Research Article

Empirical Analysis of the Impact of High and New Technology on the Export of Traditional Cultural Industry Based on Random Matrix Theory

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Accurate estimation of covariance matrix is the basis of effective development of high-dimensional optimal portfolio. Random matrix theory provides an effective means to improve the estimation of high-dimensional covariance matrix. Based on the empirical research on the export excess return rate of traditional cultural industry, the result is a combination with higher precision and lower risk. Based on relevant data, this paper constructs a stochastic matrix theoretical model to analyze the impact of human capital, new fixed asset investment, independent innovation and technology purchase, financing sources, and other factors on high-tech industry export. Based on the results of empirical analysis, some policy suggestions are put forward, such as increasing R&D investment, improving enterprises’ innovation ability, and introducing core scientific and technological talents to promote the export scale growth of high-tech industries. Model comparative analysis is made on the influence of traditional industries’ concentrated export, foreign trade environment, and cost advantage on the export of high-tech products. Through comparative analysis of the influencing factors of the export of high-tech products in the two periods before and after the export crisis of traditional culture, the new changes of the influencing factors are analyzed. In addition, through the change of the internal and external environment of the current high-tech product export, the reasons for the new change of the influencing factors are discussed.

1. Introduction

There are many economic variables that can affect the export complexity of high-tech industries, among which traditional cultural export support and R&D innovation are two important economic variables. The high-tech industry is a typical capital-intensive industry, which needs a huge amount of capital support in production and operation activities. If the high-tech industry can obtain sufficient financial support, then the high-tech industry can invest sufficient funds in research and development and the construction of scientific and technological personnel team, and develop high-tech products for export. At the same time, if the product complexity of high-tech industry exports is high, then the amount of export is often very large. If the R&D innovation level of high-tech industry is relatively high, the export complexity of high-tech industry may be high or low [1]. If the R&D innovation level of high-tech industry is relatively low, then the export complexity of high-tech industry will not be high. In general, R&D innovation of high-tech industry is positively correlated with export complexity. Of course, sometimes the high-tech industry is market-oriented and restricted by government policies, so the innovation level of many high-tech enterprises is relatively high. However, many of the high-tech products with high added value produced by these enterprises are mainly for the domestic market, not for export to meet the foreign market. Therefore, the complexity of exports does not reflect the R&D and innovation capabilities of these companies.
Random matrix theory is an effective method for processing high-dimensional data. It can distinguish "noise" from real information by comparing the statistical characteristics of eigenvalues and eigenvectors between the research object and the random system. The export market environment of traditional culture is not stable, so it is difficult to determine whether the correlation between the export prices of two traditional cultures is random or really from the interaction between the two companies. This problem can be solved effectively by using random matrix theory to compare the statistical properties of the real income correlation matrix and random correlation matrix.

It is of great significance to study the factors influencing the export of high-tech products and the new changes in the current international and domestic new environment. At present, the empirical analysis of the influencing factors of the export of high-tech products in China is mostly carried out from the static perspective, and there are few comparative analyses or dynamic description of the changes of the export trade of high-tech products in different stages. Therefore, based on previous studies, this paper tries to discuss the periodical changes and causes of the influencing factors of the export of high-tech products at two different stages before and after the international traditional culture export crisis.

## 2. Related Work

They studied the problem of technology spillover among high-tech exports. They used the knowledge spillover model to study countries. The results showed that more than half of the economic growth of these countries could be attributed to the absorption of advanced technology from leading countries, and a country’s ability to absorb technology spillovers depends on its human capital level and R&D intensity [2, 3]. Based on the diamond theory and taking the export performance of high-tech products as the dependent variable, the independent variables are as follows: domestic market demand, domestic competition situation, FDI, technology level, human resources, and exchange rate. Based on the data of 60 major high-tech product manufacturers in the world, this paper makes an empirical analysis on the relationship between them by using the measurement method of multiple regression model [4]. The result of empirical analysis shows that the technological level and human resources have a significant impact on promoting the export of high-tech products. The Pearson correlation coefficient constructed based on income series can provide effective information, but it is difficult to extract these information. Partial correlation is a statistical measure that, by eliminating the partial correlation coefficient calculated by some mediating effects, can show how the removed mediating effect affects the correlation of two variables [5, 6]. Based on the analysis of the factors influencing the export of high-tech products, it is concluded that foreign-funded high-tech enterprises have played a great role in promoting the export growth of high-tech products [7]. There is a very close relationship between the introduction of science and technology and the export scale of high-tech products, so we should continue to increase the intensity of technology introduction [8] and adjust the export structure of foreign trade. Due to incomplete exchange rate pass-through and other reasons, non-exchange rate factors have a significant impact on foreign trade of high-tech products [9]. The driving effect of high-tech products was export on economy and policy analysis of promoting high-tech product export [10]. By comparing the strategic measures taken in promoting the development of high-tech industry and foreign trade in different regions at home and abroad, it is pointed out that the export of high-tech products is dominated by the possession of independent intellectual property rights, the export of high-tech products is mainly promoted by the transformation of technological achievements, and the export of high-tech products is dominated by the way of processing trade [11]. Based on relevant data, an empirical analysis is made on the relationship between the export of high-tech products and economic growth, and the results show that the foreign trade of high-tech products can promote economic growth [12]. The problems faced by the export of high-tech industries are as follows: the export product structure is highly concentrated and the product technology content is low; processing trade is still the main way of trade, at the low end of the international industry chain; technical barriers to trade and intellectual property rights constitute double barriers to the export of high-tech products [13]. From the perspective of intra-product division of labor and intra-industry trade, this paper studies the high-tech trade with the United States [14], and the results show that the trade of high-tech products is still based on the comparative advantage of human resources and at the low level in the international division of labor.

Based on the function of partial correlation coefficient, applying partial correlation analysis to the time series of export earnings of traditional culture, we can eliminate the common influence factors between any two time series of export earnings of traditional culture and analyze the influence of the common influence factors on the export of these two traditional cultures respectively. The partial correlation matrix is applied to the analysis of the correlation structure of traditional cultural export [15], which can further study the structural characteristics of correlation and the information contained therein. The modern investment field usually contains a large number of investment varieties (denoted as N), and the asset dimension is proportional to the sample observation value T. At this time, using the sample covariance matrix to estimate the overall covariance will produce a large deviation [16]; this is also an important reason to solve the high-dimensional portfolio weight problem caused by MV portfolio outside the sample data. Specifically, as n increases, even when the unit is a general matrix, the eigenvalues of the sample covariance matrix will be far away from them [17]. This is also an important reason to solve the high-dimensional portfolio weight problem caused by MV portfolio outside the sample data. Specifically, as n increases, even when the unit is a general matrix, the eigenvalues of the sample covariance matrix will be far away from them. The distribution of eigenvalues of the sample covariance matrix is (0.480, 4.602),
and the distribution of eigenvalues of the inverse matrix is more serious. The distribution interval of eigenvalues of the sample covariance matrix is (0.093, 2.909), and the distribution interval of eigenvalues of the inverse matrix is (0.344, 10.793) [18, 19]. Therefore, it is of great theoretical and practical significance to estimate the total covariance matrix more accurately. [20] Applying the random matrix theory to analyze the traditional culture export market, we find that the asset structure related to the traditional culture export in higher dimensions does not always remain unchanged, but develops dynamically with the passage of time. Therefore, the improvement of high-dimensional MV portfolio should focus on the identification of “market information” in the sample covariance matrix and consider the time variability of stock market-related structures [21]. The “mean-variance” optimal portfolio theory is based on certain reasonable assumptions and multiple investable traditional culture exports. According to the expected return rate and variance of each traditional culture export and the covariance matrix between traditional culture exports, the effective boundary of the portfolio is calculated and the optimal portfolio is determined. Sometimes, some studies also use var or bankruptcy probability to replace variance [23].

Summarized from the literature respectively, many scholars have studied the relationship between the traditional culture support and export complexity, as well as the relationship between the complexity research innovation and export, export support, few research traditional culture of the random matrix theory, research and development, innovation and the relationship between export complexity, and based on the research on high-tech industry data is more rare. This paper will carefully examine the linkage among export support of traditional culture, R&D innovation, and export complexity, and discover the influence channels among these variables.


3.1. Random Matrix Theory Portfolio Theory Research and Analysis. Assuming that the number of traditional culture exports in the portfolio is N, their excess return rate is

\[
p(t) = \frac{P_i(t) + \Delta t}{P_i(t)} - f(t). \tag{1}
\]

Consider the case where no constraint is imposed on the weight of the portfolio. When the risk constraint of the portfolio is given, the MV optimal portfolio theoretical framework can be expressed as

\[
\arg \max E(p(t)) = a\mu. \tag{2}
\]

In terms of research methods, it emphasizes the combination of theoretical research and empirical research, qualitative research and quantitative research, and the unity of empirical analysis and normative analysis, and pays attention to the use of historical analysis, logical deduction, comparative analysis, system analysis, and other methods. Based on the theories of international trade, sustainable development, competitiveness, and government management, this paper studies the negative impact of trade protectionism on agricultural trade in a more subtle, roundabout, and reasonable way under the background of globalization. Its research framework is shown in Figure 1.

The probability density function of the eigenvalues of the random correlation matrix R is

\[
P(\lambda) = \frac{1}{2\pi} \sqrt{(\lambda_{\max} - \lambda)(\lambda - \lambda_{\min})}. \tag{3}
\]

\[
\lambda = \frac{1}{P} + 2 * \sqrt{\frac{1}{P}}. \tag{4}
\]

As panel data analysis includes time series and intertemporal data, it may lead to errors in regression results due to the instability and non-cointegration of variables and the potential endogeneity of variables. Therefore, in order to exclude the possibility of false regression, the unit root test should be carried out on panel data before model operation to judge the stability of variable data. If the data is stable, regression solution can be carried out; if the data is not stable, co-integration analysis should be carried out on the data to ensure the correctness of the results. Perform LLC (Logical Link Control) tests on panel data.

3.2. Partial Correlation Matrix of Real Export Earnings of Traditional Cultural Industry. For any time series of the export return rate of traditional culture, common market factors can be removed and characteristic components can be extracted by a single factor model:

\[
r(t) = \alpha + \beta r_m(t). \tag{5}
\]

For a single traditional culture export, the market index in the single factor model represents the common influencing factors of all traditional culture exports and reflects the systemic risk of traditional culture export, that is, the global factors that affect the export earnings of all traditional culture. In the calculation process, a simplified calculation formula is adopted for the elements C of partial correlation P:

\[
P = \frac{C_j - C_i}{\sqrt{C_j - C_i}}. \tag{6}
\]

According to the above formula, the real return correlation matrix of traditional culture export logarithmic price and the real return partial correlation matrix after removing the market index effect can be calculated. Based on RMT theory, by comparing the correlation coefficient, eigenvalue, and eigenvector of the matrices with two properties, the changes of the export related structure characteristics of traditional manufacturing culture before and after the outbreak of random matrix theory and the market information contained in the export related structure of traditional manufacturing culture can be well analyzed. Then the
influence of random matrix theory on the export system risk of traditional manufacturing culture is analyzed.

The traditional cultural industry has been expanding in scale and developing at a fast speed. However, due to its late start, weak foundation, and unreasonable structure, its proportion in the world’s total cultural industry is still low. Although it ranks second in the world, it is only half of the proportion of the United States in the world’s total trade. There is still a big gap between the scale and product competitiveness of developed countries. Before 2008, the import and export of the traditional cultural industry kept pace. However, after the financial crisis, compared with the rapid growth of the import of the traditional cultural industry, the export growth of the traditional cultural industry slowed down, and sometimes repeated, resulting in the increasingly serious deficit of the traditional cultural industry, which formed a sharp contrast with the huge trade surplus of goods.

After the financial crisis, the development of foreign trade was affected by the sluggish international economic environment, and the growth rate slowed down significantly, with no obvious momentum of recovery. The growth rate of trade in goods has been around 7% in recent years, lower than expected in the past three years. Likewise, the growth of traditional cultural industries is not optimistic. The traditional cultural industry started late with a weak foundation. The import growth keeps rising, and the growth rate is relatively stable and slightly slower. However, the export growth is highly volatile and has a good development space and potential. The specific growth is as follows.

In the past decade, the import and export of traditional cultural industry have maintained a high growth rate, with an average annual growth rate of more than 14%. In 2018, the export growth rate reached 29.6%, and in 2009, due to the financial crisis, the export growth rate of traditional cultural industry was negative. The export growth of the traditional culture industry is extremely unstable, seriously affected by multiple factors at home and abroad. Under the background of the new normal of the global economy, the export growth has dropped to within 9%. The growth rate of import was only 0.12%, remaining above 12% in the rest years, and the highest was 31.6% in 2014. The growth rate in the past three years remained within 20% and gradually slowed down. The specific trend is shown in Figure 2.

When using panel data for empirical analysis, there are generally two methods to estimate econometric models: One is fixed effect model estimation, and the other is random effect model estimation. The fixed effect model estimation requires intra-group transformation of the data first to eliminate the fixed effects in the data, and then the OLS method is used to estimate the calculated data. The random effect estimation method assumes that the non-observed effects not correlated with each explanatory variable, and then uses OLS to estimate. According to the analysis of the effect of the non-observation data in this paper includes the provinces of geographical location, the influence factors of social culture, and so on are observation of fixed, it is difficult to ensure that the observed effects associated with various explanatory variables do not, so this article tend to use fixed effects model, but at the same time, this article will also take the Hausman test to determine what kind of estimation method is better. The Eviews8.0 software will be used for fixed effect estimation and random effect estimation respectively. The method is as follows: The fixed effect estimation, random effect estimation, and HAUSMAN test are carried out on the model with the Eviews8.0 software. If the $P$ value of Hausman test result is less than the significance level of 0.05, then the fixed effect estimation should be adopted in this model; otherwise, random effect estimation should be adopted. Specific estimation results are shown in Table 1.

In this paper, the model of the estimated results shows that the companies in the zone before and after the financial crisis impact on the export of high-tech products have
changed; before the financial crisis, companies in the zone of new high-tech product export are very significant, and the influence of the high-tech zone formed after the financial crisis impact on the export of high-tech products has no longer significant. Before the financial crisis, the influence of the companies in the zone of new high-tech product export increases by 1%, the new high-tech product export growth is 0.861%, and after the financial crisis, the impact of high-tech enterprises’ product exports is no longer significant.

4. Empirical Analysis on the Evolution of the Structural Characteristics of Traditional Cultural Industry

Comparative analysis of the statistical characteristics of the correlation coefficient and partial correlation coefficient was carried out. According to the analysis of the correlation matrix of the logarithmic return rate of prices of 201 computers, communication and electronic equipment in a shares during 2016–2017 (before the outbreak of random matrix theory) and 2018–2020 (after the outbreak of random matrix theory). The probability density distribution of partial correlation coefficient and the descriptive statistics of correlation coefficient and partial correlation coefficient are shown in Figure 3 and Table 2.

Figure 3 and Table 2 show that (1) the distribution of the correlation coefficient and partial correlation coefficient of the real income of traditional cultural industry deviates from the standard normal distribution. 2016–2017 and 2018–2020 are centered on positive mean values, which indicates that in the traditional cultural industry market, positive correlation is more common than negative correlation between high and new technologies and price fluctuations of traditional cultural industry. In the correlation coefficient matrix from
2018 to 2020, the minimum value is 0.06, indicating that after the outbreak of random matrix theory. The price changes of traditional cultural industries are more similar and share prices rise and fall with each other. The random matrix theory has intensified the systematic risk of traditional culture industry.

There are generally three types of panel data models: mixed model, fixed effect model, and random effect model. The F test and Hausman test are used to select the three models before regression analysis. The F test is to determine whether there are individual fixed effects in the model. The H test is to determine whether the model is individual random effect model or individual fixed effect model.

By using EViews6, the F-test is carried out on the selected data, and the significant probability of the F test is 0, which means that the original hypothesis should be rejected and the standby hypothesis should be accepted, and the individual fixed effect model should be selected for regression analysis. Then, the H test was performed on the data. However, due to the large number of research factors in this part and the relatively small number of data years, the sample size required for the H test was not satisfied, so it was considered that the model in this part was not suitable for individual random effect model regression. To sum up, this part of the model should choose the individual fixed effect model. After running EViews6, the regression results of the individual fixed effect model are shown in Table 3.

The more money an enterprise spends on purchasing technology developed in other parts of the country, the less independent research and development capability a high-tech enterprise has, the less competitive its products will be in the international market. There are two reasons for this: First, the technology purchased is not at the world’s top level, and the products do not conform to the international development trend, which will cause a series of negative effects and hinder the export of high-tech products; on the other hand, the reason lies in that enterprises which excessively rely on technology purchase to upgrade their products and cannot form brand products with independent intellectual property rights, and the export scale has been restricted for a long time. At the same time, it also shows that the development of traditional cultural industry and high-tech industry should not rely too much on the introduction of foreign technology; otherwise, it will restrict the development of the industry.

The regression coefficients of government investment and enterprise investment are 0.057 and 0.2759, respectively, which means that if the percentage of government funds in the amount of funds raised for scientific and technological activities increases by one percentage point, the export value of high-tech products of traditional cultural industry will increase by 0.087 billion yuan. At the same time, the export of high-tech products of traditional cultural industry will increase by RMB 109.97 billion when the enterprise funds in the amount of funds raised for scientific and technological activities increase by one percentage point. High-tech industry is a special industry with high risk and high

<table>
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<th>Matrix</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>Stdev</th>
<th>P</th>
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<td>0.15</td>
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<tr>
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<tr>
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<td>0.83</td>
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</tr>
<tr>
<td>C4</td>
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<td>-0.08</td>
<td>0.72</td>
<td>0.06</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Figure 3: Probability density distribution of the real return correlation coefficient and partial correlation coefficient.
investment. The fund for scientific and technological activities is the basic condition for the development of high-tech enterprises. The government’s fund support and enterprises’ own capital investment will greatly promote the export of high-tech products.

5. Example Verification

In order to verify whether the covariance matrix estimation proposed in this paper can better reflect the relevant structure of high-tech to traditional cultural industry, the excess return rate of S&P500 traditional cultural industry in 20 years is selected as empirical research data. Data on the price of high-tech versus traditional cultural industries come from Yahoo Finance and Wind databases, and the risk-free rate used to calculate excess returns is derived from the KennethFrench Data Library. Due to the time variability of stock market related structures, a rolling window investment simulation plan is constructed in this study. The investment weight is determined by using the data of 120 months before the investment time point, and the portfolio weight is calculated at each weight update time point as time goes by. The time range for the out of sample portfolio forecast is 20 years.

Table 4 shows the results of Plugin covariance matrix estimation in MV and that of Plugin covariance matrix estimation in MV of the market index single factor model, when transaction costs are considered, in the mode of randomly selecting high-tech to traditional cultural industry and updating portfolio weight every month. Under the model of Plugin covariance matrix estimation in MV, the sharpe ratio of various improved covariance matrix methods is significantly better than that of the sample covariance matrix, but none of them can exceed the equal-weight portfolio, and the risk of all portfolios is significantly higher than the given risk 0.05. In THE MSFMV model of Plugin covariance matrix estimation, only the annual sharpe ratio of M_PCA is significantly higher than that of the equal-weight portfolio at the level of 1%.

Figure 4 shows the probability density distribution of the eigenvalues of the real return correlation matrix and partial correlation matrix and the predicted eigenvalues of RMT (Random Matrix Theory) respectively. It can be seen that the probability density distribution of the eigenvalues of the partial correlation matrix is closer to the distribution of the predicted eigenvalues of RMT, while the distribution of the eigenvalues of the original correlation matrix is significantly different from that of RMT.

The feature vector component distribution represents the contribution of the sample high-tech to the traditional cultural industry to the feature vector, and the sign of the feature vector component deviating from the feature value contains certain economic confidence. Therefore, the variation of feature vector component distribution can reflect the dynamic evolution of the correlation structure between high-tech and traditional cultural industry. Figure 5 shows the distribution of eigenvector components corresponding to the top five eigenvalues of real return correlation matrix and partial correlation matrix in 2016–2017 and 2018–2020. It can be obviously seen that the corresponding component signs are opposite, indicating that the random matrix theory makes the correlation structure of manufacturing high-tech to traditional cultural industry change significantly.

Based on the random matrix theory and partial correlation analysis method, this paper takes the closing price of a-share traditional culture industry of computer, communication, and electronic equipment manufacturing industry in industry classification of China Securities Regulatory Commission from 2016 to 2020 as the original data. This paper compares the average correlation coefficient, maximum eigenvalue, and eigenvector information of the correlation matrix and partial correlation matrix of manufacturing traditional culture industry in 2016–2017 and 2018–2020, discusses the changes of the correlation structure of manufacturing traditional culture industry before and after the random matrix theory in China and America, and further reveals the influence of random matrix theory on the systematic risk of manufacturing traditional culture industry. Figure 6 shows the regression fitting diagram of portfolio return series defined by the maximum eigenvalues of the real return correlation matrix and partial return matrix before and after the outbreak of random matrix theory.

Figure 7 shows the structure of imported production factors of traditional cultural industry. In 2014, the import of labor-intensive traditional cultural industries took an absolute lead over the export of capital and knowledge- and technology-intensive traditional cultural industries, accounting for more than 50% of the total, ranking first in the import of traditional cultural industries. The import of
capital-intensive traditional cultural industries accounted for about a quarter of the total, while the import share of knowledge- and technology-intensive traditional cultural industries was slightly lower, accounting for 23.41%.

The actual use of FDI has a close relationship with the export of labor, capital, and knowledge-intensive services in China’s traditional cultural industries. Foreign direct investment has a profound impact on the export of these three types of traditional cultural industries and has more impact on the export of capital-intensive services than other types. The rise of China’s foreign trade is completed under the guidance of foreign direct investment. Foreign direct investment, as a high-quality investment guide, will play a key role in the development and progress of China’s traditional cultural industry. The flexible and reasonable use of foreign direct investment will become an important task of China’s economic management.
6. Conclusion

It can be seen from the research in this paper that the correction of the covariance matrix in the framework of high-dimensional portfolio theory based on the random matrix theory and method can make the Markowitz “mean-variance” and the portfolio exceed the performance of equal-weight portfolio. Compared with the other covariance matrix linear contraction method, nonlinear contraction method, and random matrix theory denoising method, the covariance matrix estimation based on the minimum eigenvalue ratio of sample autocovariance matrix to identify “market information” has obtained better results in the S&P500 traditional cultural industry data. Portfolios that updated their weights monthly did no better in the Sharpe ratio than those that updated their weights semiannually, and did worse when transaction costs were taken into account. This indicates that the total covariance matrix of S&P500 component return data is likely to be similar to the spiked total model, and the factor structure hypothesis can reasonably reflect the total structure of the data. The data structure has intertemporal stability, and higher frequency of investment weight update does not improve investment efficiency. The empirical results of this paper show that R&D investment plays an important role in promoting the export of high-tech industries. However, according to relevant data, the proportion of R&D expenditure in GDP in 2008 is only 0.25%, and the proportion of R&D expenditure in GDP in the same period is 0.64%. Therefore, for a long time in the future, we should continue to increase the R&D investment in the high-tech industry, enhancing the competitiveness of products in the international market, so as to expand the export scale of high-tech products. The next step is to introduce the market index single factor model and bring the market index factor into the overall weight calculation of the portfolio as one of the investment targets, weakening the factor result in the noise term of the factor model, so as to obtain a more accurate estimation of covariance moment $W$ and lower risk and higher prevalence rate of the portfolio.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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