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Integration and development of modern art design and environmental design based on VAR modeling

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Abstract

This paper empirically analyzes the integration development of the modern art design industry and the environmental design industry by constructing a vector autoregressive model (VAR) using the National Bureau of Statistics data on modern art design and the environmental design industry. The exploration of this paper focuses on testing and analyzing the VAR model using the four aspects of smoothness test, cointegration test, Granger causality test, impulse response, and variance decomposition, and analyzing it with Eviews 10.0 software. After the study as well as calculations, it was found that OAD and OED rejected the original hypothesis at 5% significance level after second-order differencing, and the optimal lag order was 1. 48% of the fluctuations in OED were caused by OAD, and 52% were caused by itself. In period 1, 100% of the output value of OAD is caused by itself and 0% by OED. However, from period 2, the value of the contribution of OAD to itself decreases to 59.04% and then stays around 56%. P-value corresponding to OAD and OED is greater than 0.1. P-value corresponding to OED for OAD is 0.0011, which is less than 0.1. It can be concluded that the output value of environmental design is a factor in the output value of modern art and design.

Keywords: VAR model; Smoothness test; Granger causality test; Modern art and design.

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1 Introduction

Chinese traditional culture has a long history of precipitation, with distinctive national characteristics and rich cultural connotations, which contain the ideological concepts of the Chinese nation, moral norms, and humanistic spirit, which are the unique national advantages and cultural identity of the Chinese nation, and potentially affect people's aesthetic concepts, value orientation and way of thinking [1]. Chinese traditional culture in modern environmental art design can show the vitality of Chinese traditional culture and the creativity of the new era, but also to the world to show the traditional Chinese culture in the contemporary environmental art design style and charm, and then improve the world influence of traditional Chinese culture, so that more people realize the artistic value of traditional Chinese culture [2]. To change this situation and improve the influence of traditional Chinese culture in environmental design, environmental designers need to grasp the relationship between modern environmental design and traditional Chinese culture and recognize the value and status of traditional culture in art design. To change this situation and improve the influence of traditional Chinese culture in environmental design, environmental designers must grasp the relationship between modern environmental design and traditional Chinese culture, recognize the value and status of traditional culture in art design, integrate traditional culture and modern environmental art design, to show the national personality and cultural characteristics of art design, and to build a modern environmental art design road with Chinese characteristics [3-4].

The development of industrialized civilization has led to the development of environmental art design, which has the characteristics of decorative, metaphorical, and symbolic. Literature [5] uses modern 3D virtual reality technology and traditional art to realize the cohesion of traditional environmental art and promote the development of characteristic society and city and carries out case studies and analysis, and the results show that VR technology shows unlimited creative and innovative potential, breaks through the traditional boundaries, convenient and comprehensive display of the real space, and provides new and efficient ideas for the design of environmental art. Literature [6] compared a variety of circular design options and pointed out that according to the design of the project life cycle, life expectancy to the length of life of the components to be selected. Literature [7] described the traditional art research and environmental design with modern digital design technology, so that the final design of the final design of both artistic aesthetic and thinking, also takes into account the professional and technical design of the lighting environment to create a unique and comfortable environment for the customer. Literature [8] combined with the early river channel design, the lighting environment design, the lighting environment design, the design of the lighting environment design, and the design of the lighting environment design. Literature [8], the design of the lighting environment design, the design of the lighting environment design, and the design of the lighting environment design. By incorporating data from early river facility designs, 3 areas of focus were identified to improve hydropower design. Expansion of model formulations, evaluation of barrier effects, and achievement of environmental objectives were the three areas of focus. The artistic components of a store's interior design were investigated in literature [9] to see if they had an impact on consumer preferences. The use of a 2-stage probabilistic least squares approach revealed that consumers who saw art-related design and artistic elements in a store would experience significant emotional impacts. Literature [10] investigated the effects of advertising design, self-referential and argumentative quality graphic configurations of environmental emotions on advertising effects, and pointed out that advertisements with positive moral and social emotions would be very effective. According to literature [11], environmental art and design encompass almost all contemporary art and design. Literature [12] analyzes the problems that exist in the integration of environmental art design and CAD professional courses, and for these problems, it is suggested that we should base on the teaching and design ideas to solve the problems, and the curriculum should be based on the application of practice. Because of these problems, it is suggested to solve the problems based on the

teaching and learning idea of applying practice, and the course teaching should be screened and designed to meet the teaching content of the specialty, to ensure the consistency of knowledge, and to collect more new teaching methods and teaching knowledge.

In this paper, the algorithm of the VAR model is first sorted out, and the correlation between the output value of modern art design as well as environmental design industry is confirmed according to the provisions in the National Economic Industry Classification, and then the VAR model is established by using the data of 2018-2023 made public by the National Bureau of Statistics. Eviews 10.0 software was utilized to process the data from the National Bureau of Statistics and carry out the unit root test during the model establishment process. To reduce serial fluctuations and eliminate the effect of heteroskedasticity, natural logarithmic transformation was uniformly applied to the raw data, and the output values were compared with the critical values. On this basis, Johansen-Juslius was selected to carry out the testing work of the samples, and the optimal lag order was determined based on the principle of minimization of SIC statistics. Finally, the standard deviation shock diagram of the modern art and design industry from the environmental design industry is drawn based on the data, and a Granger causality test is performed. The calculation results show that there is a mutual influence relationship between the output value of the modern art design industry and the environmental design industry, and there is a certain development potential for the integration market of the two in the future.

2 VAR model

2.1 VAR algorithm and cointegration test

The VAR model is usually used to calculate the degree of convergence between the variables and can predict the development of the situation between the variables with the following mathematical expression:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + Bx_t + u_t \quad (1)$$

Where, x_t is the d -dimensional vector of exogenous variables, y_t is the k -dimensional vector of endogenous variables, $A_1, A_2, A_3, \dots, A_p$, is the k -dimensional error term, B is the matrix of coefficients to be estimated, and p is the lag order.

The cointegration test is an important step in analyzing the quantitative relationship between non-stationary economic variables in an economic system, the

It is used to determine if there is a long-term equilibrium relationship between the variables in the system. If one of the variables in the system is disturbed by external factors in a particular period and deviates from the original long-term equilibrium, then, under the influence of its intrinsic equilibrium mechanism, the variable will be adjusted to return to the original equilibrium in the next period. Cointegration tests are generally classified into two main categories: the initial category is centered around the cointegration test of regression residuals. The Johansen cointegration test chosen in this paper belongs to the second category of cointegration tests that are based on regression coefficients.

Johansen cointegration test, the original hypothesis:

$$H_{r0} : \lambda_r > 0, \lambda_{r+1} = 0 \quad (2)$$

The alternative hypothesis is then:

$$H_{r1} : \lambda_{r+1} > 0, r = 1, 2, 3, \dots, k-1 \quad (3)$$

The formula for the Trace test statistic is:

$$\eta_r = -n \sum_{i=r+1}^k \ln(1 - \lambda_i) \quad (4)$$

When $\eta_0 < \text{critical value}$, then the original hypothesis H_{00} is accepted and there is no cointegrating vector, i.e., there is no long-run equilibrium relationship. When $\eta_1 > \text{critical value}$, then the original hypothesis is rejected and H_{01} is accepted and at least one cointegrating vector exists. When $\eta_r < \text{critical value}$, then accept the original hypothesis H_{r0} , there exists r cointegration vector.

2.2 Granger causality test

The cointegration test can only reflect whether there is a long-term stable quantitative relationship between the variables, but not whether there is a causal relationship between the variables, so it is necessary to further determine whether there is a causal relationship between the variables and the cointegration relationship through Granger causality test, that is, if a change in one variable will lead to a change in the other variable. Three types of Granger causality will normally occur, which are unidirectional causality, bidirectional causality, and no causality. Setting X and Y as two variables in the system, the mathematical expression of Granger causality test is as follows:

$$Y_t = \beta_0 + \sum_{i=1}^m \beta_i Y_{t-i} + \sum_{i=1}^m \alpha_i X_{t-i} \quad (5)$$

$$X_t = \delta_0 + \sum_{i=1}^m \delta_i X_{t-i} + \sum_{i=1}^m \lambda_i Y_{t-i} \quad (6)$$

When the lag coefficients of both X and Y are zero, there is no Granger causality between the two variables. When neither is 0, there is bidirectional Granger causality. When one is 0 but the other is not 0, there is unidirectional Granger causality. Constrained F-test mathematical expression:

$$F = \frac{(RSS_R - RSS_U) / m}{RSS_U / (n - k)} \quad (7)$$

When $F > F_\alpha(m, n - k)$, the lagged coefficient of variable X is statistically significant, then X is a Granger cause of Y . When $F < F_\alpha(m, n - k)$, X is not considered a Granger cause of Y .

2.3 Impulse Response Function

Impulse response functions, which can be used to analyze the extent to which endogenous variables in a system respond when one of the variables in the model is subjected to a shock caused by an error term, and thus to see the dynamic impact of the endogenous variable over time. Impulse response function mathematical expression:

$$C_{ij}^{(q)} = \frac{\partial Y_{i,t+q}}{\partial \varepsilon_{jt}} \quad (8)$$

$C_{ij}^{(q)}$ denotes the magnitude of the effect of the i th endogenous variable in period $t+q$ after a one standard deviation sized shock to the error term of the j rd variable in period t , holding other error terms constant.

2.4 Variance decomposition

Analysis of the extent to which different shocks affect endogenous variables and the contribution of changes in variables requires variance decomposition. Variance decomposition is the decomposition of changes in all endogenous variables according to the causes of their formation, which describes the relative importance of different shocks on the dynamics of endogenous variables. The expression for the relative variance contribution that is mathematically expressed:

$$RVC_{j \geq i}(s) = \frac{\sum_{q=0}^{s-1} (\varphi_{q,ij})^2 \sigma_{ij}^2}{\sum_{j=1}^k \left\{ \sum_{q=0}^{s-1} (\varphi_{q,ij})^2 \sigma_{ij}^2 \right\}}, i, j = 1, 2, 3, \dots, k \quad (9)$$

$RVC_{j \geq i}(s)$ denotes the degree of relative variance contribution of variance Y_i to the j nd variable after a structural shock, holding all other variables constant, and the degree of influence of the j th variable on the i th variable.

3 Interaction between modern art design and environmental design

3.1 Relevance of modern art design and environmental design

Modern art design and environmental design belong to different fields of practice, the former is more artistic and emphasizes modernity in practice, while the latter is more design-oriented and emphasizes landscape value in practice. When they are integrated into multi-dimensional fields, the two topics can be considered natural ecology. Material logic is the basic logic for the integration of modern art design and environmental design, and it is also an important guarantee for the ecological development of the two, it is necessary to ensure that the design materials have natural ecological friendliness. In the logic of modern art, modern art design is active, while environmental design is passive. Environmental design works can benefit from the concept's natural ecological protection symbolism. The concept of spatial logic states that environmental design is active, while modern art design is passive.

The data selection and sample reference of this paper is the National Economic Industry Classification (NEDIC), in which modern art design is independently listed as an industry, which belongs to the cultural industry of class R. Environmental design is not very clear. Environmental design is not very clear, in the official documents, and the statistics bureau of the narrative is usually referred to as the art of environmental design or environmental design, most of the data in this paper comes from the National Bureau of Statistics in the “art and environmental design” industry.

In various industries, there is a convergence of the two. In China, universities have begun to combine the two disciplines into a single discipline called ‘art and environmental design’. Other examples, such as in urban landscape design, the use of modern art design to highlight the city’s personality, highlight the cultural heritage, and the use of environmental design to optimize the allocation of natural ecological resources. Another example is in interior space decoration, modern art design can satisfy modern people’s aesthetic taste, and environmental design can provide the most suitable ecological elements for indoor planting or breeding, and the integration of the two is conducive to maximizing the natural ecological benefits.

3.2 Data selection

The interaction between modern art design and environmental design is analyzed in this paper using a vector autoregressive model. Table 1 shows the output value of the data of the art design industry and the environmental design industry from 2018 through 2023, and the data are from the National Bureau of Statistics. Since the National Bureau of Statistics only published the industry data from 2018 to 2023, this article also refers to the China Statistical Yearbook to measure the future integration trend of China’s art and design industry and environmental design industry by constructing a VAR model, and, at the same time, doing a natural logarithmic transformation of the data to reduce the fluctuation of the sequence and eliminate the influence of heteroskedasticity. The output value of the art design industry is labeled as OAD in the article, while the output value of the environmental design industry is labeled as OED.

Table 1. Artistic design industry and environmental design industry production value

Year	OAD(hundred million)	OED(hundred million)
2018	89257	3882.18
2019	86624	3762.59
2020	98514	3527.49
2021	119064	3685.68
2022	121805	3691.87
2023(Estimate)	131619	3694.68

3.3 Stability test

Using Eviews 10.0 software to process the data in 3.1, the output results are shown in Table 2. The use of the software respectively on the art design industry output value, environmental design industry output value unit root test results, to reduce the sequence fluctuations and eliminate the impact of heteroskedasticity, first of all, the original data uniformly natural logarithmic transformation, the output of the value and the critical value of the comparison, if the output results are less than the critical value, it represents the results of the smooth, or else regarded as not smooth.

The values of artistic design output and environmental design output after second-order differencing DD(OAD) and DD(OED) rejected the original hypothesis at 5% significance level, which indicates that the second-order differencing is a smooth series. So both variables are smooth series after second-order differencing and are single-integrated of the same order and can be analyzed for cointegration.

Table 2. Unit root calculation

variable frequency motor	T statistical magnitude	1% critical value	10% critical value	P	steady or not
AD	-3.5876	-5.8762	-3.5867	0.1006	NO
ED	1.2356	-2.8674	-1.5867	0.9363	NO
D(OAD)	-3.3540	-6.2857	-3.3674	0.1443	NO
D(OED)	-1.9673	-4.6759	-2.2674	0.2837	NO
DD(OAD)	-3.9276	-3.0867	-1.5867	0.0017	YES
DD(OED)	-2.0876	-2.9176	-1.5836	0.0432	YES

In the test method selection, because the number of samples for the test is small, and the variables involved are art design output value and environmental design output value two, so after consideration, we can choose Johansen-Juslius to carry out the sample testing work. Table 3 is the use of Eviews 10.0 software analysis of the results obtained, the test process is based on the principle of minimization of SIC statistics to determine the optimal lag order. From this, it can be ascertained that when the critical value is 5%, both the tracking data and the maximum eigenvalue are greater than the critical value, which then leads to the existence of a cointegration relationship between the two variables.

Table 3. Cointegration test

Hypothesized				
No.of CE(s)	Eigenvalue	Trace Statistic	0.05Critical Value	Prob.
None*	0.9828	46.9872	14.3985	0.0004
Atmost1*	07395	10.5867	3.8573	0.0008

3.4 VAR model construction of modern art design and environmental design

Table 4 shows the optimal lag order, at Lag0, HQ is around -1, but exceeds -1. At Lag1 LogL doubles 5 times to 33.8576, and the rest of the FPE, AID, SC, and HQ values are also roughly doubled 5-6 times, with an average value of around -6. This shows that the optimal lag order is 1st order.

Table 4. Optimal lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	6.085736	NA	1.39E-03	-905867	-0.861852	-1.000726
1	33.8576	37.0185*	7.38e-04*	-6.1837	-6.4857	-6.9582*

The AR root plot is used to mainly analyze the stability of the model, it can be seen that all the eigenvalues of the concomitant matrix fall within the unit circle, which indicates that the model is stable and the impulse response analysis and variance decomposition can be continued. The AR root plot is shown in Figure 1 as it was constructed using the table above. According to the previous cointegration test, there exists a cointegration relationship between the two variables. There exists a long-term equilibrium relationship between them. To observe short-run causality, the VAR model is being constructed again.

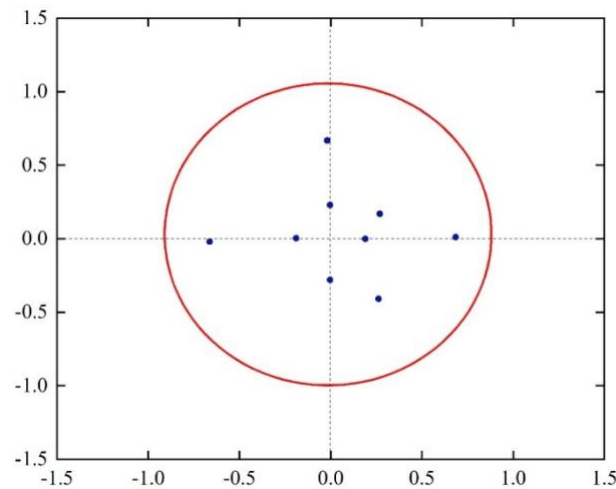


Figure 1. AR Feature polynomial root

Figure 2 for the modern art design industry on the environmental design industry to implement the standard deviation impact, the modern art design industry response function time path, the response path is positive and shows from the 0th to the 20th period of the gradual decline in the trend, close to the value of 0, indicating that the environmental design industry for the modern art design industry scale to start the stage of a greater impact, but the impact of the decreasing, along with the expansion of the scale of the modern art design industry, the environmental The external influence of the environmental design industry is minimal, that is, the future development of the industry scale of the two is stable, and there will be no large changes.

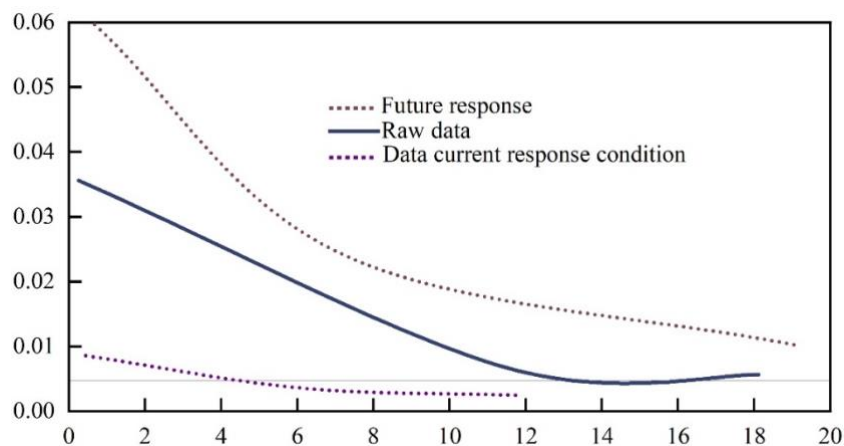


Figure 2. Standard deviation impact on the environmental design industry

Figure 3 shows the time path of the response function of the environmental design industry to itself, the environmental design impact on its impact from the 1st to the 20th period gradually decreased, and constantly converged to 0 value, indicating that the elasticity coefficient of the growth of output value of the environmental design industry is decreasing from high to low, and eventually formed a stable industry.

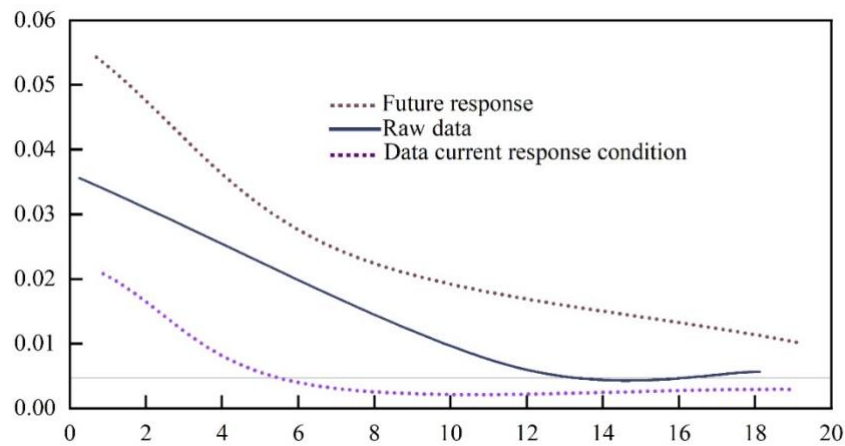


Figure 3. The time path of the environment design industry's own response function

Figure 4 illustrates the immediate response of the modern art and design industry and the environmental design industry to modern art and design. The time path of the response function of the modern art design to itself, the response path from the first to the third period of violent fluctuations, and from the fourth period of a flat decline, indicating that the elasticity coefficient of the growth of output value of the modern art design industry in the initial period of violent changes, but gradually smooth and decline, and tends to stabilize.

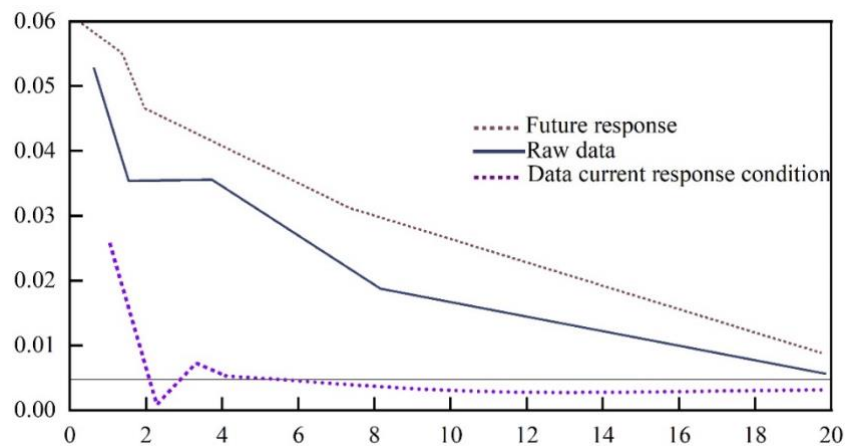


Figure 4. The modern AD and the ED respond to the pulse response of modern art design

Figure 5 shows that the modern art and design industry implements standard deviation impact on the environmental design industry, and the response path of the environmental design industry has a pulse of 0 before the 1st period, and drastic changes occur in the 4th period, with a steep increase and then a steep decline, and a gradual and slow decline after the 4th period, indicating that the expansion of the scale of the modern art and design industry causes drastic changes of the environmental design industry in the early stage, and the impact is gradually weakened after a certain period.

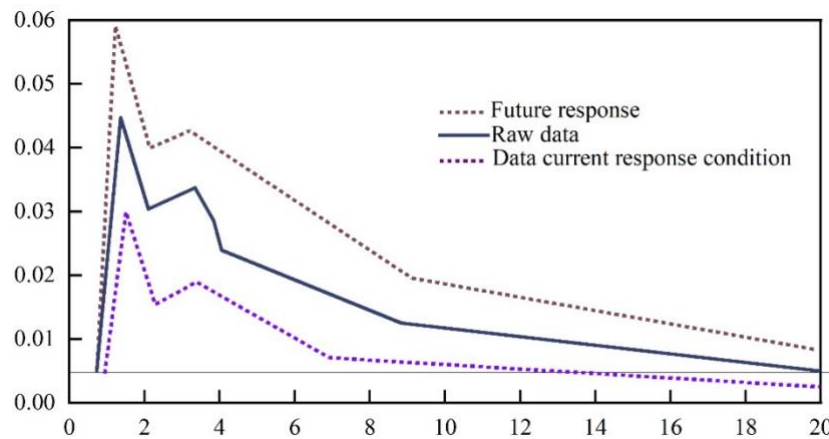


Figure 5. The AD has a standard deviation impact on the ED industry

Variance decomposition is the degree of interaction between variables by comparing the predicted variance of the variables as the degree of interaction between the variables after a variable within the system has been subjected to a shock of one standard deviation, Table 5 shows the results of the variance decomposition. In period 1, 100% of the art and design output values were caused by themselves, and 0% by environmental design. However, from period 2 onwards, the contribution of the output value of the art and design industry to itself drops steeply to 59.04%, and then levels off and stabilizes, remaining at around 56%. The contribution of the environmental design industry to the fluctuation of the art and design industry increases gradually from period 2 to 44%, then levels off and stabilizes, remaining at around 45%.

Table 5. Modern art design industry output variance

Period	S.E.	OAD	OED
1	0.039588	100	0
2	0.082847	59.04625	40.95375
3	0.093817	59.01749	40.98251
4	0.102847	57.02984	42.97016
5	0.108600	56.48572	43.51428
6	0.119480	55.60897	44.39103
7	0.115830	55.86920	44.13080
...
18	0.119224	54.91427	45.08573
19	0.119682	54.90182	45.09818
20	0.119668	54.89762	45.10238

Table 6 shows that in Period 1, 48% of the fluctuation in the output value of the environmental design industry was caused by modern art and design, and 52% was caused by itself. From the beginning of the 2nd period to the 20th period, the contribution of the modern art and design industry to the environmental design industry has remained stable and has been maintained at about 49%, without substantial fluctuations. The modern art and design industry's output value to itself to the fluctuation has remained around 51% and is expected to retain the same fluctuating trend in the future if there is no special reason.

Table 6. ED industry output variance breakdown

Period	S.E.	OAD	OED
1	0.039588	48.24902	51.75098
2	0.082847	48.80682	51.19318
3	0.093817	48.86048	51.13952
4	0.102847	48.91823	51.08177
5	0.10860	48.94862	51.05138
6	0.11948	48.96842	51.03158
7	0.11583	48.96820	51.03180
...
18	0.119224	48.99263	51.00737
19	0.119682	48.99315	51.00685
20	0.119668	48.99682	51.75098

Finally, Granger causality test was performed. Table 7 displays the results of the calculation. The output value of the modern art industry is not a Granger cause of the output value of the environmental design industry, corresponding to a P-value of 0.3550, which is greater than 0.1. It indicates that the expansion of the scale of modern art and design is not significant for the growth of the output value of the environmental design industry. The output value of modern art and design is not affected by the output value of environmental design. Its corresponding P-value is 0.0011, which is less than 0.1. This indicates that the environmental design output value is the Granger cause of the output value of modern art design, and increasing the scale of the environmental design industry contributes to the increase of the output value of the modern art design industry.

This paper measures the integration posture of modern art design and environmental design based on the VAR model, and finds that there is a dynamic interaction between the two variables, and changes in one of them will cause fluctuations in the other as well as in the endogenous variables, which indicates that the integration market of the two in the future has a certain potential for development.

Table 7. Granger causality test results

Null Hypothesis	Obs	F-Statistic	Prob.
OAD does not Granger Cause OED	9	0.95423	0.3550
OED does not Granger Cause OAD		31.1245	0.0011

4 Recommendation

This paper selects the data of the output value of the modern art design industry and the output value of the environmental design industry to predict the degree of integration between the two and the future development trend, and the variables selected when analyzing the data are small, so the results may have certain limitations. In addition, the National Bureau of Statistics has only published the data after 2018, which was not publicized before that, and there is no way to get the response data, which leads to a shorter year of investigation in this paper, and is also one of the limitations of this paper. If more data becomes available in the future, the conclusions of this paper will be updated due to the highly promising emerging industry of environmental design.

Affected by the epidemic, the output value of the emerging environmental design industry has a downward trend from 2018, followed by a significant rebound around 2023, but still has not returned

to the level of 2018. According to the conclusion of this paper, the growth of the environmental design industry will lead to the growth of the modern art and design industry, so the government should formulate policies to vigorously promote the development of the environmental design industry, improve its core competitiveness of the industry, and formulate a master planning strategy to promote the integration of the two industries.

The establishment of an early warning mechanism for the market is very necessary. During the epidemic, the output value of the modern art and design industry fell sharply in 2019, and due to the lack of an early warning mechanism, it was impossible to monitor the output value of the modern art industry and the environmental industry on time, so the former's value anomalies were directly transmitted to the environmental design industry, which to a large extent resulted in the latter's sharp decline in 2019 and 2020 for two consecutive years, which led to the reduction in the scale of the industry. The government should establish a scientific information data collection system, improve the information release system, and transmit price fluctuation information promptly to minimize the impact on related industries.

5 Conclusion

This paper uses the VAR model, adopts the data from the National Bureau of Statistics 2018-2023, and is supplemented by the data on the modern art and design industry as well as the environmental design industry in the China Statistical Yearbook to explore the integration trend and development potential of the two, and draws the following conclusions:

- 1) There is a correlation between the output value of modern art and design and environmental design industries. The response path of the modern art and design industry is positive, with the highest impact strength of 0.06, showing a gradual decline from the 0th to the 20th period, and a rebound trend in the 14th period, but it soon continues to decline, constantly approaching the 0 value. Environmental design industry for modern art and design industry scale at the beginning of the stage of greater impact, but the impact continues to decrease, with the expansion of the scale of the modern art and design industry, the environmental design industry's external influence is minimal, that is, the future relationship between the two industry scale is stable, will not appear larger changes.
- 2) The environmental design industry does not have a great impact on the modern art and design industry at the beginning, but then the impact gradually increases. In the 1st period of the data, 100% of the output value of art and design is caused by itself, but from the 2nd period onwards, the contribution rate of the output value of the art and design industry to itself decreases steeply to 59.04%, and then declines gently and stabilizes, remaining at about 56%. The contribution of the environmental design industry to the fluctuation of the art and design industry increased gradually from period 2 to 44%, then leveled off and stabilized, remaining at around 45%. The trend will endure into the future as well.
- 3) The modern art and design industry is not the Granger cause of the growth of the output value of the environmental design industry, but the growth of the output value of the environmental design industry will lead to the expansion of the scale of the modern art and design industry. The ODD that corresponds to the OED Granger value is 0.3550, which is higher than 0.1, suggesting that the hypothesis is accurate. OAD corresponding to the OED Granger value is 0.0011, which is substantially less than 0.1, indicating that the hypothesis fails, environmental design output value is the Granger cause of modern art and design output value.

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