

# Effect of Higher Education on GDP in Chongqing Based on VAR Model

Cheng Sun<sup>1</sup>

<sup>1</sup>School of Economics and Management, Chongqing University of Posts and Telecommunications, Chongqing 400065, China.

## Abstract

Economy and education are the foundation of modern social development, and higher education is a bridge connecting economic development and talent training. Therefore, the dynamic relationship between higher education and economic development has become a very important issue worthy of research. . Using the impulse response function, VAR model, and analysis of variance, the empirical research was conducted on the dynamic relationship between higher education and economic growth in Chongqing from 2003 to 2017. The results show that there is a long-term stable equilibrium relationship between higher education and economic growth in Chongqing.

## Keywords

Number of graduates; higher education; VAR model; gdp.

## 1. Introduction

Higher education comes along with economic and social development, and provides technical and talent support for economic and social development. Economic and social development also provides a material basis for the development of higher education. In the era of knowledge economy, the relationship between higher education and economic development is closer. Therefore, it is very important to coordinate the development of higher education and regional economy. Compared with first-tier cities, the national key universities have fewer enrollment indicators, weaker graduate training capacity in provinces, fewer national key disciplines, and insufficient scientific research capabilities. These have led to the backwardness of human resources in Chongqing, the lack of scientific and technological innovation capabilities, And the loss of high-quality talent. According to the Law of the People's Republic of China on Higher Education, higher education refers to education implemented on the basis of completing higher secondary education, including diploma education and non-degree education. The higher education studied in this article mainly refers to the education above the junior college level, that is, the education of high school graduates for full-time education, taking economic agglomeration as the entrance, combining the realistic background of China's urban-rural integration development or the initial stage, using spatial econometrics The theory, from the two dimensions of "theoretical analysis" and "empirical analysis", constructs a spatial Dubin model that links economic agglomeration and regional urban-rural integration and development, focusing on the direct impact of economic agglomeration on regional urban-rural integration and development and spatial spillover effects It is hoped that the research in this article will provide theoretical and empirical evidence for the provinces to build a system of urban-rural integration development.

## 2. Theoretical Basis

The model used in this paper is a vector autoregressive model, referred to as the VAR model, which is a commonly used econometric model. It was proposed by Christopher Sims in 1980.

The VAR model uses all current variables in the model to regression on several lagging variables of all variables. The VAR model is used to estimate the dynamic relationship of joint endogenous variables without any prior constraints. It is a generalization of the AR model, which has been widely used.

## 2.1. Variable Selection and Data Preprocessing

The main factors of higher education considered are based on the current status of development in Chongqing. From the perspective of the number of graduates from higher education, the number of colleges (JC), the number of undergraduates (RC), and the number of graduates (GS) in general colleges. This indicator measures the current state of higher education in Chongqing. In economic development indicators, commonly used per capita GDP (GDP) is used as a representative. All variables are logarithmized to eliminate the effect of the dimension. Each variable is expressed as LJC, LRC, LGS, LGDP in turn. See Appendix I for detailed data and sources.

## 2.2. VAR Model

Vector autoregression (VAR) is a model based on the statistical properties of the data. The VAR model constructs the model by using each endogenous variable in the system as a function of the lag values of all endogenous variables in the system, thereby extending the univariate autoregressive model to A "vector" autoregressive model consisting of multiple time series variables.

The VAR model describes that n variables (endogenous variables) in the same sample period can be used as a linear function of their past values.

The VAR (p) model can be written as:  $Y_t = c + A_1(y_{t-1}) + A_2(y_{t-2}) + \dots + A_p(y_{t-p}) + e_t$ , Where: c is an  $n \times 1$  constant vector, and  $A_i$  is an  $n \times n$  matrix.  $e_t$  is an  $n \times 1$  error vector, which satisfies:

—The mean of the error term is 0

—The covariance matrix of the error term is  $\Omega$  (an  $n \times n$  positive definite matrix)

(Satisfied for all k other than 0)-no autocorrelation exists for the error term.

## 3. Model and Data

### 3.1. Unit Root Test

Establishing a VAR model requires the data to be stationary or a co-integration relationship between variables. If the variables are stationary, you can use the VAR method to directly process them; if the data is not stable, you need to have co-integration relationships between variables of the same order.

**Table 1. VAR Model results**

VAR Model: =====
$GDP3RD = C(1,1)*GDP3RD(-1) + C(1,2)*GDP3RD(-2) + C(1,3)*GS3RD(-1) + C(1,4)*GS3RD(-2) + C(1,5)*JC3RD(-1) + C(1,6)*JC3RD(-2) + C(1,7)*RC3RD(-1) + C(1,8)*RC3RD(-2) + C(1,9)$
$GS3RD = C(2,1)*GDP3RD(-1) + C(2,2)*GDP3RD(-2) + C(2,3)*GS3RD(-1) + C(2,4)*GS3RD(-2) + C(2,5)*JC3RD(-1) + C(2,6)*JC3RD(-2) + C(2,7)*RC3RD(-1) + C(2,8)*RC3RD(-2) + C(2,9)$
$JC3RD = C(3,1)*GDP3RD(-1) + C(3,2)*GDP3RD(-2) + C(3,3)*GS3RD(-1) + C(3,4)*GS3RD(-2) + C(3,5)*JC3RD(-1) + C(3,6)*JC3RD(-2) + C(3,7)*RC3RD(-1) + C(3,8)*RC3RD(-2) + C(3,9)$
$RC3RD = C(4,1)*GDP3RD(-1) + C(4,2)*GDP3RD(-2) + C(4,3)*GS3RD(-1) + C(4,4)*GS3RD(-2) + C(4,5)*JC3RD(-1) + C(4,6)*JC3RD(-2) + C(4,7)*RC3RD(-1) + C(4,8)*RC3RD(-2) + C(4,9)$

To this end, the data in the model is first tested for stationarity. In this paper, the ADF unit root test is performed on the level of each variable and the first-order difference sequence to determine the single integer order of each sequence. Tables 1 and 2 are the replacement coefficients of the VAR model and the VAR model, respectively.

**Table 2.** VAR Model-Substituted Coefficients experimental results

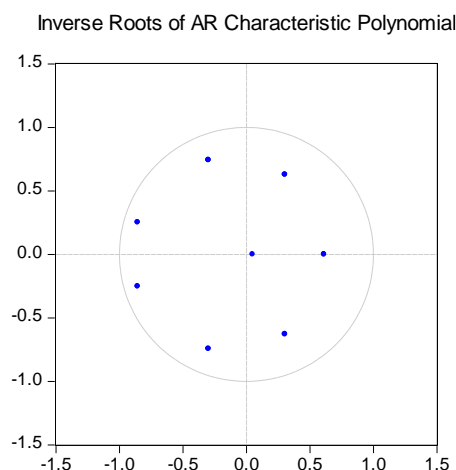
VAR Model - Substituted Coefficients: =====
GDP3RD = - 0.263839298586*GDP3RD (-1) - 0.458037354151*GDP3RD (-2) + 0.600824074036*GS3RD (-1) - 0.0349586127107*GS3RD (-2) - 0.0939376886599*JC3RD (-1) - 0.450247694085*JC3RD (-2) - 0.577341111615*RC3RD (-1) + 0.0119744726991*RC3RD (-2) - 0.000190211661063
GS3RD = - 0.410585245681*GDP3RD (-1) - 0.0230843144436*GDP3RD (-2) + 0.65973798345*GS3RD (-1) + 0.0750724057875*GS3RD (-2) + 0.860135214075*JC3RD (-1) + 0.373384098125*JC3RD (-2) - 2.04292172374*RC3RD (-1) - 1.31410593811*RC3RD (-2) - 0.00351748010101
GS3RD = - 0.410585245681*GDP3RD (-1) - 0.0230843144436*GDP3RD (-2) + 0.65973798345*GS3RD (-1) + 0.0750724057875*GS3RD (-2) + 0.860135214075*JC3RD (-1) + 0.373384098125*JC3RD (-2) - 2.04292172374*RC3RD (-1) - 1.31410593811*RC3RD (-2) - 0.00351748010101
RC3RD = - 0.084667933495*GDP3RD (-1) - 0.189945437365*GDP3RD (-2) + 0.080155061004*GS3RD (-1) + 0.0235622425187*GS3RD (-2) + 0.451188424127*JC3RD (-1) + 0.391121799426*JC3RD (-2) - 0.286045127131*RC3RD (-1) + 0.274556136053*RC3RD (-2) - 0.00771369142588

**Table 3.** ADF unit root test results

variable	ADF (t Statistics)	Critical value (5%)	smooth / Non-stationary
RC3ND	-4.120526	-3.212696(0.0129)	smooth
JC3ND	-4.587779	-3.212696(0.0066)	smooth
GS3ND	-58.46308	-3.175352(0.0001)	smooth
GDP3ND	-8.565225	-3.212696(0.0001)	smooth

### 3.2. AR root Test

If the inverses of all the root modes of the estimated VAR model are less than 1, that is, within the unit circle, the model is stable. If the model is unstable, some results such as the standard error of the impulse response function will not be valid. As shown in Figure 1, the reciprocals of all root modes of the VAR model established in this paper are within the unit circle, so the VAR model meets the stability conditions and the analysis results are reliable.



**Figure 1.** AR root modulus inverse test chart

### 3.3. Granger Causality Test

The VAR method is only a reduced form analysis, and cannot explain the causal relationship between the variables. Therefore, Granger test is needed for the causal relationship between the variables. The results in Table 5 show that P value = 0.0000. Statistically, ordinary higher education college, undergraduate and graduate graduates are all Granger reasons for GDP.

**Table 3.**

Dependent variable: GDP3RD

Excluded	Chi-sq	df	Prob.
GS3RD	1.212194	2	0.5455
JC3RD	0.913928	2	0.6332
RC3RD	0.087765	2	0.9571
All	3.967407	6	0.6811

Dependent variable: GS3RD

Excluded	Chi-sq	df	Prob.
GDP3RD	47.67731	2	0.0000
JC3RD	87.94156	2	0.0000
RC3RD	29.68907	2	0.0000
All	275.8618	6	0.0000

Dependent variable: JC3RD

Excluded	Chi-sq	df	Prob.
GDP3RD	12.49190	2	0.0019
GS3RD	1.686569	2	0.4303
RC3RD	1.329388	2	0.5144
All	55.70627	6	0.0000

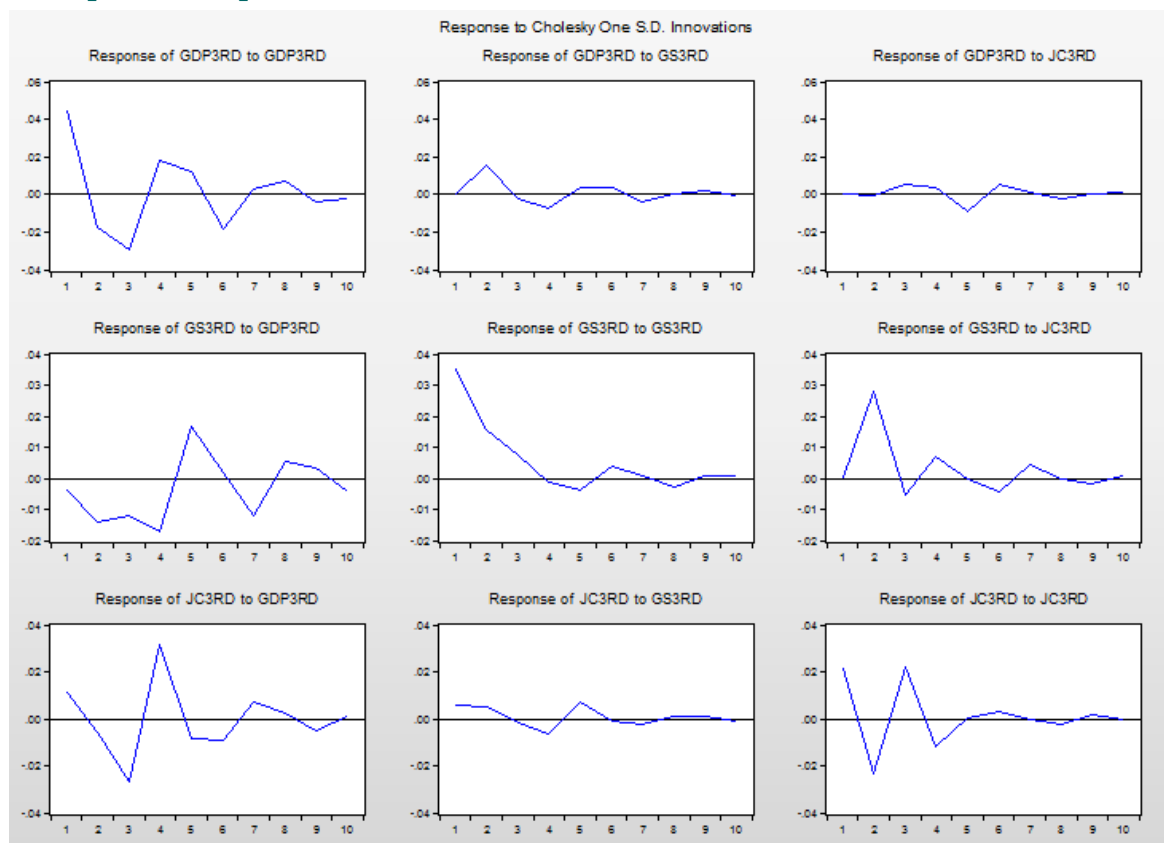
Dependent variable: RC3RD

Excluded	Chi-sq	df	Prob.
GDP3RD	3.651269	2	0.1611
GS3RD	4.786118	2	0.0913
JC3RD	9.687079	2	0.0079
All	32.15615	6	0.0000

**Table 5.** Granger causality test results

Null hypothesis	F- Statistics	P-value	Refuse/ not refuse Extinct hypothesis
Number of graduates of general higher education (jc) can cause gdp	55.70627	0.0000	Not refuse
Number of undergraduate (RC) graduates in general higher education can cause gdp	32.15615	0.0000	Not refuse
The number of graduates (gs) graduates can cause gdp	275.8618	0.0000	Not refuse

### 3.4. Impulse Response Function



**Figure 2.** Impulse response analysis

It reflects the influence of random perturbations from one unit of endogenous variables on the current and future values of each endogenous variable. From the Response of HL1ST to SJP1ST in the impulse response, it can be seen that GDP has little response to the disturbance of third-party payments. Therefore, it is further proved that the number of graduates is the Granger cause of GDP.

According to the impulse response graph, it can be seen that the interaction between the fluctuation of the number of graduates and the fluctuation of per capita GDP will eventually reach a stable value, and the stable value is zero, indicating that as the lag period increases, the previous relationship between the two is not as significant as when there are fewer lags. It can be explained that in the current development situation of Chongqing, the number of college graduates has a stronger and stronger impact on the per capita GDP, and the development mode has gradually shifted to green technology and technology-intensive industries. The per capita GDP output value will no longer be affected by the development of traditional old industry.

### 3.5. Variance Decomposition

The variance decomposition gives the relative importance information of each random perturbation that affects the endogenous variables in the VAR model. The estimation results are shown in Figure 3. From Figure 3 it can be seen more intuitively that each variable is the most responsive to its own changes.

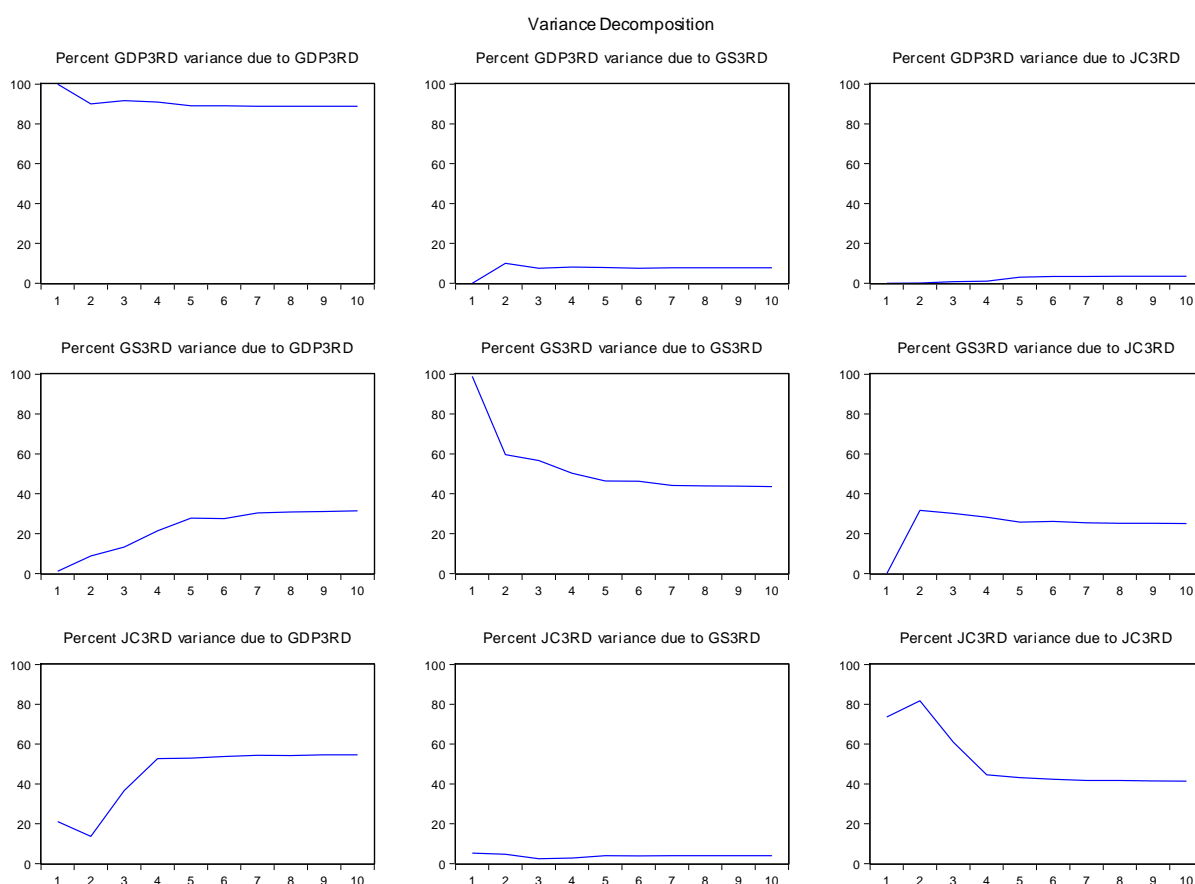


Figure 3. Analysis of variance

Separate the use of ordinary graduates from higher education to see the relationship between the variance decomposition and the GDP per capita variance decomposition. Because of the overall analysis, the variance analysis of the three graduates variables in the GDP per capita variable cannot be obtained. The relationship between the number of graduates of ordinary

colleges and universities (JC) and the change in per capita GDP in the variables with significant correlation is shown in the fifth graph and the last graph. The number of graduates and the number of graduates of colleges and universities in general In the analysis of variance, the impact of GDP fluctuations on its fluctuations is more significant. It also verifies the previous analysis. In recent years, Chongqing's economic development process is entering the transformation and development process of technical and research talents, and its undergraduate graduation index At present, it has little effect on the fluctuation of Chongqing's economic development. The main influencing factors are still focused on basic technology and scientific research.

#### 4. Research Conclusions and Recommendations

This article takes the annual data from 2003 to 2017 as the research object. Through empirical analysis, it is shown that the number of graduates of colleges, universities and graduates in Chongqing general colleges and universities is the Granger cause of GDP. GDP has an important impact. Relevant authorities need to grasp talent training and academic research in basic technology and science, and gradually improve the system of talent training.

As one of the four municipalities directly under the Central Government, Chongqing should pay more attention to the coordinated development of higher education and the economy. In order to better play the role of higher education in promoting the economy, first of all, the government must increase support for higher education, increase investment in education funding, and broaden the sources of education funding, such as sharing government investment in the form of education welfare lottery The pressure of education. Secondly, it is necessary to promote the growth of high-quality educational resources through the method of "point-to-point and face-to-face". The government should focus on superior resources to upgrade and reform higher-qualified universities in the province, support its construction of key laboratories, develop key disciplines, and further strengthen its role as a model for Chongqing's higher education. Finally, the advantages of enterprises should be brought into full play, and the government should take the initiative to provide bridges, provide support in terms of policies, funds, and land, promote cooperation between universities and enterprises, and speed up the transformation of scientific and technological achievements. The personnel went to the production line of the enterprise for study and study.

#### References

- [1] Rober E Lucas. On the mechanics of economic develop-ment [J]. Journal of Monetary Economics, 1988, 22:42.
- [2] Liu Anzhen. On the Changes of Higher Education's Contribution to Economic Growth before and after Enrollment Expansion of Colleges and Universities [J]. Statistical Education, 2009 (6): 60-64.
- [3] Zou Yang, Li Lin. Analysis of regional differences in the degree of coordinated development of higher education and regional economy [J]. Higher Education Exploration, 2008 (3): 44-48.
- [4] Miao Hong. Research on Complexity and Coordinated Development of "Higher Education Economy" Compound System [D]. Tianjin: Tianjin University, 2004.

### Appendix : Data Source: Official Website of China National Bureau of Statistics and Chongqing Statistical Yearbook

Year	Number of general college graduates (person)	Number of general undergraduate graduates (person)	Number of graduate students (person)	GDP per capita (yuan)
2003	948000	929598	2646	8091
2004	1195000	1196290	127331	9624
2005	1602000	1465786	162051	10982
2006	2048000	1726674	219655	12437
2007	2482000	1995944	270375	16629
2008	2863000	2256783	301066	20490
2009	2856000	2455359	322615	22920
2010	3164000	2590535	334613	27596
2011	3285000	2796229	379705	34500
2012	3209000	3038473	434742	38914
2013	3187000	3199716	460487	43223
2014	3180000	3413787	482210	47850
2015	3223000	3585940	497744	52321
2016	3298000	3743680	508927	58502
2017	3516000	3841839	520013	63442