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Research on the Interactive Relationship between Industrial Structure Upgrading and Economic Growth in Qinghai Province—Empirical Analysis Based on the VAR Model

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Abstract: ***There has long been an inseparable relationship between industrial structure and economic growth. On the basis of data from 1978--2021, this paper uses the VAR model to study and analyze the interactive relationship between industrial structure upgrading and economic growth in Qinghai Province. Since the reform and opening up, the optimization and upgrading of the industrial structure in Qinghai Province have been unsatisfactory, and the role of industrial structure upgrading in promoting economic growth has not been prominent. There is a long-term and stable equilibrium relationship between the upgrading of the industrial structure and economic growth in Qinghai Province, and there is an interaction between the upgrading of the industrial structure and economic growth. In the short term, the promotion of the industrial structure by the first and second industries will continue, and the impact of the tertiary industry on the industrial structure has a significant driving effect, but the process is relatively slow, and the impact of the industrial structure upgrading on the three major industries has an obvious slow and lasting lag effect.***

Keywords: Industrial structure upgrading; Economic growth; VAR model; Qinghai Province.

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1. Introduction

Since the reform and opening up, Qinghai Province has experienced rapid economic development, but its economic development has remained unbalanced and insufficient. The development of the regional economy is inseparable from the upgrading of the industrial structure. At present, our province is in a critical period of upgrading and optimizing its industrial structure and transforming its economic development mode. Given the impact of the COVID-19 epidemic, how to promote sustained and stable economic growth and accelerate the adjustment and upgrading of the industrial structure has become the main problem facing our province at this stage. Therefore, conducting a VAR empirical analysis of the interactive relationship between the upgrading of Qinghai's industrial structure and economic growth since the reform and opening up is highly important for the future high-quality economic development of our province.

2. Literature Review

The modern industrial structure was formed in the 1930s and 1940s. Early theoretical studies on industrial structure and economic growth generally revealed that economic growth promoted changes in the industrial structure. In the 17th century, William Petty, a British classical political economist, proposed the law of industrial structure change [1]. Clark (1940) proposed the three-industry classification method and proposed the famous Petty-Clark theorem. The American economist Kuznets proposed the Kuznets law [2], which explores the process of industrial structure optimization and upgrading: with the continuous development of a country or region's economy, the

industrial structure will continue to adjust and upgrade. The American economist Rostow proposed dominant industry theory [3], which divides the economic entity into three major sectors, the dominant sector, the supplementary growth sector and the derived economic growth sector, and believed that these three sectors jointly drive the growth of a country's economy. Hoffmann (1950) studied the industrialization process and its evolution law of industrial structure change and proposed the Hoffmann theorem [4]. Liu Hanzhen et al (2024) pointed out that the development of environmental technology has played an important role in socio-economic development, including economic growth, life expectancy, and social employment levels. While managing consumption and inflation, strengthening supply chains, digitization, and foreign investment can promote sustainable technological development [5].

Since the reform and opening up, scholars in the province have conducted a comprehensive study on the relationship between the industrial structure and economic growth in our province. Scholars' views can be divided into four categories. The first category analyzes the factors affecting the economic growth of Qinghai Province. Ma Jun (2005) conducted an empirical study on the factors of economic growth in Qinghai Province and suggested that the industrial structure of Qinghai Province generally followed a "three-two-one" structural model. The secondary and tertiary industries played a major role in driving economic growth. After the 1990s, secondary industry became the dominant factor in the economic growth of Qinghai Province [6]. The second category of views analyzes the economic growth and industrial structure of Qinghai Province from the perspective of resources. Jiang Jianying et al. (2010) analyzed the relationship between economic growth and resource endowment in Haixi Prefecture, Qinghai Province, and suggested that, on the basis of comparative advantages, improving the factor endowment structure would promote the upgrading of the regional industrial structure [7]. Ma Xiulan (2011) suggested that Qinghai Province, as a resource-rich province, should adjust its industrial structure, find new urgent growth points, and take the path of low-carbon economic development [8]. The third viewpoint analyzes the evolution of Qinghai Province's industrial structure. Zhang Haifeng (2009) conducted a quantitative evaluation and analysis of the evolution characteristics of Qinghai Province's industrial structure from 1949--2007 and suggested that since 1998, Qinghai Province's industrial competitiveness has increased, the industrial structure has been continuously optimized, and economic growth has depended mainly on the development of secondary industry. The fourth viewpoint analyzes the relationship between Qinghai Province's economic growth and industrial structure [9]. Sun Lixia (2012) analyzed the adjustment of Qinghai Province's industrial structure and the coordinated development of the regional economy and reported that economic development is unbalanced, the three-industry structure and competitiveness are not coordinated, and it is necessary to accelerate the reasonable adjustment of the secondary and tertiary industries and optimize the industrial structure [10]. Ding Chunli (2016) analyzed the relationship between the industrial structure and economic growth in Qinghai Province and reported that the low level of development of primary industry has a limited ability to drive the economy, that secondary industry cannot effectively drive employment growth in the province, and that tertiary industry is developing rapidly but at a low level. A benign relationship needs to be formed between the industrial structure and economic growth in Qinghai Province [11]. This paper selects indicator systems for industrial structure upgrading and economic growth and establishes a VAR model to conduct an empirical analysis of the interactive relationship between industrial structure upgrading and economic growth in Qinghai Province, which has theoretical and practical significance for the green development of Qinghai Province's economy and high-quality economic development.

3. Empirical Analysis

3.1 Introduction to VAR Model

The vector autoregression (VAR) model was proposed by American economist Sims. It is a model that establishes the relationship between variables by treating each endogenous variable in the system as a function of the lagged values of all endogenous variables in the system [12]. It is usually used to study the dynamic changes in interrelated time series variables.

The general VAR (p) model without exogenous variables is as follows:

$$Y_t = \alpha + \Psi_1 Y_{t-1} + \Psi_2 Y_{t-2} + \text{----} + \Psi_P Y_{tP} + \varsigma_i \quad (1)$$

In the above formula, Y_t is an m-dimensional variable sequence; Ψ_i (i=1,…,p) is the parameter matrix to be estimated; ς_i is a random disturbance term; and p is the maximum lag period. To ensure the stationarity of the sequence, a difference stationary sequence is used to establish a VAR model.

3.2 Empirical Analysis of the VAR Model

3.2.1 Data selection, sources and processing

This paper selects annual data from 1978--2021 as samples to conduct an empirical study on the interactive relationship between industrial structure upgrading and economic growth in Qinghai Province. The data come from the “China Statistical Yearbook” and the “Qinghai Statistical Yearbook”.

Industrial structure upgrading is the process of industrial structure transformation from a low level to a high level. There are different indicators for measuring industrial structure upgrading. Some scholars believe that the output value ratio of the tertiary industry to the secondary industry can better reflect the service-oriented tendency of the economic structure, whereas others use the proportion of the tertiary industry output value to GDP as a measure. This paper uses the “industrial structure level coefficient R” proposed by Jing Xueqing et al. (2005) to measure the level of industrial structure upgrading [13], which is calculated as follows:

$$R=\sum_{i=1}^{R}\sum_{j=1}^{i}q(j) \tag{2}$$

In the formula, q(j) represents the proportion of the output value of the jth industry in a country or region to GDP. This coefficient is mainly used to measure the development level of the industrial structure. Since the industrial structure is generally dominated by primary industry, secondary industry, and tertiary industry, primary, secondary, and tertiary industries are assigned values of 1, 2, and 3, respectively. Thus, the simplified industrial structure level coefficient can be obtained as follows:

$$R=1\times q(1)+2\times q(2)+3\times q(3) \tag{3}$$

The value range of R is 1--3. The higher the R value is, the greater the level of the industrial structure; that is, the closer R is to 1, the lower the industrial structure is, and the closer R is to 3, the greater the industrial structure is. According to the structure calculated by formula (4), the overall level of Qinghai Province’s industrial structure has been stable and has risen since the reform and opening up (see Figure 1).

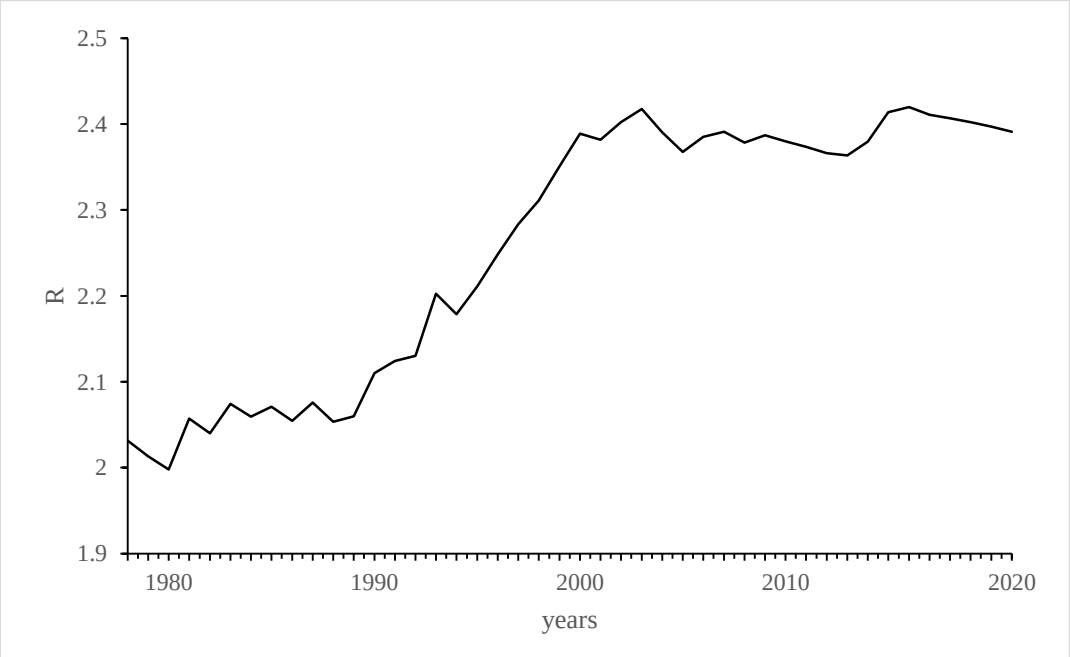

Figure 1: Changes in the industrial structure of Qinghai Province since the reform and opening up

In general, economic growth manifests as an increase in the output value of the three major industries. This paper selects the added value of the three industries as indicators to measure the economic growth of Qinghai Province and names them G1, G2, and G3. Moreover, to eliminate the impact of price levels, the price level of 1978 is used as the benchmark, and the output value of the three industries in each year is converted into net added value

calculated at constant prices in 1978. The formula is as follows:

$$G_{it}=G_{i1978}\times(GDPI_t\div GDPI_{1978}) \quad (4)$$

where i represents the low-i industry; t represents time, in years; and $GDPI_t$ is the GDP index in the tth year at constant prices in 1978.

3.2.2 Data Stationarity Test

To eliminate the impact of heteroskedasticity on the empirical analysis of this paper, the original data are logarithmized. This method does not change the original trend of the original data series. The logarithmic series are represented as lnG1, lnG2, lnG3 and lnR. To avoid the emergence of the "pseudoregression problem", before the VAR model is constructed, this paper uses the ADF unit root test method to test the stability of each time series dataset after taking the logarithm.

Table 1 shows that lnG1, lnG2 and lnG3 all pass the test at the 5% level, which means that the original sequence level is stationary. Only lnR fails the unit root test at the 5% significance level and is not stationary. Therefore, next, we perform first-order difference processing on the sequence and perform the ADF unit root test on the difference sequence. The test results are shown in Table 2.

Table 2 shows that the variables dlnG1, dlnG2, dlnG3, dlnG4 and dlnR that have undergone first-order difference processing all passed the test at the 1% significance level, so the original level sequence is first-order integrated, which is consistent with the establishment conditions for the VAR model; therefore, the VAR model can be established on the basis of the difference sequence.

Table 1: ADF test results for the horizontal sequence

variable	Inspection type	ADF test value	Critical value at 1% level	Critical value at 5% level	critical value at 10% level	conclusion
lnG1	(C,T,1)	-6.420	-4.424	-3.532	-3.119	smooth
lnG2	(C,T,1)	-5.180	-4.424	-3.532	-3.119	smooth
3G	(C,T,1)	-6.525	-4.424	-3.532	-3.119	smooth
LqCy	(C,T,1)	-0.427	-4.424	-3.532	-3.119	unstable

Table 2: ADF test results of first-order difference series

variable	Inspection type	ADF test value	Critical value at 1% level	Critical value at 5% level	Critical value at 10% level	conclusion
dlnG1	(C,T,1)	-8.618	-4.233	-3.536	-3.202	smooth
dlnG2	(C,T,1)	-7.894	-4.233	-3.536	-3.202	smooth
dlnG3	(C,T,1)	-9.215	-4.233	-3.536	-3.202	smooth
dln	(C,T,1)	-4.664	-4.233	-3.536	-3.202	smooth

3.2.3 VAR model establishment and stability test

Before the VAR model is established, the best lag period of the model should be determined. There are many criteria for the selection of lag order, including LR statistics, the AIC information criterion and the SBIC Schwartz criterion. This paper adopts the AI or SBIC minimum principle as the judgment standard and uses Stata 16.0 software to determine the optimal lag period. The results are shown in Table 3.

This paper selects the order corresponding to the most significant variables as the optimal lag period of the VAR model; that is, 4 is selected as the optimal lag order, and a VAR model is constructed. After the model is estimated, the stability of the VAR model is tested through the AR root diagram, as shown in Figure 2. The reciprocals of the roots of all the equations are located within the unit circle. The overall model is robust.

Table 3: Test results of the optimal lag period of the VAR model

|lag|	LL	LR	df	p	FPE	AIC	HQIC	SBIC
|2|	320.482				1.10E-12	-16.2299	-16.1686	-16.0592
|1|	364.84	88.716	16	0.000	2.50E-13	-17.6841	-17.378	-16.831*
|2|	382.225	34.769	16	0.004	2.40E-13	-17.7551	-17.2042	-16.2195
|3|	399.351	34.253	16	0.005	2.40E-13	-17.8129	-17.0171	-15.5948
|4|	430.793	62.883 *	16	0.000	1.3e-13 *	-18.6048 *	-17.5641 *	-15.7042

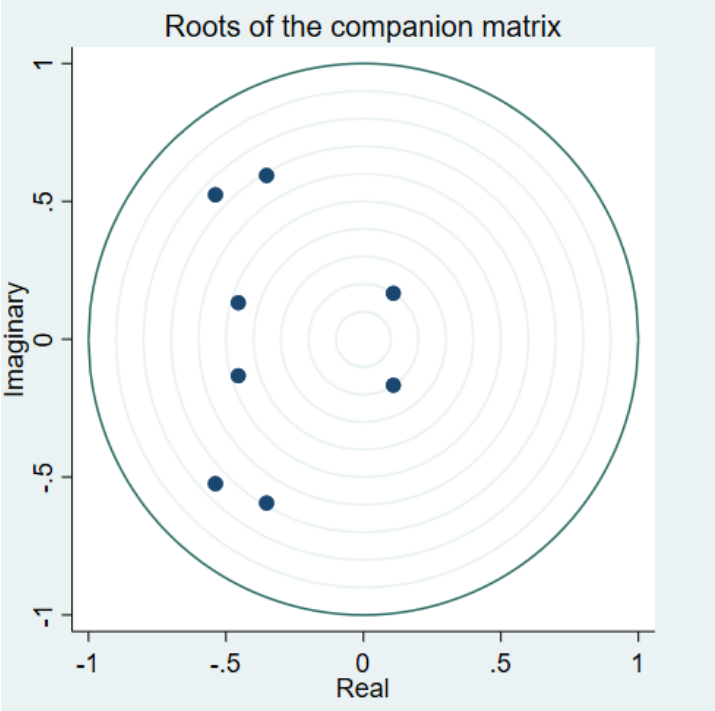

Figure 2: AR root diagram of the VAR model

3.2.4 Johansen cointegration test

When the horizontal sequence is tested before, the horizontal series is not stationary, so this paper uses the Johansen cointegration test to examine whether there is a long-term equilibrium relationship between variables. The test results are shown in Table 5.

Table 5 shows that when rank=0, 1, 2, 3, or 4, the value of the trace statistic is greater than the critical value of the 5% significance level, and the null hypothesis that there is no cointegration relationship should be rejected. Therefore, there is a long-term cointegration relationship between the variable sequences of the VAR model.

3.2.5 Granger causality test

Since the VAR model is stationary and meets the conditions for Granger causality testing, Granger causality testing can be performed on the variables in the model. The test results are shown in Table 6.

Table 6 shows that under the condition of a significance level of 5%, the primary industry in Qinghai Province is the Granger cause of secondary industry and industrial structure optimization, and the secondary industry is the primary industry, the tertiary industry and the Granger cause of industrial structure optimization. The optimization of the industrial structure is the Granger reason for the development of tertiary industry.

Table 5: Johansen cointegration test results

Equation	Excluded	chi2	df	Prob>chi2	Equation	Excluded	chi2	df	Prob>chi2
dlnG1	dlnG2	7.292	2	0.026	dlnG3	dlnG1	0.776	2	0.678
dlnG1	dlnG3	0.486	2	0.784	dlnG3	dlnG2	3.9026	2	0.142
dlnG1	dlnR	9.357	2	0.009	dlnG3	dlnR	5.9826	2	0.050
dlnG1	ALL	15.369	6	0.018	dlnG3	ALL	9.4247	6	0.151
Equation	Excluded	chi2	df	Prob>chi2	Equation	Excluded	chi2	df	Prob>chi2
dlnG2	dlnG1	11.708	2	0.003	dlnG4	dlnG1	1.376	2	0.503
dlnG2	dlnG3	6.312	2	0.043	dlnG4	dlnG2	1.619	2	0.445
dlnG2	dlnR	12.561	2	0.002	dlnG4	dlnG3	1.473	2	0.479
dlnG2	ALL	30.991	6	0.000	dlnG4	dlnALL	5.090	6	0.532

The test results show that with the economic growth of Qinghai Province, the three major industries have different contribution rates to economic growth and industrial structure optimization. The primary industry played a leading role in economic growth and industrial structure in the early stage of reform and opening up, but with the continuous development of the economy, its contribution weakened. The secondary industry not only promoted

the development of the primary industry and the tertiary industry but also played a vital role in the optimization and upgrading of the industrial structure. The tertiary industry played a vital role in the optimization and upgrading of the entire industrial structure.

It plays a key role but lacks the driving force for the first and second industries, and the development of the tertiary industry in Qinghai Province has not fully played a role in adjusting the industrial structure due to its late development. This test result is consistent with the industrialization development process since China's reform and opening up. The test results also reveal that the adjustment and optimization of Qinghai's industrial structure are not ideal, that the role of industrial structure upgrading in economic growth is not very prominent, and that there is very obvious uncoordinated development among the three major industries.

3.2.6 Impulse response function and variance decomposition analysis

This paper further introduces an impulse response function and variance decomposition analysis to analyze the short-term dynamic relationship between industrial structure upgrading and economic growth in Qinghai Province. The impulse response function reveals the response of endogenous variables to error shocks, and variance decomposition analysis quantifies the contribution of structural shocks to the changes in endogenous variables.

Table 6: Granger causality test results

		maximum		trace	value
rank	parms	LL	eigenvalue	statistical	value
0	20	298.8477		157.8564	47.21
1	27	329.68378	0.77780	96.1804	29.68
2	32	353.76969	0.69116	48.0122	15.41
3	35	370.18017	0.5509	15.1912	3.76
4	36	377.77578	0.30962		

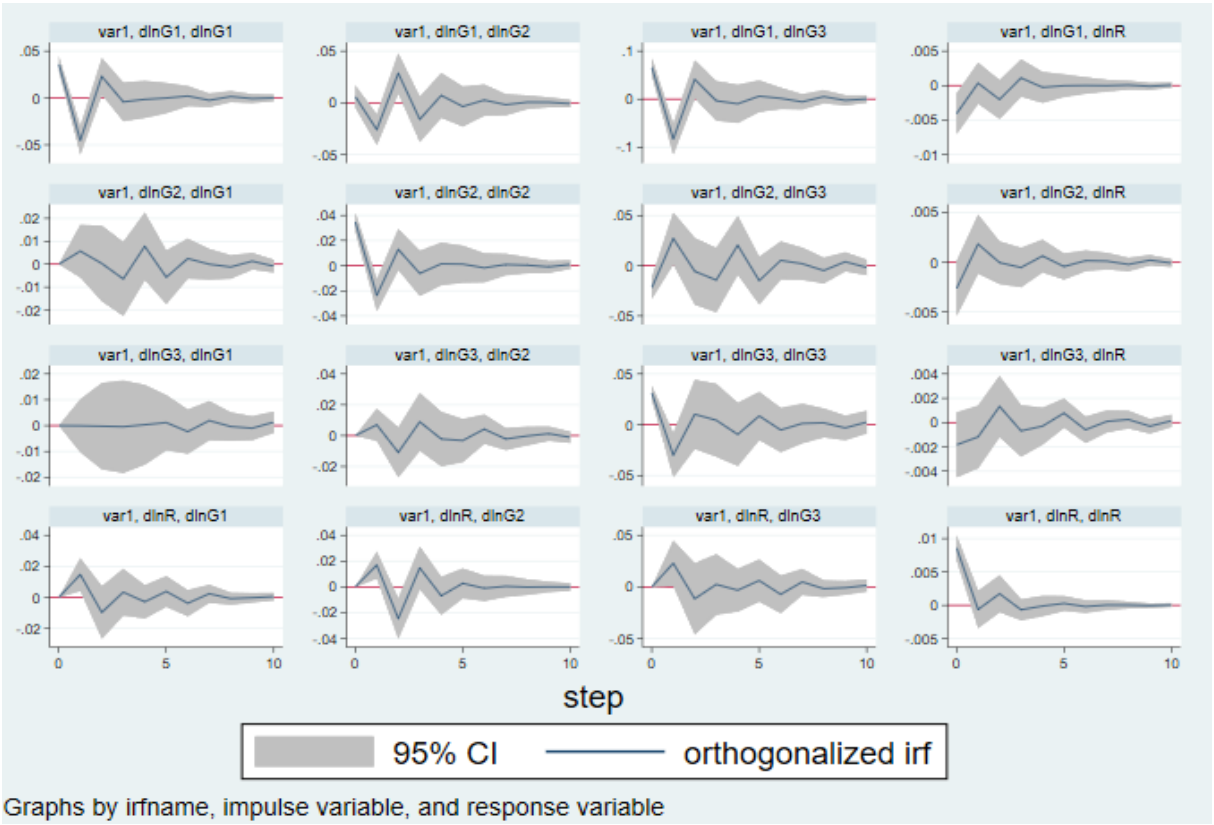

Figure 3: Impulse response diagram of the VAR model

Figure 3 is a pulse response diagram of the VAR model with 10 periods, which reflects the short-term pulse response effect between the variables. The last row reflects the impact of industrial structure optimization and upgrading on the three industries. The impact of industrial structure upgrading on secondary industry is very large, which makes the fluctuation range very large. The impact on secondary industry tends to be stable, and the impact

on primary industry is not very large. From the perspective of the impact of the three industries on the upgrading of the industrial structure in the last column, the impact of the primary industry on the upgrading of the industrial structure is initially negative, and then the impact of the primary industry gradually stabilizes, and the impact gradually decreases. The impact of the secondary industry on the industrial structure is transformed into a positive value in the following periods, rising rapidly at first and then gradually becoming slower. The impact of the tertiary industry on the industrial structure has a very obvious positive effect. The above results indicate that the impact response of the upgrading of the industrial structure to the three major industries is much greater than the impact of the three major industries on the industrial structure. These findings indicate that the industrial structure of Qinghai Province is uncoordinated and unreasonable and that the effect of industrial structure adjustment on economic growth is a slow process.

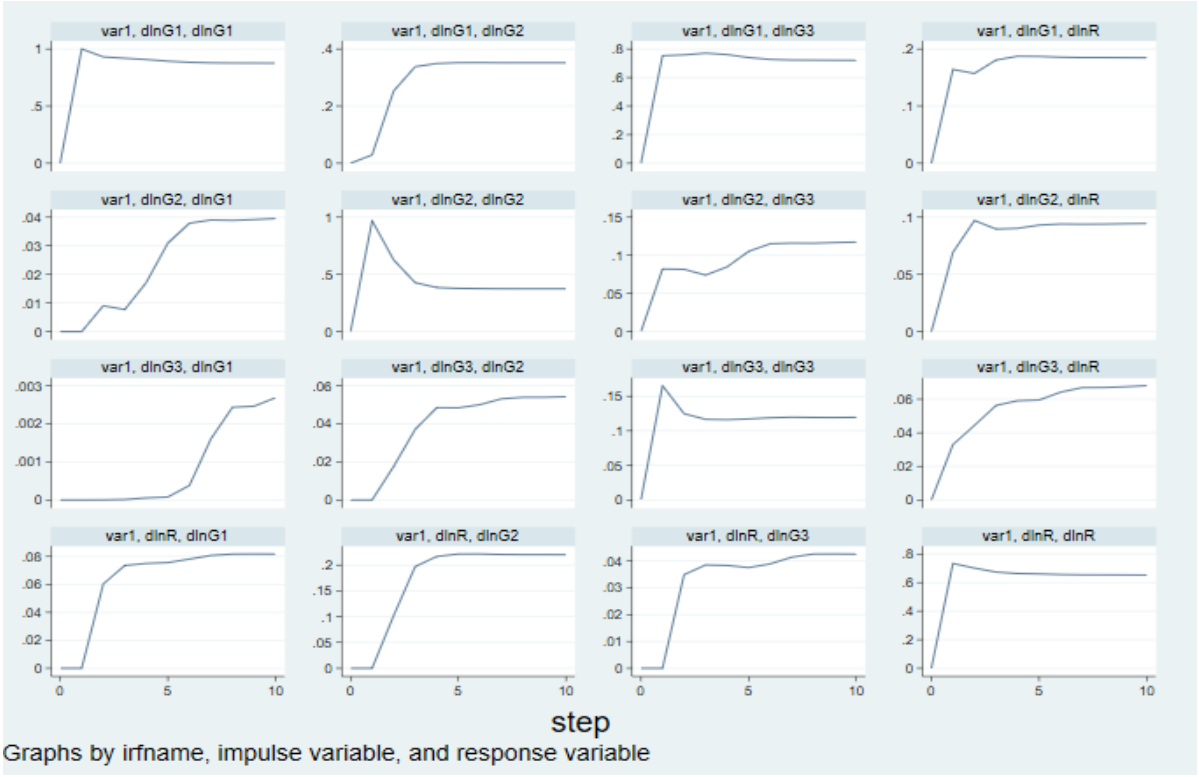

Figure 4: Variance decomposition of the VAR mode

From the last column of Figure 4, we can see that the contribution of the primary industry to the upgrading of the industrial structure rose rapidly within the first one or two periods to reach a small peak, and there was a small temporary decline around the third period, and then it rose and gradually stabilized; the initial contribution of the secondary industry to the industrial structure was negative, and it quickly reached its peak around the third period, and then it slightly declined and stabilized; the contribution of the tertiary industry to the upgrading of the industrial structure clearly showed a slow and steady rise. From the last row, we can see that the contribution of the upgrading of the industrial structure to the three major industries was reflected only after one or two periods, but its contribution lasted for a long period. The contribution of the three major industries to the upgrading of the industrial structure is positive. While the contribution of the primary industry is declining, the contribution of the secondary industry is rising, and the secondary industry supplements the primary industry. The impact of the upgrading of the industrial structure in Qinghai Province on economic growth has a lag effect, and the process is slow, but the effect is relatively lasting. Therefore, the upgrading of the industrial structure has a lasting and far-reaching impact on the sustainable development of the economy of Qinghai Province.

4. Conclusion

Through VAR empirical analysis of the interactive relationship between industrial structure upgrading and economic growth in Qinghai Province since the reform and opening up, the following conclusions are drawn: (1) According to the Granger causality test results, the optimization and upgrading of the industrial structure in Qinghai Province is not ideal, and the role of industrial structure upgrading in promoting economic growth is not

very prominent. The development of tertiary industry has not fully adjusted the industrial structure due to its late development. (2) According to the Johansen cointegration test results, there is a long-term stable equilibrium relationship between industrial structure upgrading and economic growth in Qinghai Province. In general, there has been an interaction between industrial structure upgrading and economic growth since the reform and opening up. (3) According to the pulse response function and variance decomposition results, in the short term, the promotion of the first and second industries to the industrial structure continues, and the impact of the tertiary industry on the industrial structure has a significant driving effect; however, the process is relatively slow, and the impact of industrial structure upgrading on the three major industries has an obvious slow and lasting lag effect.

Given the impact of the COVID-19 epidemic, the slowdown in China's economic growth rate is an objective trend. Under this general background, the impact of industrial structure upgrading on Qinghai Province's economic growth has been slow and lasting. Therefore, we need to continue to increase the innovation and development of secondary and tertiary industries and accelerate the optimization and upgrading of the industrial structure in our province, thereby promoting the economic growth of our province and laying a more solid foundation for high-quality economic development at this stage.

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