot Granger cause Budget	6.107287	1	0.0135	Reject **
	dPatent cannot Granger cause Budget	0.154413	1	0.6944	Accept
	[illegible] cause Budget	7.632743	2	0.0220	Accept

Figure 4.VAR stability test.

5.3. Granger Causality Test

The Granger causality test is a statistical explanation of the relationship between variables, which is essentially a test of whether a variable's lag variable can be introduced into other variables' equations. We have used the stationary sequence to establish the VAR model and verified its stability. Considering this, we also carried out the Granger causality test to distinguish between endogenous variables and exogenous variables. The results are shown in Table 3.

Table 3.Vector auto-regression (VAR) Granger causality test results.

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NOTE: ** means to reject the original hypothesis at 5% confidence, * to reject the original hypothesis at 10% confidence level.

5.4. Impulse Response Function and Variance Decomposition

The results of the static tests of the VAR model show that all the eigenvalues of the model are found in the unit circle (Figure 4). That's why it's a fixed VAR model. At the same time, Granger's causality test verifies that the annual difference between the patent application authorization and the annual growth rate of the national financial education fund is a change in the Granger case. The annual growth rate of GDP. Therefore, in view of this, this document continues to implement the impulse response and the decomposition of the variance under the influence of the first-order difference in the annual growth rate of patent applications and the annual growth rate of the national fund of financial education.

Based on the establishment of the VAR model, the impulse response function (IRF) is used to analyze the feedback of the first-order difference value of the annual GDP growth rate of a unit when the perturbation term is added. an endogenous variable. Different sizes.

Figure 5. reflects the impact of positive impulses on the first-order difference in the annual growth rate of patent applications and the first-order difference in the annual growth rate of higher education funds.

Table 4. dGDPvariance decomposition.

Variable	Period	dGDP	dPatent	Budget
	1	100.0000	0.0000	0.0000
	3	74.40299	8.685590	16.51024
	5	74.70537	8.615701	16.67893
	7	74.61637	8.586434	16.79719
dGDP				
	9	74.59861	8.588031	16.81336
	13	74.59897	8.587961	16.81307
	17	74.59895	8.587963	16.81308
	20	74.59895	8.587963	16.81308

GDP in different time dimensions. From the perspective of the time of influence, the growth rate of the patent application authorization and the annual growth rate of the national financial education fund have a more evident impact on medium and long-term economic growth, affecting eight Sustainability periods.

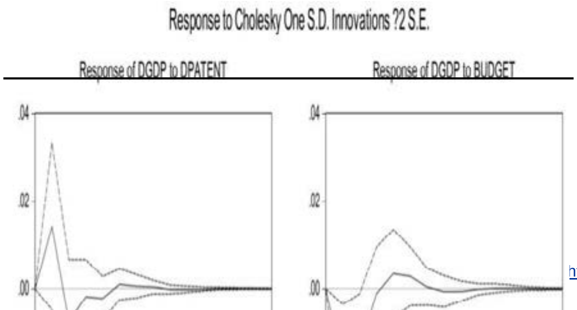

Figure 5. Economic growth response function caused by the impact of the quantity of patent application(Left)and the funding for higher education (Right).

To further the analysis of the contribution of each structural impact to the growth rate of the GDP, and the evaluation of the importance of each impact at different time dimensions, we used the method of variance decomposition to decompose the contribution of the annual growth rate of patent applications and the annual growth rate of higher education funds to the GDP growth rate.

Considering the results of the variance decomposition, as shown in Table 4. In this table, out of the two factors that we examined, the change in the national financial education funds' growth rate has a stronger influence on the GDP growth rate.

6. DISCUSSION

How is an investment in education, especially in higher education, how to promote economic growth through technological innovation? Technological innovation is the source of power for social and economic development. Education is an important way for technological innovation and the accumulation and accumulation of knowledge. Therefore, investment in education, especially in higher education, to improve the quality of personnel and gradually increase the accumulation of human capital, thus promoting technological innovation and progress. In addition, the central variable technology that determines economic growth has innovation and progress, which will inevitably accelerate economic growth. At the same time, the different stages of technology development correspond to the corresponding stages of economic development. The different levels of economic development in developed and developing countries are the result of technological innovation in different stages. Therefore, investment in education, especially in higher education, accelerates economic growth through technological innovation.

How does economic growth support the development of higher education? This can analyze the impact of economic growth on the development of higher education in two aspects. First, economic growth provides a material basis for the coordinated development of education. To a certain extent, education refers to the activities formed through the basic form of human capital investment and training and capacity building according to the plan. From this perspective, investment and the functioning of education can be seen as a process of entry and exit of an industry. To coordinate the development of education, it is necessary to guarantee a sustained long-term educational investment, which must be based on sustained and stable economic growth. Second, economic growth has a restrictive and guiding role in the development of education. The level of economic development determines the scale, content, organization, teaching methods and educational methods of education, and also determines the quality of work and the quality of staff training. Then, economic growth has more possibilities for educational investment. If we increase our investment in education, they will enter a new cycle. In addition, it promotes technological innovation through the accumulation of human capital, thus accelerating economic growth. Therefore, it is a spiraling and self-reinforcing process. Technological innovation and economic growth not only have a causal

7. CONCLUSIONS

Using the above analysis, the following key findings can be obtained. Investments in higher education and technology are two factors that influence economic growth. The test results show that indicators reflecting spending on higher education and technological innovation remain, and factors affecting fluctuations in economic growth, whether in the short or long term, have made contributions that cannot be ignored. It is worth noting that the impact of a combination of investments in higher education and technological innovation is long-term in nature and will not decrease with time, but will increase to some extent. This is a theoretical analysis of our investment in higher education. It corresponds. Technological transformation and innovation have experienced a process of accumulation, transfer, and transformation, which ultimately affects economic growth. From the point of view of direct relations, an increase in investment in higher education is the engine of technological innovation, and technological innovation is a factor of economic growth. From an analysis of the impulse response results, it can be seen that the main reason is that technological innovation has a cumulative positive effect on economic growth. Economic growth gradually decreases with time, with a strong long-term nature, in accordance with the gradual elimination of the introduction of new technologies. Law Investments in education and economic growth are not just cause-effect relationships. Investment in education will not directly lead to economic growth, but ultimately will affect economic growth through the accumulation of human capital and technological innovation. The process of exposure is a dynamic and self-assessment process. , Investment in higher education is an important source of technological innovation, and the positive impact of technological innovation on economic growth can only be seen for a long time. Thus, investments in higher education require perspectives and long-term thinking to achieve quick success, and immediate benefits should be avoided.

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