

Can sustained development of education lead to employment - an empirical study based on TVP-VAR model

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Abstract: This paper explores the time-varying nature of the continuous development of education and employment from 1993-2021, completes the measurement of education integrated scale and education integrated talent indicators using the entropy power method, constructs a TVP-VAR model, and completes the investigation of the dynamic relationship between changes in education development and changes in employment growth using equally spaced impulse responses and time-point impulse responses. It is found that: there are different degrees of positive and negative impact fluctuations of the change in increase in education expenditure, the change in increase in education integrated scale and the change in increase in the number of education integrated talents on the change in employment growth, and overall the change in increase in education expenditure, the change in increase in education integrated scale and the change in the number of education integrated talents positively affect the change in employment growth under medium-term shocks. Based on the results of the study, this paper puts forward relevant suggestions for further promoting the positive impact of continuous development of education on employment growth.

1. Introduction

In today's era of globalization and knowledge-based economy, education is seen as an important driver of economic growth and social progress. Education not only improves people's knowledge and skills, but also promotes innovation and creativity, and increases productivity and labor market competitiveness. Therefore, the continuous development of education is seen as one of the necessary conditions for achieving sustainable development and economic prosperity.

However, the relationship between education and employment is not always clear and simple. Although there are many studies that suggest a positive relationship between education and employment, the mechanisms and influencing factors of this relationship still need further research. Therefore, this study aims to examine the impact of the continued development of education on employment and to analyze the long- and short-term effects of this impact, as well as the long- and short-term effects of related policies.

To achieve this goal, this study uses a TVP-VAR model to analyze the relationship between continuous development of education and employment. The TVP-VAR model is a time-varying vector autoregressive model that captures the effect of time variation on the relationship between variables. The empirical analysis

was conducted by using data from 1991 to 2020 in China. The contribution of this study is to fill some gaps in the existing literature on the relationship between sustained development of education and employment. This study not only provides a more accurate analysis method, but also offers new ideas and suggestions for formulating education policies and promoting employment. It is hoped that this study will provide a valuable reference for scholars and policy makers in related fields.

2. Literature Review

For both domestic and international issues on factors affecting employment, international scholars have analyzed the impact of employment from different perspectives and using different measures. Bhorat (2016)^[1] estimated Olley and Pakes' two-stage regression of the modified Cobb-Douglas production function to analyze the extent to which labor force education affects the nature and trajectory of South Africa's economic growth. The results show that the degree queue contributes to economic growth and employment; Singh (2022)^[2] conducted second-order partial least squares structural equation modeling (PLS-SEM) through mitigation analysis and found that learners would be able to maintain their experience by connecting with the outside world and building a sustainable society, thus creating sustainable employment opportunities and social empowerment in

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Saudi Arabia; Zhang Chewei (2019) [3] analyzed from the macro and micro aspects and pointed out that the main contradiction of employment in China has gradually changed from the total contradiction characterized by lack of employment positions to the structural contradiction characterized by low employment quality. The improvement of the wage level and employment quality of ordinary workers has become an important issue to be solved. It also suggested that emerging industries should be used to optimize the employment structure, so that high-quality economy can incubate more high-quality jobs. Tanwar (2019) [4] explores the relationship between employer brand dimension and employer choice (EOC) and also analyzes the role of individual-organizational fit in transferring employer brand dimension to parallel opportunity position. Moroko[5] collected and analyzed enterprise brand data and concluded that the success of employer brand has two key dimensions: attractiveness and accuracy.

At present, there are abundant researches on the sustainable development of education. In his report, Chabbott (2020) [6] reviews the evidence on the role of education in economic development, focusing on issues that have emerged in the literature over the past two decades: the contribution of education to economic growth, the screening hypothesis, Labour market segmentation, the return on investment in schooling, and the impact of education on unemployment and income distribution. The report concludes with an optimistic assessment of the contribution of investment in education to the development process, particularly when it is directed at primary education, general education and improving the quality of teaching, and when it is accompanied by cost recovery in higher education; Shuiia(2020)[7] proposes that education for sustainable development is important in achieving the 2030 Agenda and other goals, not only because education will play a key role in implementing these goals, but also because education will amplify its impact by addressing emerging sustainability challenges. Tadesse (2020) [8] reviews the impact of coronavirus on education systems around the world. As a solution to continuing education systems, countries have devised strategies to use educational technology, zero-cost Internet education resources, free online learning resources, and broadcast instruction. During the shutdown, educational institutions designed curricula and developed teaching strategies for post-coronavirus. Educational institutions design strategies to recover lost learning and return schools to reopen. Mukhtasa[9] studied the creation of the German education system, the working efficiency of the German education system and the opportunities for students. In addition, it also shows the effectiveness of the German higher education system in the relation between theory and practice.

In summary we are able to find that educational development at home and abroad is linked to economic and social employment and can contribute to alleviating the current employment tensions. However, the available literature lacks accurate data modeling studies on the direct impact of continuous educational development on employment. And in the current employment situation, it

is crucial to address employment issues through educational development. Therefore, the study of whether and to what extent education development has an impact on employment is of great practical importance.

3. Data sources and research methods

3.1 Data source

In order to investigate whether the sustained development of education can drive employment, this study selects annual data from China for the years 1991 to 2020. The indicators used to measure the sustained development of education are *education funding*, *education comprehensive scale*, and *education comprehensive talent*. The employment situation is measured by the indicator *number of employed individuals*. The indicator *education comprehensive scale* is obtained using the entropy weight method by combining the numbers of *regular higher education institutions*, *regular high schools*, *junior high schools* and *regular primary schools*. The indicator *education comprehensive talent* is obtained using the entropy weight method by combining the numbers of *graduates from regular higher education institutions*, *graduates from regular high schools*, *graduates from junior high schools* and *graduates from regular primary schools*. All data are sourced from the National Bureau of Statistics of China. The variables *education funding*, *education comprehensive scale*, *education comprehensive talent*, and *number of employed individuals* are denoted as *EF*, *CSOS*, *CNOE*, and *NEP*, respectively. To address issues such as multicollinearity and heteroscedasticity, this study takes the natural logarithm of the four variables. The transformed variables are represented as *LnEF*, *LnCSOS*, *LnCNOE*, and *LnNEP*, indicating the processed values of *education funding*, *education comprehensive scale*, *education comprehensive talent*, and *number of employed individuals*, respectively.

3.2 Research Methodology

3.2.1 Entropy method

The entropy method is widely used to measure the degree of value dispersion in decision making. As the degree of value dispersion increases, the degree of dispersion and differentiation increases accordingly, which in turn provides richer information. The entropy method assesses the value of indicators by measuring the degree of dispersion between them. When the degree of dispersion of the measured values is greater, the degree of differentiation between indicators is also greater, thus enabling more information to be obtained. In this study, we use the entropy weighting method to determine the weights of two indicators, *comprehensive scale of education* and *comprehensive number of talents in education*. The specific steps of the entropy weighting method are as follows:

We need to evaluate m indicators and n samples by putting the first j of the sample i . The measured value of

the first indicator is denoted as x_{ij} .

(1) Standardized treatment of indicators: the first j in the first sample i . The standardized value of the first indicator is recorded as p_{ij} and its calculation method is as follows:

$$p_{ij} = \frac{x_{ij}}{\sum_{j=1}^n x_{ij}}$$

(2) The entropy value of the i The entropy value of the first indicator is defined as:

$$E_i = \frac{\sum_{j=1}^n p_{ij} \cdot \ln p_{ij}}{\ln n}$$

E_i The range of entropy values is $[0,1]$. E_i The larger the value, the greater the index i . The greater the degree of differentiation, the more information can be deduced, and therefore the higher weight is given to the indicator.

(3) The weights are calculated as follows:

$$\omega_i = \frac{1 - E_i}{\sum_{j=1}^m (1 - E_i)}$$

3.2.2 TVP-VAR model

The TVP-VAR model is an extension of the traditional SVAR model, which is endowed with time-varying and nonlinear characteristics by relaxing the constant parameter constraints and introducing time-varying features. This study draws on the approach of Nakajima et al. (2011)^[10] to derive the TVP-VAR model based on the SVAR model, and obtains the expression for the TVP-

VAR model:

$$Y_t = X_t \beta_t + A^{-1} \sum_t \varepsilon_t, t = s + 1, s + 2, \dots, n$$

Among them. $X_t = I_t \otimes (y_t', y_{t-1}', \dots, y_{t-s}')$, $\otimes$ denotes the *kronecher* the product of the products; β_t denotes the coefficients; and A^{-1} denotes the linkage coefficient matrix; the random fluctuation covariance $\sum_t$ do time-varying treatment. Its volatility matrix is $h_t = (h_{1t}, h_{2t}, \dots, h_{kt})$ consistent with $h_{it} = \log \delta_{it}^2$ ($i = 1, 2, \dots, k$) condition. The vector matrix is $\alpha_1 = (\alpha_{21}, \alpha_{31}, \alpha_{32} \dots \alpha_{k,k-1})$ composed of lower triangular elements. Assume that the parameters to be estimated obey the wandering characteristics and have $\beta_{t+1} = \beta_t + u_{\beta t}$, $\alpha_{t+1} = \alpha_t + u_{\alpha t}$, $h_{t+1} = h_t + u_{ht}$.

$$\begin{bmatrix} e_t \\ u_{\beta t} \\ u_{\alpha t} \\ u_{ht} \end{bmatrix} = N(0, \begin{bmatrix} I & 0 & 0 & 0 \\ 0 & \sum_{\beta} & 0 & 0 \\ 0 & 0 & \sum_{\alpha} & 0 \\ 0 & 0 & 0 & \sum_h \end{bmatrix})$$

Among them.

$$\beta_{t+1} \sim N(u_{\beta_0}, \sum_{\beta_0}), \alpha_{t+1} \sim N(u_{\alpha_0}, \sum_{\alpha_0}), h_{t+1} \sim N(u_{h_0}, \sum_{h_0}).$$

4. Empirical Analysis

4.1 Indicator Construction

In this paper, the entropy weighting method is used to assign weights to the secondary indicators, and then the primary indicator values are calculated.

Table.1 The weight results of each secondary indicator

Tier 1 Indicators	Secondary indicators	Weights
CSOS	Number of general higher education schools	19.49%
	Number of general high schools	13.52%
	Junior High School	16.18%
	Number of general elementary schools	23.09%
CNOE	Number of graduates from general higher education institutions	14.12%
	Number of general high school graduates	9.31%
	Number of junior high school graduates	7.75%
	Number of general elementary school graduates	7.83%

4.2 Unit root test

The variables selected in this paper are annual data, which

also belong to time series, in order to avoid "pseudo-regression" analysis results. The ADF unit root test (Dickey, 1979)^[11] was conducted for each variable separately. The results of the test are shown in Table 2, indicating that all variables are smooth series.

Table 2 Each variable ADF Test results

name	ADF-stat (t-stat)	1% critical value	5% critical value	10% Threshold	Prob.*	Conclusion
<i>LnEF</i>	-2.819593	-3.689194	-2.971853	-2.625121	0.0683	unstable
<i>DLnEF</i>	-3.553379	-4.323979	-3.580622	-3.225334	0.0528*	stable
<i>DDLnEF</i>	-6.388993	-3.711457	-2.981038	-2.629906	0.0000***	stable
<i>LnCSOS</i>	-1.259249	-3.689194	-2.971853	-2.625121	0.6338	unstable
<i>DLnCSOS</i>	-1.716747	-3.689194	-2.971853	-2.625121	0.4122	unstable
<i>DDLnCSOS</i>	-6.217915	-3.699871	-2.976263	-2.627420	0.0000***	stable
<i>LnCNOE</i>	-1.956167	-3.689194	-2.971853	-2.625121	0.3033	unstable
<i>DLnCNOE</i>	-2.102242	-3.689194	-2.971853	-2.625121	0.2453	unstable
<i>DDLnCNOE</i>	-6.235153	-3.699871	-2.976263	-2.627420	0.0000***	stable
<i>LnNEP</i>	-2.431662	-3.711457	-2.981038	-2.629906	0.1433	unstable
<i>DLnNEP</i>	-2.817693	-4.323979	-3.580622	-3.225334	0.2030	unstable
<i>DDLnNEP</i>	-4.267873	-3.711457	-2.981038	-2.629906	0.0027***	stable

It can be seen from Table 2 that $LnEF$, $LnCSOS$, $LnCNOE$, $LnNEP$ are not smooth, and after the first-order difference, we get $DLnEF$, $DLnCSOS$, $DLnCNOS$, $DLnNEP$, where $DLnEF$ are smooth series, while $DLnCSOS$, $DLnCNOS$ and $DLnNEP$ are non-stationary series. Then the data are processed to check the score, and get $DDLnEF$, $DDLnCSOS$, $DDLnCNOS$ and $DDLnNEP$. Therefore, this paper uses the data after the second-order difference treatment to establish $TVP - VAR$. Therefore, this paper uses the second-order differenced data to build a model to explore the dynamic relationship

between the incremental change in the development of education and the change in employment growth, i.e., to explore whether the continuous development of education can drive employment.

4.3 Time-varying effects

This paper develops $TVP - VAR(2)$ model to explore the dynamic relationship between the continuum of education and employment.

Table 3 TVP – VAR Estimation of model parameters

Parameter	Mean	Stdev	95%U	95%L	Geweke	Inef.
sb1	0.6127	0.2818	0.2270	1.3099	0.007	21.45
sb2	6.7494	4.3132	1.2107	18.0692	0.096	124.34
sa1	0.0055	0.0015	0.0033	0.0093	0.178	6.82
sa2	0.0055	0.0015	0.0034	0.0092	0.161	13.74
sh1	0.0025	0.0003	0.0020	0.0033	0.435	0.76
sh2	0.0025	0.0003	0.0020	0.0032	0.358	0.61

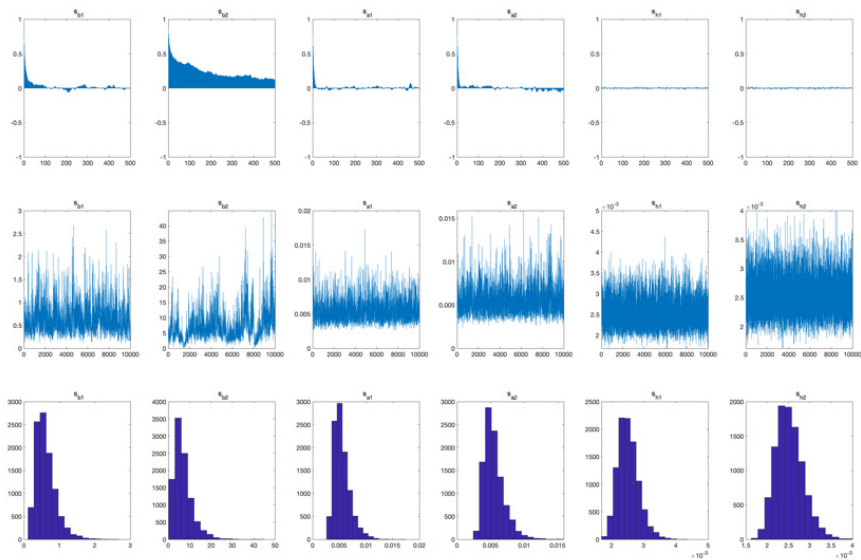


Figure 1 TVP – VAR Graph of model sampling results

By performing 10,000 simulations using the Markov Monte Carlo (MCMC) method under Bayesian inference, we obtained the model sampling results and parameter estimation results, as shown in Figure 1 and Table 3. In the first row, we observe a significant decrease in the autocorrelation coefficient of the model after iterative sampling, indicating that the 10,000 sampling iterations using MCMC simulation can effectively eliminate the autocorrelation feature in the simulation. In the second row, the paths of the parameters show obvious *white noise* trajectory fluctuations, indicating that the model parameter values fluctuate steadily around the mean and that the parameters are independent of each other. The third row shows that the sampled data are normally distributed, which further indicates that the sampled data are valid. Therefore, it can be concluded that the model's parameter sampling results are reliable. By observing

Table 3, we can find that the Geweke diagnostic values corresponding to each time-varying parameter are less than the critical value of 1.96 at the 5% significance level, which indicates that the MCMC sampling results have converged to the posterior distribution of the parameters, and thus the established TVP-VAR model has significant stability. In addition, the maximum null factor of the parameters is 124.34, and the rest are less than 100, which indicates that the sampling results of the posterior distribution of the parameters are valid, and therefore the construction of the TVP-VAR model is meaningful.

4.3.1 Equally spaced impulse response

The theme of this paper is to explore the impact of the continued development of education on employment. In order to study this issue, we choose annual data for the

analysis. Considering that the Chinese government has established a "five-year plan" policy, we set different time constraints for the impact of shocks in the analysis, which

are 1, 3 and 5 years, representing short, medium and long term effects, respectively. The results of the analysis can be found in Figure 3.

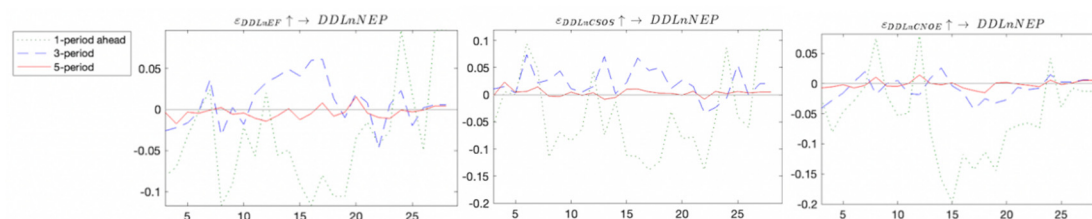


Figure 2 Equally spaced impulse response diagram

From Figure 2, it can be seen that for a positive shock of one unit of increase in education expenditure change, under the short-term shock effect, the increase in education expenditure change negatively affects the change in employment growth overall in 1993-2016 and positively affects the change in employment growth only in 2000 and 2005; while in 2017 and 2020 the increase in education expenditure change positively affects the change in employment growth and reaches the increase in education expenditure positively affects the change in employment growth and reaches a positive maximum in 2017 and 2020. Under the medium-term shock effect, there are positive and negative fluctuations in the impact of the increase in education expenditure on the change in employment growth, but it continues to positively affect the change in employment growth in the period of 2004-2011. In the long run, the impact of the increase in education spending on employment growth fluctuates positively and negatively, but to a lesser extent than in the short and medium term. To summarize and analyze the reasons for this, it takes some time for the increase in education spending to be translated into actual employment and economic benefits. Therefore, in the short term, especially in the longer time period of 1993-2016, the job market may not have responded to the changes in the increase in education spending in a timely manner. The increase in education spending has been concentrated in the nine years of compulsory education, while the job market demand for these specific fields or levels is relatively low. This results in a smaller impact of increased education spending on overall employment growth. Sustained increases in education spending over the medium term may contribute to the accumulation of human capital, i.e., an increase in the educational attainment and skills of the labor force. This can increase the productivity and competitiveness of the labor force, thus contributing to job growth. Increases in education spending contribute to technological progress and innovation. Investment in education can foster innovation and technological research and development talent, and promote the application of technological progress in various industries, thereby creating more jobs. The fluctuations under the long-term shock effect may reflect the dynamic adjustment process between the increase in education spending and employment growth. The response of the job market takes longer to adjust to the adjustment of human resource structure brought about by changes in education funding.

According to Figure 2, for a positive shock of one unit of increase in the combined size of education, in the short-term shock effect, the overall increase in the combined size of education negatively affects the change in employment growth, while in the recent years, i.e., 2020, the increase in the combined size of education positively affects the change in employment growth and reaches the maximum positive effect. In the medium-term shock effect, the increase in the size of the education complex as a whole positively affects the change in employment growth in the period 1993-2020. In the long run, the increase in the combined size of education positively and weakly affects the change in employment growth. To summarize and analyze the reasons for this: similar to the increase in education spending, it may take some time for the increase in the combined size of education to translate into actual employment opportunities and economic benefits. Therefore, in the short run, especially in the longer time period of 1993-2020, the job market may not respond in time to changes in the increase in the combined size of education. An increase in the combined size of education may mean that more people are educated, raising the overall quality and skill level of the workforce. This positively affects demand in the job market, thereby contributing to employment growth. An increase in the combined size of education may have fostered more innovation and entrepreneurship, thus driving innovation and entrepreneurial activity. This further stimulates job growth. An increase in the combined size of education may mean that more people are receiving higher education and vocational training, improving the quality and skill level of the workforce. This makes the workforce more competitive and able to adapt and create more jobs. Although this effect is weak, in the long run, the increase in the combined size of education still helps to improve the quality of the labor force, which in turn contributes to some degree to employment growth.

According to Figure 2, for a positive shock of one unit increase in the number of educationally integrated talents, there are fluctuations in the positive and negative effects of the change in the number of educationally integrated talents on the change in employment growth under the short-term shock effect; there are both positive and negative effects during the period 1993-2005, and the negative effect on the change in employment growth continues after 2006. In the medium-term and long-term shock effects, there are positive and negative fluctuations in the impact of the increase in the number of educational

aggregates on the change in employment growth, but the overall impact is smaller than the impact of short-term shocks. To summarize and analyze the reasons for this: similar to the previously mentioned cases of education spending and the combined size of education, it may take some time for the increase in the number of educationally integrated talents to have a substantial impact on employment. Therefore, in the short term, especially in the period 1993-2005, the job market may not have fully responded to the change in the number of educationally integrated talents. Meanwhile, the demand in the job market in the short term may be influenced by a variety of

factors, such as economic cycles, industry developments, and policy changes. These factors may lead to fluctuations in the demand for educationally integrated talent in the short term, which in turn may have a positive or negative impact on employment growth. For medium and long-term shock effects, the increase in the number of educationally integrated talents may lead to structural problems in the labor market. While employment opportunities increase in some areas, others may face a surplus of talent and underemployment. This may lead to a lesser degree of overall impact on employment growth.

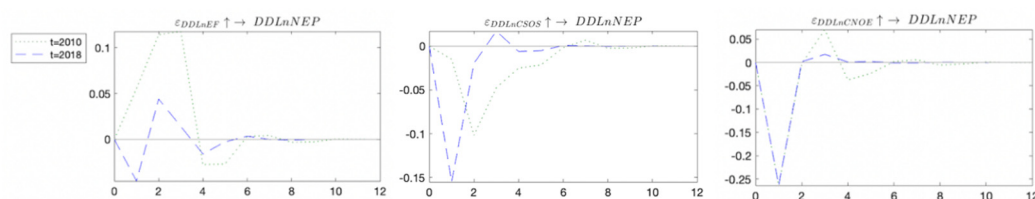


Figure 3 Time-point impulse response diagram

In this paper, specific time points were selected: 2010 and 2018 for point-in-time impulse response analysis. The reasons for selecting these three time points are: In 2010, the Party Central Committee and the State Council of China promulgated the National Medium- and Long-term Education Reform and Development Plan and held the first national education work conference in the new century. In 2018, the Ministry of Education, the Ministry of Finance and the National Development and Reform Commission jointly issued the "Opinions on Accelerating the 'Double First-class' Construction of Higher Education Institutions Guiding Opinions on the Construction of 'Double First Class'". All of these major policies affect the development of education, so these three specific time points were selected to explore the impact of the development of education on employment growth.

According to Figure 3, from 2010, the increase in education expenditure first positively affects the change in employment growth, then negatively affects the change in employment growth, and finally the effect weakly tends to zero. In contrast, the increase in the combined size of education negatively affects the change in employment growth, reaching the maximum negative effect in period 2, and then the degree of negative effect decreases and finally tends to zero. The impact of the increase in the number of integrated education personnel on the change in employment growth is zero until the second period, and then the positive and negative impact alternately affects the change in employment growth, and finally tends to zero. To summarize and analyze the reasons for this: In 2010, the Chinese Party Central Committee and the State Council promulgated the National Medium and Long-Term Education Reform and Development Plan, an initiative that indicates that education received more government support and investment during that period. Thus, in the initial period, the increase in education funding may have had a positive impact and contributed to employment growth. However, over time, the effects of other factors may gradually emerge, leading to a weakening and zero impact of increased education

spending on employment growth. Initially, the increase in the combined size of education may lead to excess supply, reaching a negative maximum impact especially in period 2. This is because the job market is temporarily unable to fully absorb the large number of education graduates. However, over time, the education system and the job market may gradually adapt and adjust, thus mitigating the negative impact and bringing the degree of impact to zero. Prior to period 2, the impact of the change in the increase in the number of educational aggregates on employment growth was zero, probably because the change in the number of educational aggregates during that period had not yet had a substantial employment effect. However, over time, the increase in the number of educationally integrated talents may have started to have an impact on employment growth, possibly because educational reform and development measures have gradually driven changes in employment opportunities and market demand for graduates. However, due to a combination of other factors, the effect of an increase in the education composite talent count on employment growth may also alternate between positive and negative effects and eventually converge to zero.

According to Figure 3, from 2018, the change in increase in education expenditure first negatively affects the change in employment growth, then positively affects the change in employment growth, and finally the effect weakly tends to zero. The impact of the change in the increase in the combined size of education and the change in the increase in the combined number of talents in education on the change in employment growth is similar, both negatively affecting the change in employment growth, and only positively affecting the change in employment growth in period 3, while the impact tends to zero afterwards. To summarize and analyze the reasons for this, in 2018, the Ministry of Education, the Ministry of Finance and the National Development and Reform Commission jointly issued the "Guidance on Accelerating the Construction of 'Double First-class' in Higher Education Institutions". This policy aims to improve the

quality and level of higher education and promote the construction of some higher education institutions to become world-class universities. However, it may take some time for such a policy adjustment to take full effect, and it will have some impact on the job market. Therefore, in the early stage of the policy implementation, the impact of the change of increase in education funding and the change of increase in the combined scale of education and the number of talents on employment growth may show a negative impact. In the impact of the change in the increase in the combined size of education and the change in the increase in the combined number of talents in education on employment growth, except for short-term fluctuations, the overall impact shows a negative impact. This may be related to the structural adjustment of the labor market. When the combined size of education and the number of talents increase, the employment market may take some time to adapt and absorb the increased labor supply. This restructuring process may lead to a negative impact on employment growth in the short run.

5. Main Findings and Recommendations

By constructing a TVP-VAR model, this paper explores whether the sustained development of education can lead to employment and obtains the following main conclusions:

(1) The positive and negative effects of changes in education spending, changes in the size of education complex and changes in the number of education complex talents on changes in employment growth fluctuate to different degrees, with the largest positive and negative fluctuations in the short term, the positive effects of changes in education spending, changes in the size of education complex and changes in the number of education complex talents on employment growth in the medium term, and the positive effects of changes in education spending, changes in the size of education complex and changes in the number of education complex talents on employment growth in the long term. In the long term, the changes in education spending, the changes in the size of education complex and the changes in the number of education complex talents have weak effects on employment growth.

(2) Enacting education-related policies can, to some extent, promote changes in employment growth.

Based on the above findings, the following recommendations are made in this paper:

(1) Improving the quality of education: Although there may be fluctuations in the impact of increased education spending, increased combined size of education and increased combined number of talents in education on employment growth, the development of education has a relatively weak impact on employment growth in the long run. Therefore, focusing on improving the quality of education is key. The government and educational institutions should work to improve the content and methods of education to ensure that education produces high quality human resources that meet the needs of a

modern economy.

(2) Continuous monitoring and adjustment of policies: The research results show that policies have an impact on the relationship between education and employment. Therefore, it is recommended that the government and relevant departments continuously monitor the effects of education policy implementation and make adjustments according to the actual situation. The policy should pay more attention to the close connection between education and employment to ensure that the development of education matches the needs of the job market.

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