

## Research Article

# An Empirical Study on the Relationship between Education and Economic Development Based on PVAR Model

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In order to effectively analyze the dynamic relationship between education and economic development, an empirical study on the relationship between education and economic development based on the PVAR model is proposed. This article expounds on the principles, assumptions, identification, and estimation methods of the PVAR model, takes the education level and economic development level as the research object, explains the corresponding variables, and selects the indicators. Using Cobb–Douglas production function as a theoretical model, this article analyzes the theoretical relationship between the education level and economic development level. Based on this theoretical relationship, this article makes an empirical analysis on the relationship between education level and economic development level using the PVAR model. The results show that, on the whole, economic development can drive the development of education, but there are obvious regional differences in the impact of economic growth on the development of education. The impact of economic growth in the eastern region on education is significantly higher than that in the central and western regions. There is an interactive relationship between education level and economic development level, and there is a certain incubation period for education level and economic development level to play their role.

## 1. Introduction

As a major undertaking involving the national economy and the people's livelihood, education affects not only the inheritance of a country's national culture and spiritual wealth but also the sustainable and healthy development of a country's economy and society [1–3]. Economic development is one of the most indispensable links in the development of all countries in the world and one of the most basic parts in the history of human development. Economic development provides power and guarantee for the activities of all countries and other human beings [4–6]. Education and economic development are closely related. Education is the technical means of economic development, and economic development is the driving force and guarantee of educational development. In order to achieve good economic development, a country must improve the quality of its human resources and do a good job in the development of human resources and scientific management, and education is the key to the work [7–9].

The innovation ability of a country's knowledge, technology, and management is determined by the country's education level. In turn, the improvement of economic level urges people to improve their demand for educational activities and improve their value and taste through more educational activities. With the continuous improvement of ability and values, people will put forward higher requirements for the current educational system and form to meet the future learning needs. However, the existing research ignores the research on the direct contribution of education investment or education expenditure to economic growth. Most of the existing quantitative studies focus on the long-term impact and indirect contribution of education to economic growth and follow the idea of education → improvement of labor quality → economic growth. However, the education sector is an important part of the tertiary industry. Theoretically, the investment in education and increasing education expenditure will inevitably directly drive the development of the tertiary industry. However, there is a lack of quantitative research in this field.

Although China has made great achievements in education and economic development, on the whole, China has a vast territory, the development situation and relevant policies are different in various regions, and there are great differences in the education level and economic development in various regions [10–12]. Moreover, the education level in most areas lags behind the local economic development level, which not only does not give full play to the role of education in promoting economic development but also seriously hinders the further development of the local economy [13–15]. Therefore, this article proposes an empirical study on the relationship between education and economic development based on the PVAR model. Firstly, based on the theoretical analysis results of the PVAR model, then the two variables of education level and economic development level are explained and the indicators are selected. Finally, the Cobb–Douglas production function is used to analyze the theoretical relationship between education level and economic development level so as to provide a theoretical basis for empirical analysis.

## 2. Theoretical Basis of PVAR Model

Holtz Eakin (1987) first used the PVAR model to analyze the interaction between endogenous variables of panel data. He studied the vector autoregressive model of panel data; that is, all variables are regarded as endogenous variables to analyze the relationship between each variable and its lag term. Using panel data, the PVAR model can not only effectively solve the problem of individual heterogeneity but also fully consider individual and time effects.

**2.1. Principle of PVAR Model.** The PVAR model is a problem of establishing VAR based on panel data [16–18]. The general model of PVAR can be expressed as follows:

$$Y_{i,t} = \tau_i + \sum_{k=1}^m \Phi_{l,k} Y_{i,t-k} + \sum_{j=1}^m \psi_{l,j} X_{i,t-j} + \gamma_i + u_{i,t}. \quad (1)$$

In formula (1),  $Y_{i,t}$  is the  $M \times 1$  vector of  $M$  observable variables of section individual  $i$  at time point  $t$ ,  $X_{i,t}$  is the  $M \times 1$  vector of observable deterministic strictly exogenous variables,  $\Phi_{l,k}$ ,  $\psi_{l,i}$  is the coefficient matrix to be estimated of  $M \times M$ ,  $\gamma_i$  is the unobservable  $M$  individual fixed effect matrix of individual  $i$ , and  $u_{i,t}$  is the random error term [19–21].

In practical application, it is often the case that the coefficient matrix to be estimated of the lag endogenous and exogenous variables is not time-varying; that is,

$$Y_{i,t} = \tau_i + \sum_{k=1}^m \Phi_k Y_{i,t-k} + \sum_{j=1}^m \psi_j X_{i,t-j} + \gamma_i + u_{i,t}. \quad (2)$$

### 2.2. PVAR Model Assumptions.

Hypothesis 1: for any number of individuals  $N$  and period length  $T$ ,  $Y_{1,t}, Y_{2,t}, \dots, Y_{N,T}$  is an observable variable.

Hypothesis 2: for any  $i = 1, \dots, N$ ,  $t = 1, \dots, T$ ,  $u_{i,t}$  is an independent and identically distributed random variable whose random error term satisfies zero expectations and the covariance matrix is  $\Omega$ ; that is,  $u_{i,t} \sim i.i.d(0, \Omega)$ .

Hypothesis 3: when  $s < t$ ,  $Y_{i,t}$ ,  $X_{i,t}$ , and  $\gamma_i$  are orthogonal to the random error term; that is,

$$\begin{aligned} E[Y_{i,s}] &= E[X_{i,s}] \\ &= E[\gamma_i] = 0, \quad (s < t). \end{aligned} \quad (3)$$

According to the above assumptions, a foundation is laid for the identification of coefficients, lag period, and other parameters of the PVAR model in the next step.

**2.3. PVAR Model Identification.** The so-called model identification refers to the estimation and judgment of parameters such as coefficients and lag period in the model [22–24].

The first-order difference of formula (2) can be obtained:

$$\Delta Y_{i,t} = \Delta \sum_{k=1}^m \Phi_k Y_{i,t-k} + \Delta \sum_{j=1}^m \psi_j X_{i,t-j} + \Delta u_{i,t}. \quad (4)$$

From Hypothesis 3, we know that when  $s < t - 1$ , the following is

$$\begin{aligned} E[\Delta Y_{i,s}] &= E[\Delta X_{i,s}] \\ &= 0, \quad (s < t - 1). \end{aligned} \quad (5)$$

Assuming that  $y_{i,t}^j$  is the  $j$  variable in the economic variable vector  $Y_{i,t}$ , the first-order difference model of  $y_{i,t}^j$  is expressed as a vector:

$$\Delta y_{i,t}^j = \sum_{k=1}^m \Phi_k^j \Delta Y_{i,t-k} + \sum_{l=1}^m \psi_l^j \Delta X_{i,t-l} + v_{i,t}^j. \quad (6)$$

In formula (6),  $v_{i,t}^j$  is the random error term of the single-equation first-order difference model with the endogenous variable  $y_{i,t}^j$  [25–27]. Therefore, from the orthogonality condition of Hypothesis 3, formula (6) has a vector of instrumental variables:

$$Z_{i,j} = [1, \Delta Y'_{i,t-2}, \Delta Y'_{i,t-3}, \dots, \Delta Y'_{i,2}, \Delta X'_{i,t-2}, \Delta X'_{i,t-3}, \dots, \Delta X'_{i,2}]. \quad (7)$$

That is, the number of instrumental variables in formula (6) is  $2t - 3$ .

**2.4. PVAR Model Parameter Estimation.** This article mainly studies the fixed effect PVAR (1) model with a common deterministic event trend. The conclusion of the PVAR (1) model can be simply deduced and can be applied to PVAR ( $m$ ) model. Therefore, this article focuses on the GMM estimation of the fixed effect PVAR (1) model. The fixed effect PVAR (1) model is as follows:

$$(I_m - \phi L)(Y_{i,t} - \gamma_i - \delta) = u_{i,t}. \quad (8)$$

The GMM estimation process of formula (8) is as follows:

$$\Delta Y_{i,t} - \delta = \phi(\Delta Y_{i,t-1} - \delta) + \Delta u_{i,t}, \quad (t = 2, 3, \dots, T). \quad (9)$$

Thus, the moment condition is obtained:

$$E\left\{\left[(\Delta Y_{i,t} - \delta) - \phi(\Delta Y_{i,t-1} - \delta)\right]Q_{i,t}^T\right\} = 0, \quad (t = 2, 3, \dots, T), \quad (10)$$

where  $Q_{i,t}^T = (1, Y_{i,0}^T, Y_{i,1}^T, \dots, Y_{i,t-2}^T)^T$ .

Let  $\Delta Y_i = (\Delta Y_{i,2}, \dots, \Delta Y_{i,T})^T$ ,  $\Delta u_i = (\Delta u_{i,2}, \dots, \Delta u_{i,T})^T$ ,  $\Delta Y_{i-1} = (\Delta Y_{i,1}, \dots, \Delta Y_{i,T-1})^T$ , and  $R_i = [\Delta Y_{i-1}, I_{T-1}]$ ,  $\Lambda = [\phi, \psi]$ ,  $\psi = [I_m - \phi]\delta$ , “stack”  $T - 1$  formula (9) to get the following:

$$\Delta Y_i = R_i \Lambda + \Delta u_i, \quad i = 1, 2, \dots, N. \quad (11)$$

Meanwhile, formula (11) multiplies the left tool variable matrix:

$$Q_i = \begin{bmatrix} Q_{i2} & 0 & \cdots & 0 \\ 0 & Q_{i3} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & Q_{iT} \end{bmatrix}, \quad (12)$$

$$Q_i \Delta Y = Q_i R_i \Lambda + Q_i \Delta u_i.$$

By solving the minimization problem [28–30],

$$\min_{\lambda} \sum_{i=1}^N (Q_i \otimes I_m) \text{Vec}(\Delta Y_i) - (Q_i R_i \otimes I_m) \text{Vec}(\Lambda). \quad (13)$$

Get  $\Lambda$ 's estimate. The following is

$$\Sigma = \begin{bmatrix} 2\Omega & -\Omega & \cdots & 0 \\ -\Omega & 2\Omega & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 2\Omega \end{bmatrix}. \quad (14)$$

Moreover, by solving the moment condition equation,

$$E\left\{\left[(\Delta Y_{i,t} - \delta) - \phi(\Delta Y_{i,t-1} - \delta)\right] - 2\Omega\right\} = 0, \quad (t = 2, 3, \dots, T). \quad (15)$$

The covariance matrix  $\Omega$  of  $u_{i,t}$  can be estimated. If all the roots of the characteristic formula (11) are outside the unit circle, that is, the model formula (11) is a trend-stationary PVAR process, then when  $N \rightarrow \infty$ , the above GMM estimation is consistent and obeys the asymptotic normal distribution.

### 3. Theoretical Model Analysis of the Relationship between Education and Economic Development

Firstly, the two variables of education level and economic development level are explained and the indicators are selected; then, the theoretical relationship between education level and economic development level is analyzed based on

Cobb–Douglas production function [31–33], which puts forward a theoretical basis for the empirical analysis of the interaction between the two.

**3.1. Model Description.** Due to the great limitations of the VAR model in the application process, the results obtained can be true and reliable only when the number of variables is small. The advantage of panel data is that it can collect a large number of sample observations. Therefore, the effective measure to solve the limitations of the VAR model is to combine the panel and VAR model, which gives birth to the panel data vector autoregressive model (PVAR).

In recent years, the PVAR model has been widely used, especially in studying the impact of economic fluctuations on the world, countries, and industries. Therefore, this article analyzes the relationship between education and economic development with the help of this model.

The PVAR model is expressed by the following formula:

$$y_{it} = \alpha_{i,0} + \sum_{j=1}^p \alpha_{i,0} y_{i,t-j} + \gamma_i + \theta_t + \varepsilon_{it}. \quad (16)$$

In formula (16),  $i$  represents region,  $t$  represents time,  $j$  represents lag period,  $\gamma_i$  represents individual effect,  $\theta_t$  represents time effect, and  $\varepsilon_{it}$  represents random disturbance term.

According to the above theoretical model, PVAR studies the relationship between education and economic development. PVAR inherits the advantages of the VAR model, regards the research variables as endogenous variables, and takes each endogenous variable as a function of the lag value of all endogenous variables in the system so as to provide a rich structure and capture more characteristics of the data. In addition, the PVAR model allows individual effects and heteroscedasticity in the data. Due to the existence of a large number of cross-sectional data, the model allows the lag coefficient to change with time, relaxing the requirements of time stationarity of the data.

**3.2. Index Selection.** According to the above model, the following two indicators are selected to analyze the relationship between education and economic development.

- (1) Education level: the development of education can also reflect a country's comprehensive national strength. In order to eliminate the influence of population and synthesize the topics and content involved in this article, the number of college students per 100000 population is selected as the index to measure the level of education.
- (2) Economic development level: economic development refers to the improvement of a country or region's economic structure, the innovation of social structure, the quality of social life, the improvement of consumption capacity, and input-output efficiency [34–36]. China's population base is large, and the population distribution in various regions is also inconsistent. In order to eliminate the impact of the

population, combined with the research theme and content of this article, per capita GDP is selected to measure the level of economic development.

**3.3. Theoretical Relationship Analysis.** In order to better explore the theoretical relationship between education level and economic development level, the Cobb–Douglas production function model is used as the analysis basis, education is incorporated into labor factors, economic development is used as output, and an economic growth model is constructed. Construct a production function for the  $i$  city:

$$P_i = A_i (M_i \cdot M_i')^\beta v. \quad (17)$$

In formula (17),  $P_i$  represents the economic output,  $A_i$  represents the technical level,  $M_i$  represents the education factors in labor factors,  $M_i'$  represents the other factors in labor factors, and  $v$  represents the disturbance terms. Taking the natural logarithm on both sides of formula (17), we have the following:

$$\ln P_i = \ln A_i + \beta (\ln M_i \cdot \ln M_i') + \ln v. \quad (18)$$

Using lowercase letters to replace formula (18) and calculating the growth rate between  $t$  period and  $t - 1$  period, you can get the following:

$$\dot{p} = \dot{a} + \dot{\beta}(\dot{m} + \dot{m}'). \quad (19)$$

Then, dividing both sides of formula (19) by  $p_{t-1}$  at the same time to calculate the  $EG_t$  path value of the equilibrium economic growth rate in period  $t$ , we can get the following:

$$EG_t^\delta = \frac{\dot{p}_t}{p_{t-1}} = \frac{1}{p_{t-1}} [\dot{a} + \dot{\beta}(\dot{m} + \dot{m}')]. \quad (20)$$

The deviation of economic growth is as follows:

$$\begin{aligned} \text{res}_t &= ERG_t - EG_t^\delta = ERG_t - \frac{\dot{p}_t}{p_{t-1}}, \\ &= ERG_t - \frac{1}{p_{t-1}} [\dot{a} + \dot{\beta}(\dot{m} + \dot{m}')]. \end{aligned} \quad (21)$$

Based on the principle of production function and the above inference, we can know that economic growth benefits from investment in education, which can explain the relationship between economic development level and education level.

## 4. Empirical Research

In order to further analyze the dynamic relationship between China's education level and economic development level, a PVAR model is established for empirical research. At the same time, Stata11.0 and Eviews9.0 software are used to estimate the parameters of the system, obtain variance decomposition and impulse response function, so as to accurately analyze the impact force and action direction between them.

**4.1. Stability Test.** Before establishing the PVAR model, it is necessary to judge whether each variable is stable, that is, whether the collected data has a unit root. Use edu and eco to represent the level of education and economic development after processing. This article chooses the LLC test and PP-Fisher test in the unit root test method. Using the software Eviews9.0, the results of the unit root test for each variable or its difference value are shown in Table 1.

In Table 1,  $d(\cdot)$  represents the first-order difference of variables. The numerical value represents the  $t$  value obtained by the unit root test of the variable.  $***$ ,  $**$ ,  $*$  all mean that the  $t$  value is significant at the level of 1%, 5%, and 10%, respectively.

According to Table 1, the two variables in the whole country are stationary series, so the two variables in the whole country are  $I(0)$  processes. The first-order differences of the two variables in the eastern, central, and western regions are stationary sequences, so each variable in these three regions is an  $I(1)$  process.

**4.2. Determination of Lag Period of PVAR Model.** After determining the stationarity of the model variables, the next step is to determine the lag period suitable for constructing the PVAR model. This article selects the AIC information criterion, BIC information criterion, and HQIC information as the method of determining the lag period. The lag period of the model is tested using Stata11.0, and its specific procedures and operating steps are borrowed from the Stata package of the PVAR model. The specific test results are shown in Table 2.

According to Table 2, according to the criterion of minimum information value, the lag of the PVAR model suitable for the whole country is 4, and the lag of the PVAR model suitable for the eastern region is 4. The lag of the PVAR model suitable for the central region is 3, and the lag of the PVAR model suitable for the western region is 4.

**4.3. Estimation of the PVAR Model.** In order to ensure the stability of the model and the accuracy of parameters, the mean difference method and the previous difference method on the cross-section need to be used to eliminate the time effect and individual fixed effect of variables, respectively, before estimating the model. In this article, the method of estimating the model is the generalized moment estimation method (GMM estimation Method). The specific GMM estimation results of the PVAR model are shown in Table 3.

According to Table 3, (1) taking the level of economic development as the explanatory variable, on the whole, the level of economic development has a positive effect on itself. This positive effect is more obvious in the whole country and the eastern region. That is, the estimated coefficients of lag periods 1 to 4 are greater than 0 and significant at the significance level of 5%, which also shows that the economic development of the whole country and the eastern region in the previous period has a strong role in promoting its own later development. In terms of the four levels of education, its overall effect on the level of economic development shows positive and negative fluctuations. That is, the lagging education level sometimes has a

TABLE 1: Unit root test of each variable.

Area	Variable	LLC	PP-Fisher
Whole country	eco	-12.4798 ***	211.987 ***
	edu	-12.9384 ***	389.478 ***
East	d (eco)	-6.12987 ***	54.5919 ***
	d (edu)	-10.1687 ***	105.857 ***
Central	d (eco)	-4.38465 ***	30.6987 **
	d (edu)	-11.4721 ***	31.9172 **
West	d (eco)	-2.18765 **	47.7794 ***
	d (edu)	-7.57986 ***	81.3957 ***

TABLE 2: PVAR model lag period test.

Area	Lag order (lag)	AIC	BIC	HQIC
Whole country	1	-5.74972	-5.24832	-5.54873
	2	-6.82687	-6.21346	-6.58397
	3	-6.84425	-6.11079	-6.55247
	4	-7.10294 *	-6.23894 *	-6.75793 *
East	1	-5.47135	-4.3569	-5.02183
	2	-4.9148	-3.47178	-4.33353
	3	-6.83473	-5.01248	-6.10198
	4	-9.39398 *	-7.1241 *	-8.48669 *
Central	1	-7.61029	-6.1839	-7.04317
	2	-8.09864	-6.21294	-7.36417
	3	-11.1023 *	-8.64367 *	-10.1748 *
	4	-9.72284	-6.53641	-8.67687
West	1	-4.29124	-3.24568	-3.85558
	2	-3.42365	-2.08721	-2.88471
	3	1.47024	3.15289	2.15097
	4	-7.52485 *	-5.45487 *	-6.70127 *

TABLE 3: GMM estimation results of the PVAR model.

Area	Variable	h_eco		h_edu	
		Coef.	t	Coef.	t
Whole country	L1.h_eco	1.358 ***	-5.04	0.682 ***	-3.26
	L1.h_edu	0.12	-1.06	0.372 ***	-2.62
	L2.h_eco	0.968 ***	-4.28	0.624 ***	-3.12
	L2.h_edu	-0.329 ***	-2.67	0.186 ***	-3.68
	L3.h_eco	0.657 ***	-3.18	0.274	-2.68
	L3.h_edu	0.682 ***	-4.34	0.319 ***	-1.57
	L4.h_eco	0.828 ***	-3.34	0.457 **	-2.36
	L4.h_edu	-0.003	-0.02	0.081	-0.79
East	L1.h_eco	0.748 ***	-4.02	0.717 ***	-3.52
	L1.h_edu	-0.249	-1.05	0.293	-0.93
	L2.h_eco	0.379 **	-2.13	0.589 **	-2.3
	L2.h_edu	0.338	-1.45	0.212	-0.78
	L3.h_eco	1.429 ***	-5.87	1.329 ***	-4.26
	L3.h_edu	-0.710 ***	-4.02	-0.639 ***	-3.15
	L4.h_eco	1.564 ***	-6.68	1.576 ***	-5.38
	L4.h_edu	-0.177	-1.35	0.116	-0.64
Central	L1.h_eco	0.429 ***	-2.82	-0.32	-0.56
	L1.h_edu	0.812 ***	-2.7	-2.412 **	-2.38
	L2.h_eco	-2.312 ***	-3.24	2.977	-1.03
	L2.h_edu	0.131	-1.08	-0.052	-0.26
	L3.h_eco	-0.055	-0.28	-0.209	-0.45
	L3.h_edu	-0.130	-0.54	-0.35	-0.43
	L4.h_eco	0.612 ***	-3.67	-1.716 **	-2.38
	L4.h_edu	-0.366 ***	-2.69	1.245 **	-2.52

TABLE 3: Continued.

Area	Variable	h_eco		h_edu	
		Coef.	t	Coef.	t
West	L1.h_eco	0.539 **	-2.6	-0.454	-0.99
	L1.h_edu	0.031	-0.18	0.781 **	-2.42
	L2.h_eco	0.716 ***	-8.83	0.314 **	-2.24
	L2.h_edu	-0.054	-0.36	0.782 ***	-2.59
	L3.h_eco	-0.256	-1.43	0.845*	-1.96
	L3.h_edu	1.167 ***	-12.33	0.492 ***	-3.32
	L4.h_eco	0.798 **	-2.45	-2.433 ***	-3.64
	L4.h_edu	-0.186	-0.81	1.069 **	-2.14

positive effect on the level of economic development and sometimes shows a negative effect. This shows that the level of education and the level of economic development have strong sensitivity and force. At the same time, it can also show that the driving effect of education level on economic development level is not easy to appear in a short time. Based on the analysis of the above GMM estimation results, we can know that the economy plays a strong role in promoting its own development, and this role is more obvious in the eastern region. (2) Taking the education level as the explanatory variable, considering the economic development level of each region at the four levels, although several periods of economic development level have a negative effect on the education level, the overall economic development level still has a positive effect on the education level. Especially in the eastern region, the lagging economic development level of phases I, III, and IV has a significant positive effect on the level of education, which also shows that the rapid economic development on the whole can promote the development of education. As far as the education level itself is concerned, the education level at the national level and the western region has an obvious positive effect itself, which also shows that the current development of education in the whole country and the western region will play a strong role in promoting the development of education in the future. The positive effect of the education level in the eastern and central regions on themselves is not obvious and sometimes even inhibits their own development. Based on the analysis of this part, we can know that the development of education is largely due to rapid economic growth. There are regional differences in the role of education in promoting itself. Education in the western region can promote its own development positively, while the eastern and central regions are just the opposite.

#### 4.4. Result Analysis of PVAR Model

**4.4.1. Impulse Response Function Analysis.** The PVAR model usually discussed is essentially a system, which is composed of variables. Therefore, when estimating the model, the focus of the analysis is not only to analyze the impact of the change of a variable on another variable but also to analyze the dynamic response of the whole model system when a variable changes. Specifically, it is first to give the impact of a unit positive standard deviation to the error term and then observe the changes of endogenous variables in subsequent periods. This method is called impulse response function (IRF).

*Analysis of Impulse Response Function in the Whole Country.* After 500 runs of Monte Carlo simulation, when the level of economic development is impacted by a unit of positive standard deviation, the level of economic development and education will respond. The IRF of the whole country under the level of economic development is shown in Figure 1.

As can be seen from Figure 1, for the whole country and region, when the economic development level is impacted by a unit positive standard deviation, the response of economic development level and education level generally reflects a positive impact, and this impact has a long-lasting effect. This also shows that economic growth can promote the development of its own economy and education.

When the education level is impacted by a unit's positive standard deviation, the economic development level and education level respond, and the IRF of the whole country under the education level is shown in Figure 2.

As can be seen from Figure 2, for the whole country and regions, when the education level is impacted by the positive standard deviation of a unit, the response of the education level itself and the economic development level is in a fluctuating state. Still, it generally shows a negative impact, which also reflects that the development of education is difficult to promote economic development in the short term.

*Analysis of Impulse Response Function in the Eastern Region.* After 500 Monte Carlo simulations, when the economic development level is impacted by a unit positive standard deviation, the economic development level and education level respond. The IRF of the eastern region under the economic development level is shown in Figure 3.

As can be seen from Figure 3, for the eastern region, when the economic development level is impacted by a unit positive standard deviation, the response of economic development level and education level generally shows a positive impact, and this positive impact reaches the peak in phase IV. It can be seen that the impact of economic growth in the eastern region on its own economy and education is sustainable.

When the education level is impacted by a unit positive standard deviation, the economic development level and education level respond. The IRF of the eastern region under the education level is shown in Figure 4.

As can be seen from Figure 4, for the eastern region, when the education level is impacted by a unit positive

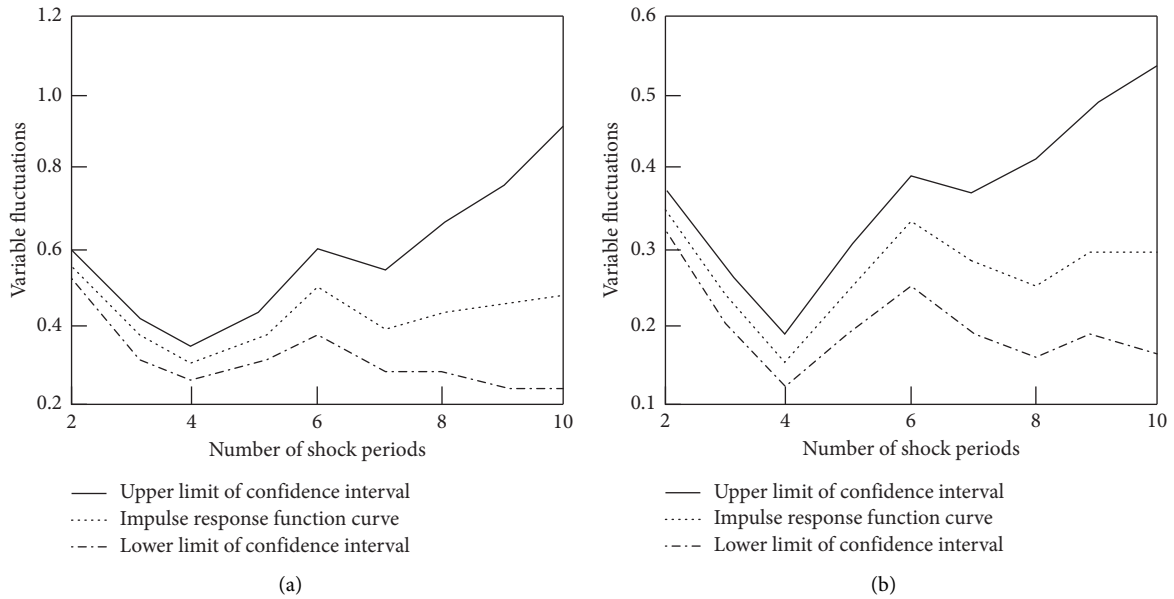


FIGURE 1: Impulse response function of the whole country under the level of economic development. (a) Response to the level of economic development. (b) Education level response.

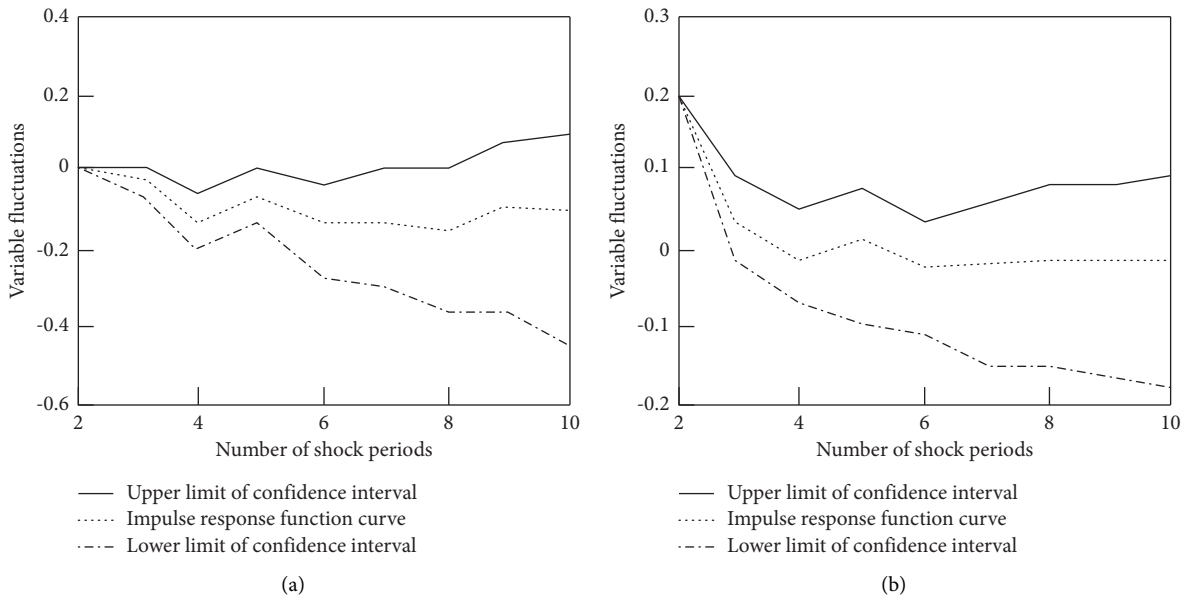


FIGURE 2: Impulse response function of the whole country under the educational level. (a) Response to the level of economic development. (b) Education level response.

standard deviation, the response of economic development level and education level shows a negative impact in the first four periods, while the response of the following three shows a positive impact. This shows that education in the eastern region has a certain incubation period to promote education itself and the economy.

*Analysis of Impulse Response Function in the Central Region.* After 500 Monte Carlo simulations, when the economic development level is impacted by a unit positive standard deviation, the economic development level and

education level respond. The IRF of the central region under the economic development level is shown in Figure 5.

As can be seen from Figure 5, for the central region, when the economic development level is impacted by a unit positive standard deviation, the response of the economic development level itself shows a positive impact, while the response of the education level fluctuates between positive and negative effects. This also shows that the economic growth of the central region can drive the development of its own economy and education to a certain extent.

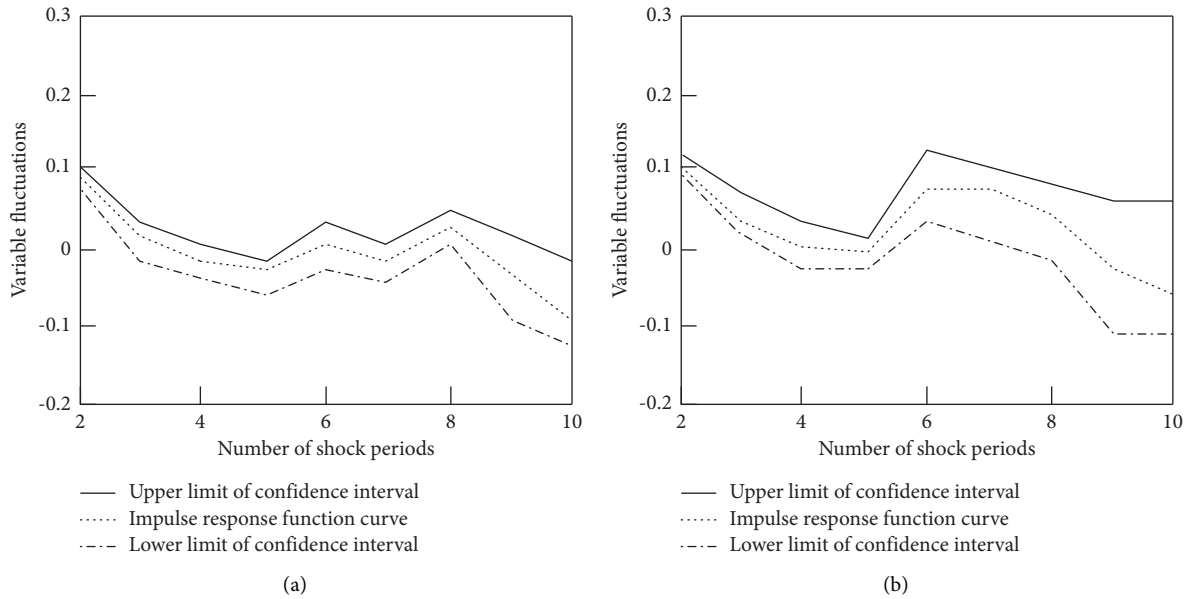


FIGURE 3: Impulse response function of the eastern region under the level of economic development. (a) Response to the level of economic development. (b) Education level response.

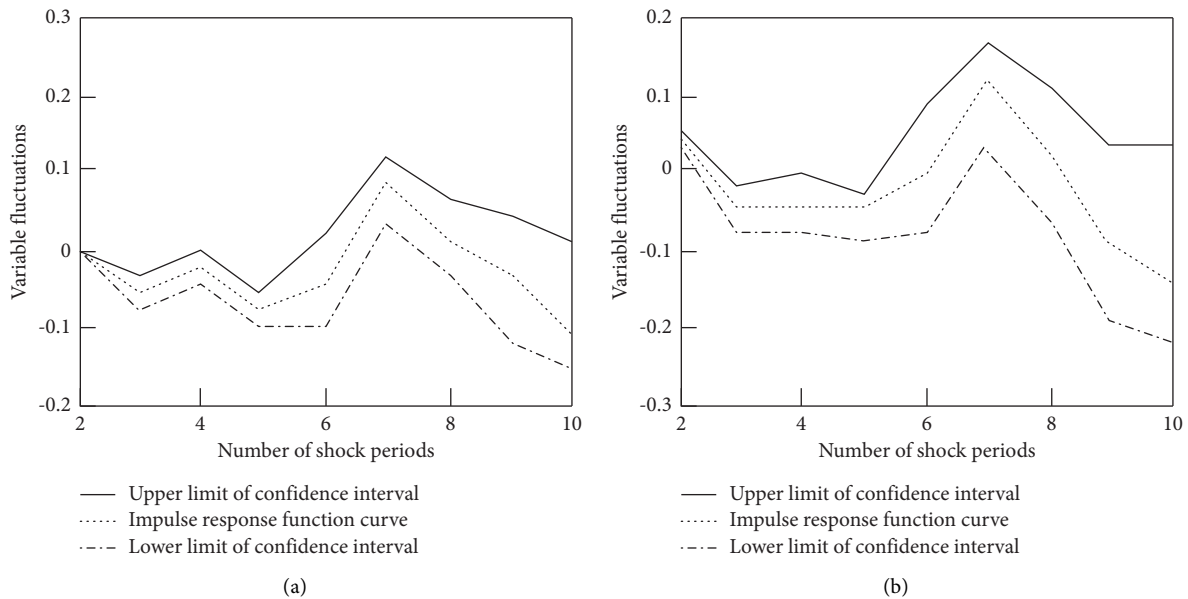


FIGURE 4: Impulse response function of the eastern region under education level. (a) Response to the level of economic development. (b) Education level response.

When the education level is impacted by a unit positive standard deviation, the economic development level and education level respond. The IRF of the central region under the education level is shown in Figure 6.

As can be seen from Figure 6, for the central region, when the education level is impacted by a unit positive standard deviation, the responses of economic development level and education level fluctuate between positive and negative effects, and there will be a relatively large positive response in the latter three. This also shows that the development of education in the central region has a certain

incubation period to promote its own economy and education.

*Analysis of Impulse Response Function in the Western Region.* After 500 Monte Carlo simulations, when the economic development level is impacted by a unit positive standard deviation, the economic development level and education level respond. The IRF of the western region under the economic development level is shown in Figure 7.

As can be seen from Figure 7, for the western region, when the economic development level is impacted by a unit positive standard deviation, the response of the economic



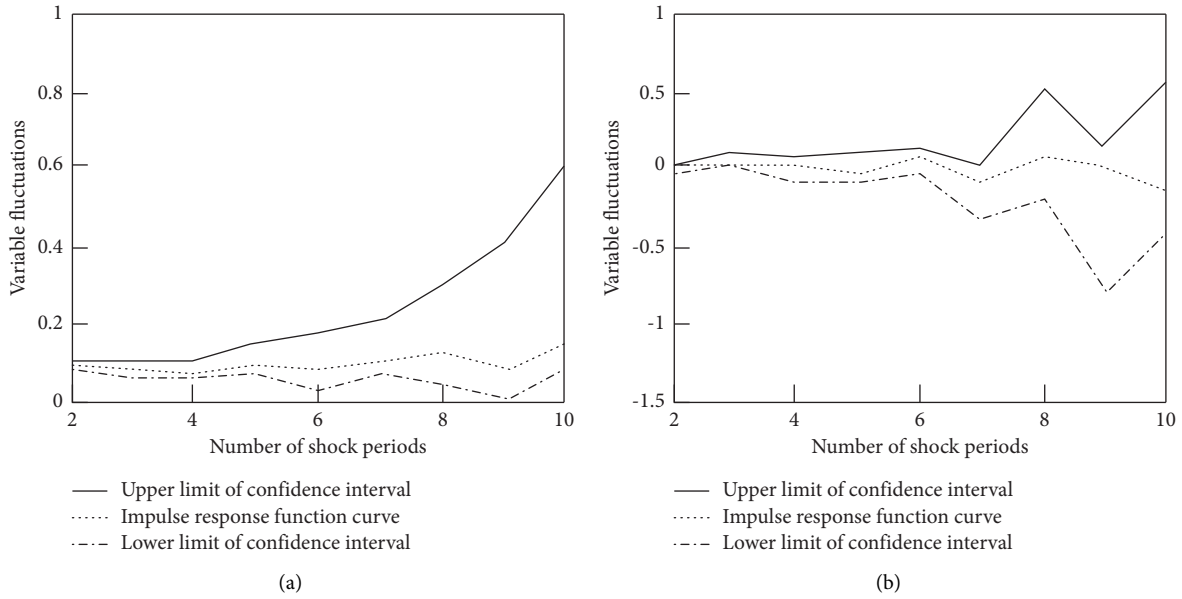


FIGURE 5: Impulse response function of the central region under the level of economic development. (a) Response to the level of economic development. (b) Education level response.

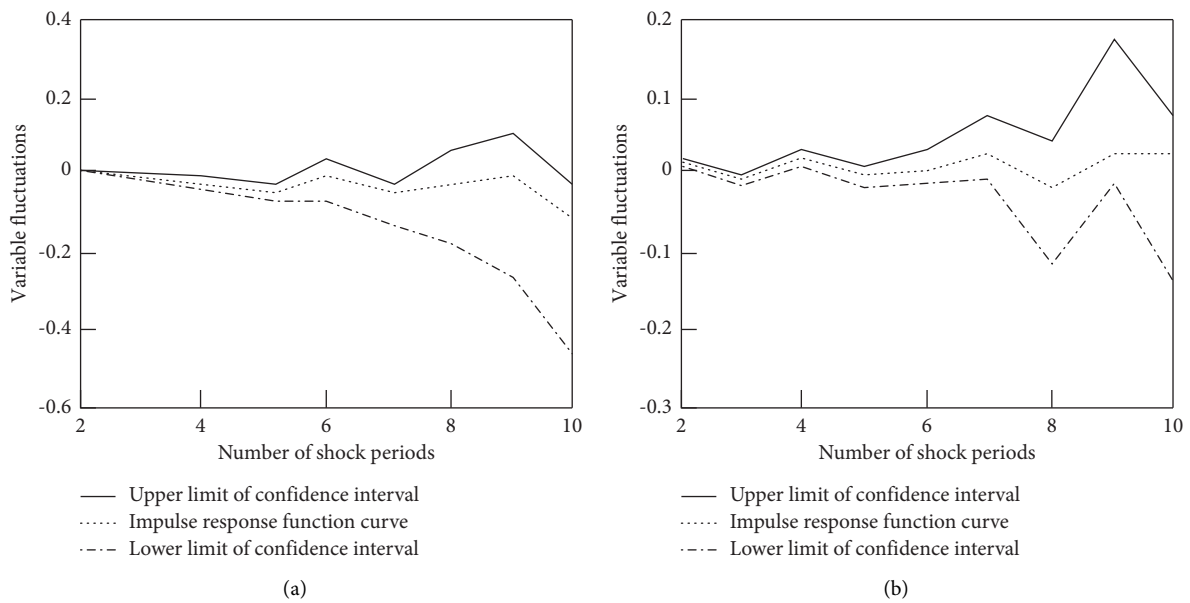


FIGURE 6: Impulse response function of the central region under education level. (a) Response to the level of economic development. (b) Education level response.

development level itself in the first two periods shows a positive impact, while the response of the education level basically shows a negative impact, but the response range is relatively small.

When the education level is impacted by a unit positive standard deviation, the economic development level and education level respond. The IRF of the western region under the education level is shown in Figure 8.

As can be seen from Figure 8, for the western region, when the education level is impacted by a unit positive

standard deviation, the responses of economic development level and education level are roughly the same. In the previous periods, neither of them will be affected, and the response values of the latter two have a slow upward trend. This shows that the promotion of the development of education in the west to its own economy and education is not easy in a short time.

Combining the results of IRF analysis at four levels, we can get the results similar to GMM estimation analysis: economic growth can not only drive its own development

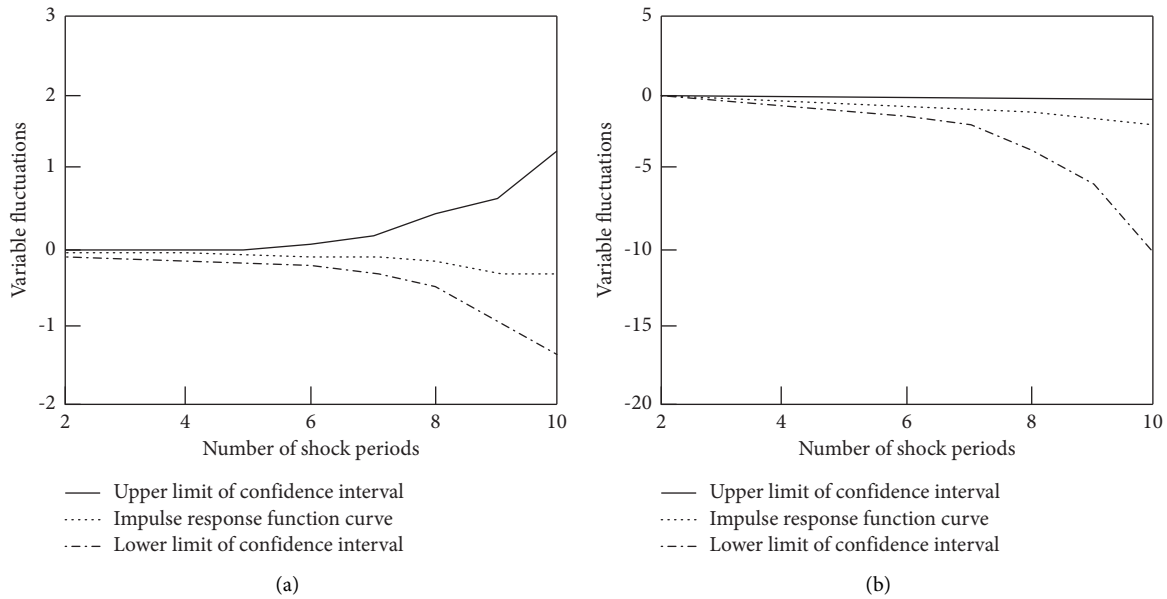


FIGURE 7: Impulse response function of the western region under the level of economic development. (a) Response to the level of economic development. (b) Education level response.

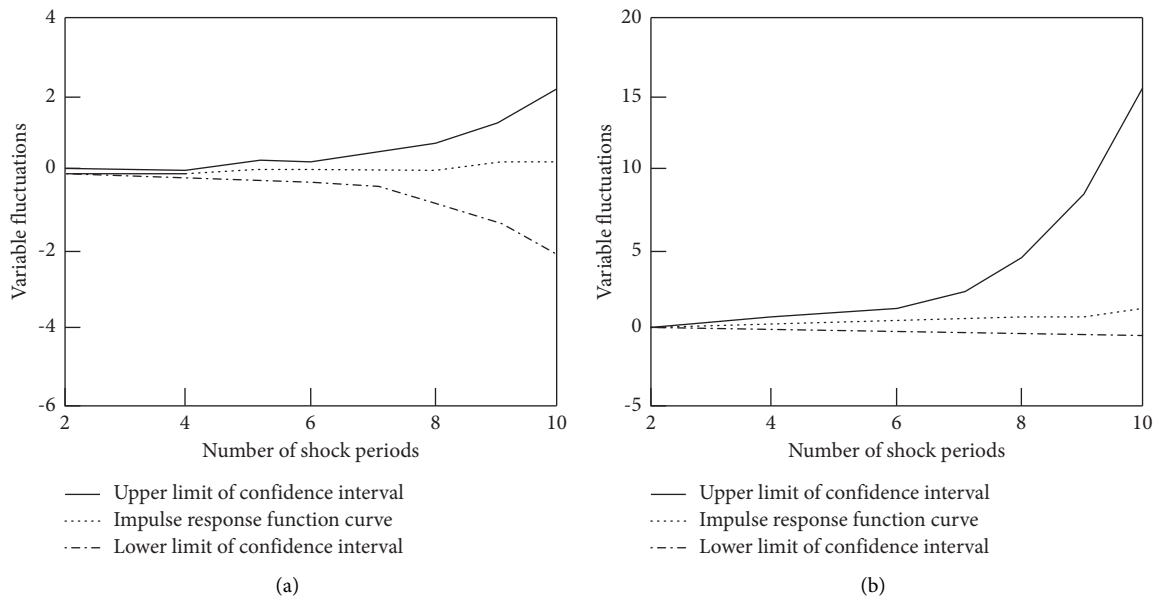


FIGURE 8: Impulse response function of the western region under education level. (a) Response to the level of economic development. (b) Education level response.

but also promote the improvement of education level. The role of education in promoting both is difficult to show in the short term.

4.4.2. *Variance Decomposition Analysis.* Similar to IRF, variance decomposition is another method to analyze the dynamic change of the whole model system. This method is to analyze the proportion of mean square error borne by each variable in the whole model and use it to measure the importance of the change of the variable to the whole model.

The results of the method decomposition of the national, eastern, central and western PVAR models made by the software Stata11.0 are shown in Table 4.

According to Table 4, (1) the interpretation degree of 20 periods in China and central regions is basically consistent with that of 10 periods; that is, the interpretation degree of variables to all variable error terms remains basically stable for a long time. (2) Most of the changes in the economic development level of the whole country, the eastern, central, and western regions, are caused by themselves, and all of them exceed 50%. This shows that the level of economic

TABLE 4: Variance decomposition of the PVAR model.

Area	Variable	Number of shock periods	eco	edu
Whole country	eco	10	0.579	0.006
	edu	10	0.56	0.058
	eco	20	0.59	0.008
	edu	20	0.541	0.07
East	eco	10	0.858	0.001
	edu	10	0.858	0.001
	eco	20	0.829	0.004
	edu	20	0.829	0.004
Central	eco	10	0.719	0.286
	edu	10	0.719	0.286
	eco	20	0.719	0.286
	edu	20	0.719	0.286
West	eco	10	0.668	0.002
	edu	10	0.415	0.419
	eco	20	0.658	0.002
	edu	20	0.623	0.08

development has strong inertia. At the same time, it can be seen that the economic development of the eastern and central regions depends more on their own role. (3) The development of education in the whole country, eastern, central, and western regions, depends more on promoting the economy. Moreover, from the 10th to 20th period, the influence of the economic development of the western region on the development of education has gradually increased, and the influence on the development of education has changed more greatly. (4) Compared with other regions, the influence of education in Central China on the economy and education is stronger, and the dependence of education in Central China on itself is also higher than that in other regions.

## 5. Conclusion

Using the Cobb–Douglas production function as the theoretical model and PVAR model, this article makes an empirical analysis on the relationship between education level and economic development level. The following conclusions can be obtained:

- (1) On the whole, economic development can drive the development of education, but there are obvious regional differences in the impact of economic growth on the development of education. The impact of economic growth in the eastern region on education is significantly higher than that in the central and western regions. This also shows that there is a regional imbalance in China's education and economic development, and the development degree of the East is obviously better than that of the middle and west.
- (2) There is an interactive relationship between the level of education and the level of economic development, but these interactive relationships are not equal and there are great differences. The model analysis shows that economic growth can promote the development of education, but on the contrary, the improvement

of education level does not promote economic growth very significantly, and some even inhibit economic growth in the short term.

- (3) There is a certain incubation period for the interaction between the level of education and the level of economic development. Through empirical analysis, we can know that in the short term, educational development in the areas with rapid economic development can also develop rapidly. It is difficult for education to play its role in promoting economic development in the short term, but with the passage of time, the influence of education is gradually highlighted.

## Data Availability

The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

## Conflicts of Interest

The author declares no conflicts of interest regarding this work.

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