Study on the Volatility of International Crude Oil Shipping Market Based on Prosperity Index

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Abstract: International crude oil shipping market is an important part of tanker shipping market, and its fluctuation performance is becoming more and more obvious with the rapid development of macro economy, which has been paid attention by scholars at home and abroad. The fluctuation of international crude oil shipping market is easily affected by factors such as economy, policy, capacity, maritime transportation distance and war, thus showing contraction and expansion. The fluctuation of its market will affect the strategic position of the country on the one hand, and the fluctuation of crude oil as the "blood" of industry on the other hand will directly affect the downstream industry chain. Therefore, how to forecast the future development trend of international crude oil shipping market, so as to reduce the loss and avoid the risk has become the concern of relevant operators. This paper constructs a model of international crude oil shipping market prosperity index based on the actual demand, and validates the model of international crude oil shipping market prosperity index by using RBF neural network to ensure the accuracy and practicality of the model.

Keywords: crude oil; shipping market; volatility; prosperity index; RBF neural network

1 Introduction

The tanker shipping market is a product of the global economy and the demand for energy in international trade. "During the 13th Five-Year Plan (2016 - 2020), China formed a comprehensive layout of the oil transportation system, and the 14th Five-Year Plan (2021 - 2025) calls for the transportation system of crude oil and other major cargoes to be continuously improved. In this context, it is more important to always pay attention to the changes of international tanker shipping market trends. The cyclical fluctuations in the international crude oil shipping market have a huge impact on the whole industry and can directly affect the revenue of the shipping market and the value of tankers. At present, there are some indices that indicate the rise and fall of the international crude oil shipping market, but the economic crisis in 2008 showed that it is wrong to adopt only a single index or indicator to predict the development trend of the whole market. A single index or indicator does not adequately reflect the actual situation of the whole market. Therefore, it is necessary to build a perfect model of international crude oil shipping market sentiment index, which can make an assessment of the present or future development trend of the market, and the government can make corresponding development strategies and countermeasures accordingly,

so as to prepare the market in advance and reduce the loss of shipping enterprises, government and other parties.

2 Factors influencing the Prosperity of international crude oil shipping market

Under the invisible regulation of the market, the macro economy has a certain cycle fluctuation law, the international crude oil shipping market is also a similar economic system exists, with the characteristics of macro economy, so it will also show the cyclical characteristics. From the historical data, the crude oil market is very volatile. But this kind of fluctuation is not untraceable, it is actually influenced by many different factors, this paper analyzes the factors affecting the prosperity situation of international crude oil shipping market from the following perspective.

① Macroeconomic trends

The demand in the international crude oil shipping market is the world demand for crude oil, which can also be said to be derived from the international oil market, so the market demand in the crude oil shipping market is closely related to the macro economy and oil trade.

② Vessel Capacity

Tanker is a necessary capacity tool for international crude oil shipping market. In addition to the influence of the existing tanker capacity, the order quantity of new shipbuilding, order quantity of shipbreaking, fleet size and the price of second-hand ships are all influencing factors of tanker capacity.

③ Shipping transportation cost

If the cost of tanker transportation is higher, the revenue of the shipping company will be reduced, while lower transportation cost will increase the revenue of the shipping company.

④ Sea transportation distance

The distance travelled by sea is also a factor that affects the crude oil shipping market, and in simple terms, there are differences in freight rates depending on the distance from the port of departure to the port of destination. The distance travelled by sea determines the demand in the crude oil shipping market.

⑤ Crude oil trade flows

The distribution of crude oil, the industrial chain, the economic capacity and the natural conditions of each crude oil importing and exporting country in the world are very different, thus also determining the flow of crude oil.

⑥ Related policies and regulations

International political events, regional military wars, and legal protection clauses in various countries can affect the amount of international crude oil demanded.

3 International crude oil shipping market prosperity index system construction

In the shipping market, previous authors mostly take the global shipping market, container shipping market and dry bulk shipping market as the research objects for the construction of the prosperity index model. Ning Xiaolin et al.[1] selected new shipbuilding orders, international shipping market available capacity, global trade volume, shipping market volume, spot freight price, bunker price and crude oil price as global shipping market prosperity indexes; Wang Lelin et al.[2] selected industrial growth rate, coastal construction investment, Dow Jones index national total import and export, BDI index, port throughput and CPI index as global shipping market prosperity indexes Li Jing et al.[3] selected Dow Jones industrial index, steel production index, capacity scale, China export container tariff index, container term charter index, new ship dismantling volume, etc. as dry bulk shipping market prosperity indicators; Qing Qian et al.[4] selected dry bulk shipbuilding new order quantity, fleet dismantling quantity, global trade volume, global shipping market volume, tariff index, FFA fuel price, etc. as dry bulk shipping market prosperity indicators. prosperity indicators.

Based on the analysis and summary of the factors influencing the prosperity of international crude oil shipping market and with reference to the previous research results, this paper selects 12 prosperity indicators from three aspects of international crude oil shipping market supply, market demand and market performance respectively, thus constructing the prosperity indicator system of international crude oil shipping market, as shown in Table 1:

Table 1 International crude oil shipping market prosperity indicator system

Classification of indicators	Indicator Symbols	Indicator Name	Indicator Unit
Market Demand	X1	Steel Production Index	Index
	X2	Crude Oil Inventory	Thousands of barrels
	X3	PMI Purchasing Managers' Index	Index
Market Supply	X4	Singapore 380CST	$/Tonne
	X5	New shipbuilding orders	DWT
	X6	Tanker fleet size	DWT million
	X7	Tanker Dismantling Volume	DWT million
Market Performance	X8	Baltic Crude Oil Tariff Index (BDTI)	Index
	X9	Newbuilding Price Index	Index
	X10	Used Ship Price Index	Index
	X11	Disassembly Price Index	Index
	X12	Breant Crude Oil Price	$/bbl

The contents of the prosperity indicators are different from each other and the order of occurrence of each indicator is different. Before classifying the indicators, benchmark

indicators are selected to determine the benchmark cycle of the market. In this paper, X8 Baltic Crude Oil Tariff Index (BDTI) is selected as the benchmark indicator, which is basically consistent with the actual trend of the crude oil shipping market, and the rest of the indicators are compared with it in terms of time difference, so as to determine the order of occurrence of each. By using the time difference relationship to determine the type of indicators, i.e., leading indicators (ahead of the benchmark indicators), consistent indicators (synchronized with the benchmark indicators) and lagging indicators (behind the benchmark indicators), the classification of indicators is the basis for the prosperity indicator system to achieve the prediction of the future direction of the market.

This paper uses time difference correlation analysis to classify the data based on a total of 194 monthly prosperity indicators from January 2005 to February 2021, and the classification results are shown in Table 2.

Table 2 Classification results of prosperity indicators

Relevance	l=-2	l=-1	l=0	l=1	l=2	Indicator Type
X1	0.595	0.6	0.603	0.574	0.546	Consistent
X2	0.466	0.5	0.532	0.528	0.511	Consistent
X3	0.089	0.155	0.288	0.346	0.361	Advance 2
X4	0.124	0.111	0.083	0.033	0.01	Lagging 2 periods
X5	0.416	0.394	0.366	0.351	0.323	Lagging 2 periods
X6	0.548	0.562	0.571	0.554	0.534	Consistent
X7	0.223	0.211	0.212	0.213	0.107	Lagging 2 periods
X9	0.71	0.699	0.683	0.65	0.618	Lagging 2 periods
X10	0.743	0.747	0.748	0.722	0.691	Consistent
X11	0.007	0.067	0.136	0.185	0.198	Advance 2
X12	0.063	0.023	0.016	0.052	0.066	Advance 2

On this basis, the entropy method was used to determine the weights of the prosperity indicators, and the results were calculated in Table 3:

Table 3 Distribution of the weighting of prosperity indicators

Indicator Type	Indicator Name	Indicators	Weights	Weights and
	PMI Purchasing Managers' Index	X3	0.04009	
Preceding indicators	Disassembly Price Index	X11	0.07238	0.22349
	Breant Crude Oil Price	X12	0.11102	

	Steel Production Index	X1	0.11341	
	Crude Oil Inventory	X2	0.03561	
Consistent indicators	Crude oil tanker fleet size	X6	0.11915	0.57029
	Baltic Crude Oil Tariff Index (BDTI)	X8	0.13891	
	Used Ship Price Index	X10	0.16321	
	Singapore 380CST	X4	0.04264	
Lagging indicators	New shipbuilding orders	X5	0.04193	0.20622
	Crude Oil Tanker Breakdown Volume	X7	0.04963	
	Newbuilding Price Index	X9	0.07202	

3 Model Construction of International Crude Oil Shipping Market Sentiment Index and Analysis

The prosperity index model cannot be separated from the DI (Diffusion Index) model and CI (Composite Index) model, the effective combination of which can reflect the magnitude and direction of fluctuations in the crude oil shipping market in a comprehensive manner.

In this paper, we have chosen to compile a weighted diffusion index with the following formula[5]:

$$DI_t = \sum_{i=1}^{n} w_i * I \left(X_t^i, \ X_{t-1}^i \right) \times 100\% \qquad (1)$$

In equation (1), t represents the time point, n is the total number of indicators, then x_t^i represents the value of the ith indicator at time point t, DI_t represents the diffusion index at time point t. I represents the diffusion degree, when the value of the ith indicator at time point t is greater than the value of the previous moment, I is 1, the indicator is diffusion indicator at this time; when the value of the ith indicator at time point t is equal to the value of the previous moment, I is 0.5 When the value of the ith indicator at the moment t is less than the value at the moment t-1, I is 0, and the indicator is called the non-diffusion indicator at this moment.

The basic compilation idea of the synthetic index is to first find the symmetric rate of change of each indicator at different points in time, and then the average rate of change of each group of indicators can be found, and the relative index for the rest of the months can be calculated on a monthly basis.

Analysis by the results of the calculation of synthetic index, diffusion index:

①Comprehensive diffusion index analysis

From the trend chart,as shown in Figure 1,we can see that the crude oil market mainly experienced 4 expansion periods and 5 contraction periods in the 194 months from January 2005 to February 2021. a longer contraction period was maintained from March 2008 to October 2009, and a longer expansion period was observed in the international crude oil

shipping market from September 2013 to March 2015, except for these two time periods The comprehensive diffusion index fluctuates around the prosperity turning point of 50% up and down, which indicates that the development state of the market is more stable, and the specific fluctuation magnitude of each phase needs to be analyzed and judged in conjunction with the comprehensive synthetic index.
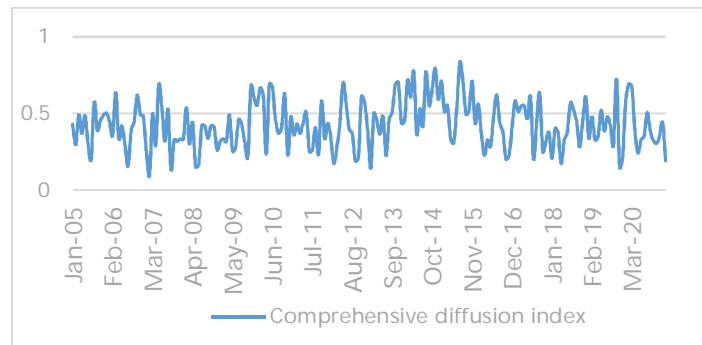

Figure 1 Trends in the Composite Diffusion Index

②First, consistent, and lagged diffusion index analysis

The financial crisis in 2008 caused a shock to the global economy, and the crude oil shipping market is no exception. In order to more intuitively judge the time difference relationship between the three leading, consistent and lagging diffusion indices, this paper chooses the data of three years before and after 2008 to plot the trend of the three comparisons, as shown in the Figure 2. From the above graph, it can be seen that, in the context of the financial crisis, the consistent diffusion index began to fall below 50% in March 2008 and remained in a state of market contraction until October 2009. It is worth noting that the prior diffusion index started to show a slump in November 2007 and remained in the slump space until June 2009, which is seen by comparison to be about 4 months ahead of the consensus diffusion index. The Figure 2 shows the trend comparison between the lagged diffusion index and the consistent diffusion index. The lagged diffusion index showed a trough only around June 2008 and ended the recession until January 2010, with a lag of 3 months compared to the consistent diffusion index.
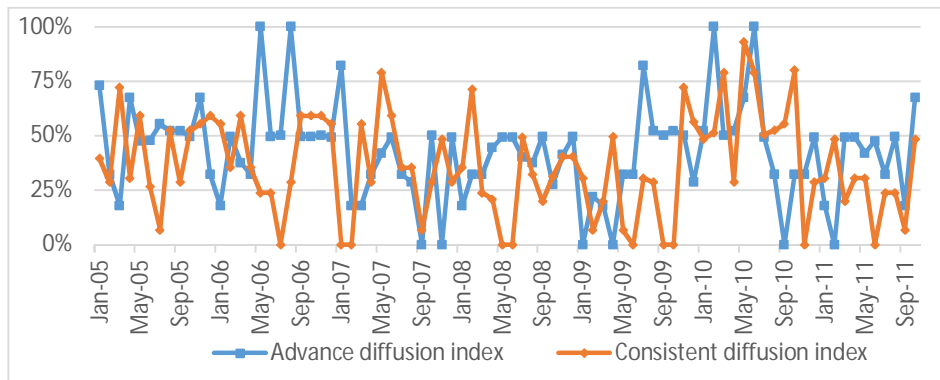
(a)Trend comparison of prior and consistent diffusion indices
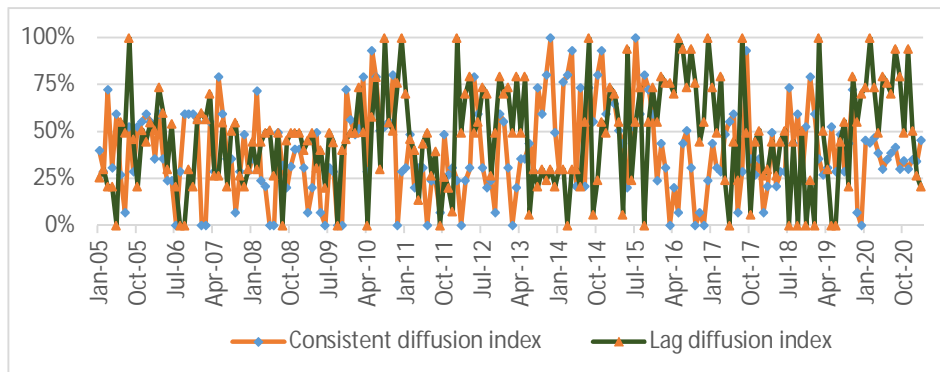
(b)Trend comparison lagging and consistent diffusion indices

Figure 2 Trend comparison of prior, lagging and consistent diffusion indices

③Analysis of synthetic index

Figure 3 and Figure 4 show the trend comparison of the prior, consistent and lagging synthetic indices, which can represent the volatility of the international crude oil shipping market in a more visual way. From Figure. 3, it can be seen that the prior synthetic index was in a depressed state before and after the financial crisis in 2008, and the overall volatility of the index did not change much in the whole year of 2015 and from January 2017 to August 2018, which is a prosperity transition period of the market. The unanimous synthetic index ushered in the development phase of the market from May 2009 and October 2013 respectively, when the synthetic index rose significantly. it reached its peak in July 2015, when the international crude oil shipping market developed overheated, after which the market started to cool down. From the trend comparison chart in Figure 4, it can be seen that the lagging synthetic index lags behind the consistent synthetic index by a certain time lag, which in the shipping market usually indicates the changes in the ship market.
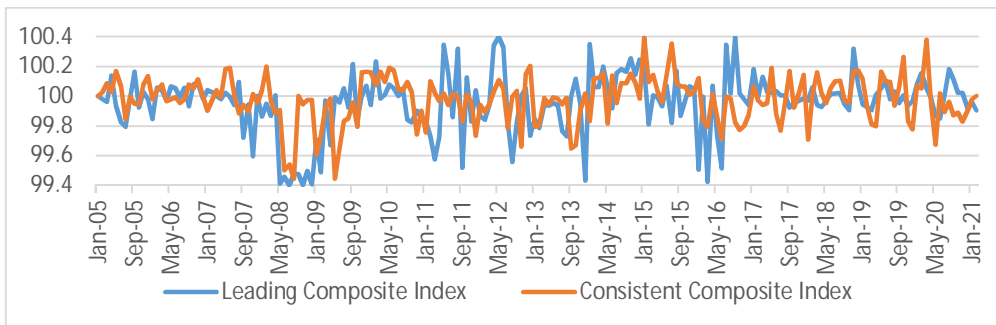
Figure 3 Comparison of the trend of the first and consistent synthetic index
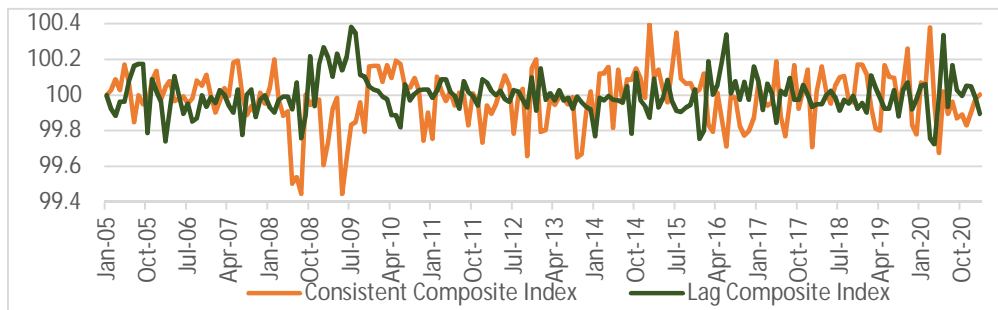

Figure 4 Consistent, lagging synthetic index trend comparison

④Comparative analysis of diffusion synthetic index

1）Comparative analysis of prior prosperity index

The Advance Prosperity Index can forecast and analyze the future fluctuation of the international crude oil shipping market, which is valuable for predicting the prosperity of the market.

Figure 5 shows the comparison chart of advance diffusion index and advance synthetic index. From Figure 5, it can be seen that the advance diffusion index fluctuated above and below 50% of the prosperity turning line from January 2005 to August 2007, while the advance synthetic index showed a very stable trend at this time, which can indicate that the international crude oil shipping market was in a stable development stage during this period. In the time period from May 2008 to June 2009, the prior diffusion index was below 50%, and the prior synthetic index was also in the state of abrupt decline at this time, and the performance of both of them is consistent that the current market is in a depressed state. Figure 5 shows that the prior synthetic index has been maintained at a certain level since September 2016, with the exception of 2020, which had a downward trend, and the rest has remained around 100 overall.
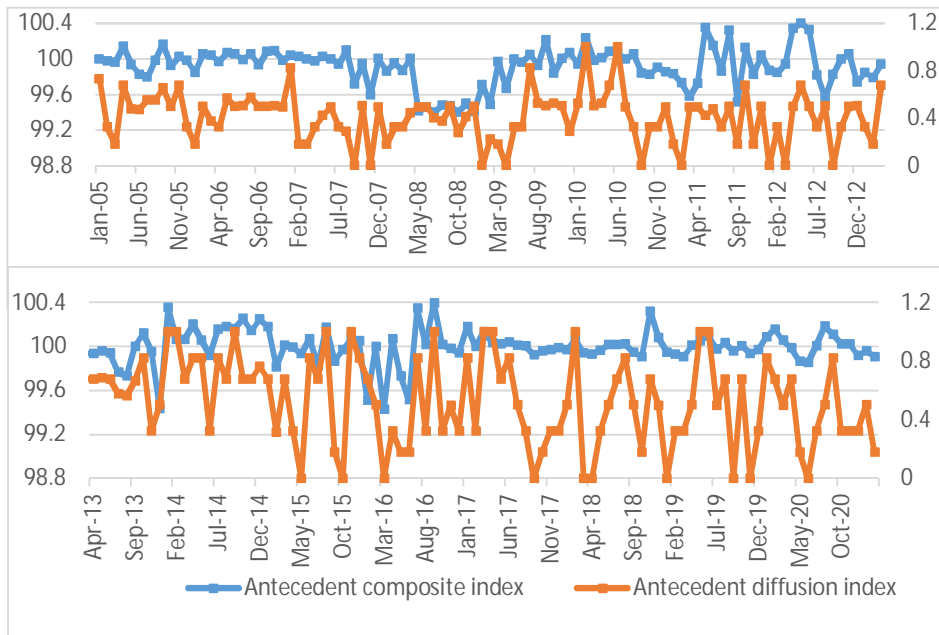
Figure 5 Comparison of prior diffusion index and prior synthesis index

(2) Consistent prosperity index comparison analysis

The consistent prosperity index can indicate the development trend of current international crude oil shipping market, and it can be seen from the comparison chart of consistent diffusion index and consistent synthetic index in Figure 6 that the market development trend reflected by consistent synthetic and consistent diffusion index is basically the same in the international crude oil shipping market, when the former is lower than the prosperity turning point, the consistent synthetic index at this time also shows a downward fluctuation trend; when the consistent diffusion index When the former is below the prosperity turning point, the consistent synthetic index also shows a downward fluctuation; when the consistent diffusion index shows the characteristics of prosperity, the latter also shows a rising fluctuation curve; when the consistent diffusion index fluctuates up and down around the 50% prosperity turning line, the consistent synthetic index can be used to judge the current state of the market at this time.
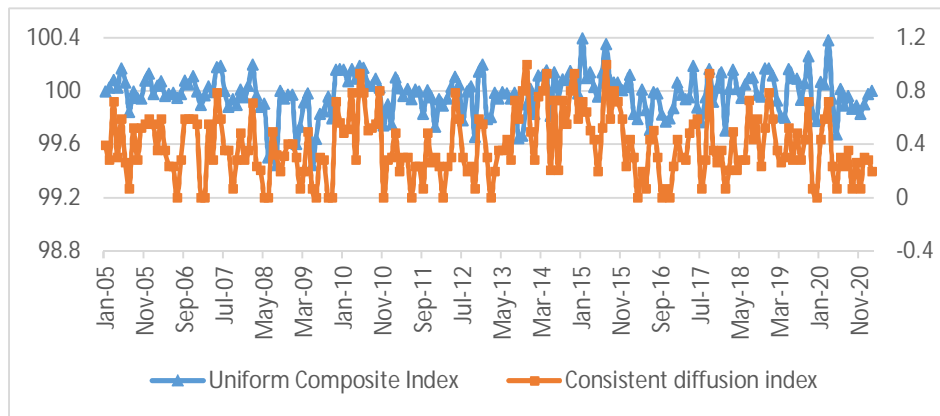
Figure 6 Comparison of consistent synthetic index and consistent diffusion index

Specifically, from January 2005 to February 2008, the consistent diffusion index fluctuated up and down around the prosperity turning line, and the consistent synthetic index also behaved very smoothly at this time, indicating that the international crude oil shipping market fluctuated steadily during this period. February 2008 was the prosperity turning point of the consistent diffusion index, after which the diffusion index dropped from 71.38% to below 50%, indicating that the current market was in a depressed state. The consistent synthetic index also began to decline from the peak state until October 2009, when the diffusion index returned to above the prosperity turning point, and the consistent synthetic index also returned to normal from the decline state. January 2013 - June 2013, December 2015 - June 2016, and April 2020 - February 2021, the three time intervals in which the consistent diffusion index was below 50% and in a state of recession, the consistent synthetic index also showed a significant downward trend at this time.

(3) Comparative analysis of lagging prosperity index

When the international crude oil shipping market has turned a prosperity point, the lagged prosperity index has not yet reached the turning point. The lagged prosperity index can be used as a tool to verify the prosperity index model. Figure 7 shows the comparison chart of lagged diffusion index and lagged synthetic index. From the chart, it can be seen that there is no obvious fluctuation in lagged synthetic index at the beginning, and around October 2008, the lagged synthetic index has obvious downward fluctuation trend, mainly due to the impact of financial crisis on international crude oil shipping market, when the fuel price is higher and the shipbuilding order quantity has a certain degree of decline. From March 2010, the lagged diffusion index began to fluctuate up and down around the prosperity turning point, at which time the lagged synthetic index remained stable and the whole market began to pick up. From June 2020, the lagged synthetic index showed a downward trend, and the diffusion index also dropped below 50% at this time, indicating that the current market demand for capacity has decreased, tanker idling is obvious, and the newbuilding market is depressed.
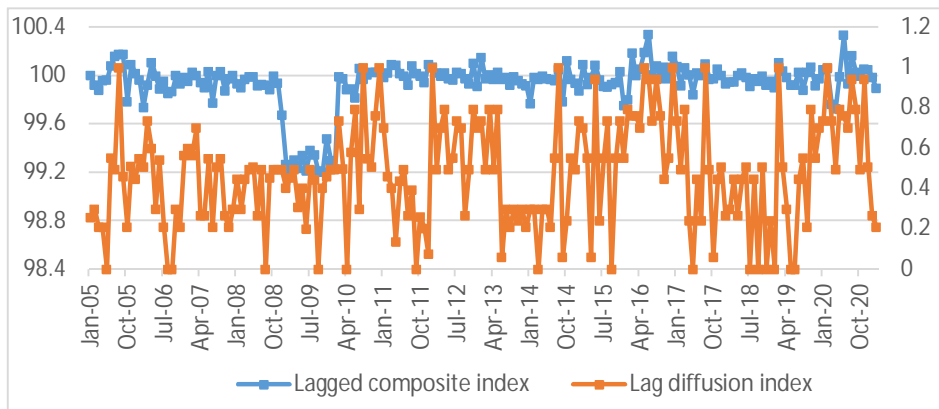
Figure 7 Comparison of hysteresis diffusion index, hysteresis synthesis index

4）Comparative analysis of comprehensive prosperity index

The comprehensive prosperity index covers the characteristics of different categories of prosperity indices and can reflect the development of international crude oil shipping market in a more comprehensive and integrated manner.

Figure 8 shows the comparison of the composite synthetic index and the composite diffusion index, from which the overall trend of the international crude oil shipping market can be seen. Among them, the composite diffusion index has gone through four main recessionary cycles, including March 2008 to October 2009, January 2013 to August 2013, October 2017 to June 2018, and April 2020 to February 2021. During this period, the overall crude oil market is in a state of contraction.

The comprehensive synthetic index began to show a certain degree of downward trend in March 2008, but only lasted for about 1 year, which indicated that the international crude oil shipping market belonged to the abnormal development stage within that period and was affected by force majeure, i.e. by the financial crisis. However, countries have introduced countermeasures to regulate the market in this background, and stopped the development trend of market slump in time, and the comprehensive diffusion index recovered to above the prosperity turning line from April 2009. 2013, against the background of shipping economy depression, the comprehensive diffusion index fell from 57% to 14%, but it did not last long. After that, the expansion and contraction state of international crude oil shipping market alternated, and when the comprehensive diffusion index reached the peak in March 2020, there was a downward trend, directly from 67% to below 50%, and it remained in the depressed range until February 2021, when the comprehensive synthetic index also showed a significant decline, indicating that the current market development is relatively unstable.

The comparative analysis of the composite diffusion index and composite synthetic index shows that the model of international crude oil shipping market prosperity index is basically in line with the actual market development trend.
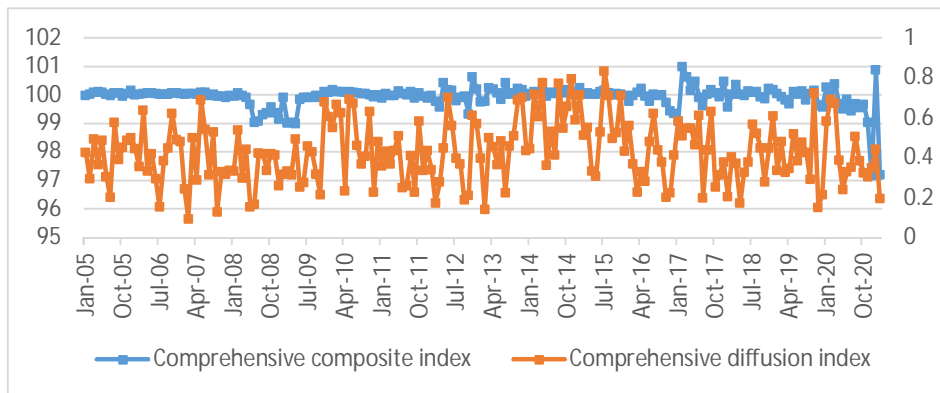
Figure 8 Comparison of comprehensive synthetic index and comprehensive diffusion index

4 RBF-based model validation of international crude oil shipping market prosperity index

The construction of the international crude oil shipping market sentiment index model initially needs to screen a large number of indicators, and finally select several indicators with wide coverage, so there is an obvious non-linear relationship among the indicators. Whether the international crude oil shipping market sentiment index model can accurately monitor and forecast the market is the key of the research, so this paper validates the established sentiment index model. Since the consistent sentiment index is basically consistent with the market development trend and the advance sentiment index is 3-6 months ahead of the consistent sentiment index, this paper intends to select a suitable forecasting method to predict the consistent sentiment index and judge whether it is synchronized with the advance sentiment index, so as to determine the feasibility of the international crude oil shipping market sentiment index model.

RBF neural network (Radial Basis Function), also known as Radial Basis Neural Network, is based on the theory of function approximation, which can deal with nonlinear problems well and has the advantages of strong applicability, gradual approximation of fit, and global optimal convergence[6]. Therefore, RBF can be applied in time series prediction, function approximation processing, etc. Its network topology is as follows:

As shown in Figure 9, the RBF neural network is a network connected by a three-layer structure, which is described as follows:

The first layer, the input layer, where the number of input nodes is determined by the number of input variables;

(a) The second layer is the implicit layer, between the input and output layers, whose nonlinear transformation function is set in a variety of ways, usually using a Gaussian function;

The third layer, the output layer, represents a linear problem when the information reaches the output layer directly through the input layer, and cannot be passed across the implicit layer to the output layer when dealing with nonlinear problems. The existence of the output layer is a

mapping from the low-dimensional space to the higher-dimensional space.The RBF neural network topology is shown in Figure 9：
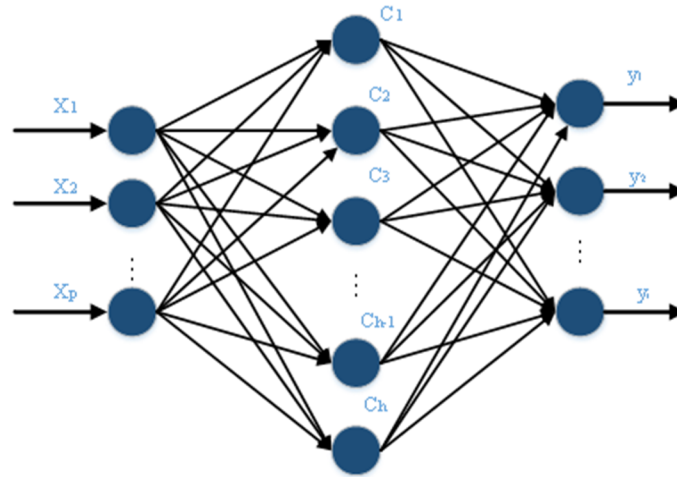

Figure 9 RBF neural network topology

The input variables of this paper are time series, and the trend of the consistent sentiment index is forecasted by the rolling forecast method, i.e., the consistent sentiment index of the first part is used to forecast the consistent index of the second part. The consistent sentiment index of international crude oil shipping market from January 2005 to February 2021, which is obtained after index classification and calculation, is divided into two samples, the training sample and the test sample (test sample). The data from January 2005 to December 2019 is applied as the training sample and the data from January 2020 to February 2021 is the test sample. Rolling forecast of the consistent diffusion index, consistent synthetic index for March 2021 - June 2021.

The concept of rolling forecasting considers the data at the current moment to be related to the data at the previous moment, and the difference between the two moments is n,called the time lag, i.e., there exists a function that can make the time series satisfy Eq:

$$y(t) = f(y(t-1), y(t-2), y(t-3),..., y(t-n)) \tag{2}$$

The y(t) in Eq. (2) represents the time series, and the key of this function is to determine the value of the time lag n. Different values of n will predict different results, so the optimal value should be chosen. In this paper, different values of n are brought in by the experimental method, including 2, 3, 4, 5, ... , 12, and finally determined as 5 (both the consistent diffusion index prediction model and the consistent synthetic index prediction model time lag is 5). The calculation results are shown in Tables 4 and Table 5. In order to judge whether the RBF neural network prediction model has certain superiority, BP neural network was applied to compare with:

Table 4 Comparison of consistent diffusion index prediction based on RBF neural network and BP neural network

Month	Actual value	BP predicted value	Error rate	RBF predicted value	Error rate
2020.01	0.452537719	0.324501181	-0.282930092	0.459674313	0.015770164
2020.02	0.437816147	0.431486066	-0.014458309	0.461220696	0.053457483
2020.03	0.465006534	0.436002853	-0.062372631	0.45257087	-0.026742987
2020.04	0.383431319	0.407227983	0.062062389	0.403975919	0.053580911
2020.05	0.300733391	0.407218127	0.354083512	0.323520139	0.075770593
2020.06	0.351396445	0.433352383	0.233229274	0.352537587	0.003247448
2020.07	0.383431319	0.431657783	0.125776016	0.403975919	0.053580911
2020.08	0.416245047	0.4342645	0.043290492	0.44897981	0.078643008
2020.09	0.300733391	0.411329016	0.36775306	0.323520139	0.075770593
2020.10	0.342958245	0.322596761	-0.059370156	0.341650918	-0.003811915
2020.11	0.300733391	0.378475224	0.258507486	0.323520139	0.075770593
2020.12	0.351396445	0.411329016	0.170555428	0.352537587	0.003247448
2021.01	0.339256439	0.427146753	0.259067487	0.337500527	-0.005175767
2021.02	0.451576863	0.322596761	-0.28562159	0.460011914	0.018679105

The root mean square error RMSE of RBF neural network prediction results is 0.00015; the RMSE of BP neural network prediction results is 0.003, which indicates that the RBF radial basis network prediction effect is better than BP neural network, and the prediction of consistent diffusion index of international crude oil shipping market is more accurate.

In order to verify the accuracy of the international crude oil shipping market prosperity index model more comprehensively, we continue to verify the consistent synthetic index on the basis of the consistent diffusion index. In this paper, the consistent synthetic index of international crude oil shipping market from January 2005 to February 2021 is divided into two samples. the data from January 2005 to December 2019 is the training sample, and the data from January 2020 to February 2021 is the testing sample. The rolling forecast of the consistent synthetic index for March 2021 - June 2021 is still compared with it using BP neural network, as shown in Table 5:

Table 5 Comparison of consistent synthetic index prediction based on RBF neural network and BP neural network

Month	Actual value	BP predicted value	Error rate	RBF predicted value	Error rate
2020.01	100.0703982	100.0103184	-0.06004%	99.95880109	-0.11152%
2020.02	100.0524886	99.98452558	-0.06793%	99.96027153	-0.09217%
2020.03	100.3809699	100.0296878	-0.34995%	100.0348875	-0.34477%
2020.04	99.94636497	99.94292066	-0.00345%	100.0191511	0.07283%
2020.05	99.67484964	99.90881498	0.23473%	100.0263182	0.35262%
2020.06	100.0198604	99.92710788	-0.09273%	99.96703094	-0.05282%
2020.07	99.89454067	100.0465774	0.15220%	99.95687991	0.06241%

2020.08	99.96417044	99.91714073	-0.04705%	100.0589845	0.09485%
2020.09	99.87067924	100.0620032	0.19157%	99.9537732	0.08320%
2020.10	99.89054033	100.050702	0.16034%	99.96239155	0.07193%
2020.11	99.82857983	100.0479034	0.21970%	99.94456881	0.11619%
2020.12	99.90239863	100.036265	0.13400%	99.98435348	0.08203%
2021.01	99.97800764	99.9078972	-0.07013%	99.94692558	-0.03109%
2021.02	100.00127	99.90978878	-0.09148%	99.99995786	-0.00131%

The root mean square error RMSE of RBF neural network prediction results is 0.0114; the RMSE of BP neural network prediction results is 0.0129, thus indicating that the RBF radial basis network prediction effect is better than BP neural network, and the prediction is more accurate for the consistent synthetic index of international crude oil shipping market.

Since the purpose of the validation in this paper is to judge whether the model of international crude oil shipping market prosperity index constructed in the previous paper is accurate, i.e., to judge whether the forecasting function of the prior index is accurate. Through the comparative analysis of the prior, consistent and lagged diffusion indices above, it is considered that the prior index is 4 months ahead of the consistent index, so the consistent synthetic index and consistent diffusion index of international crude oil shipping market for a total of 4 months from March 2021 to June 2021 are forecasted separately on a rolling basis, and the forecast results are compared with the prior prosperity index from November 2020 to February 2021, and we can get A comparison table of the forecast results of the RBF-based consistent prosperity indices, as shown in Table 6:

Table 6 Comparison of consistent prosperity index prediction results based on RBF

RBF Consensus prosperity Index Forecast			Actual value of Advance Prosperity Index		
Month	Consistent Diffusion Index Forecast	Consistent synthetic index forecast	Month	Precedence Diffusion Index	Precedence Synthesis Index
March 2021	0.331468392	99.98512771	November 2020	0.323862365	100.0232398
April 2021	0.331468392	100.0187135	December 2020	0.323862365	99.91934803
May 2021	0.437618467	99.97750629	January 2021	0.493243993	99.95605179
June 2021	0.179933359	99.94314579	February 2021	0.179381628	99.90494588

The RMSE of the consistent diffusion index is 0.0004; the RMSE of the consistent synthetic index forecast is 0.0017, both of which are less than 0.04, indicating that the error between the forecast value of the consistent prosperity index and the prior prosperity index is small, which also indicates that the international crude oil shipping market prosperity index system is more accurate. Accordingly, the crude oil shipping market prosperity for a total of four months from March 2021 to June 2021 gives information with certain reference value. In this time period, the diffusion index is lower than the prosperity turning line, which indicates that the market is in contraction, and the synthetic index fluctuates around 100 at this time, which indicates that

the market is in a stable contraction period. Tanker companies should provide high standard transportation services and comprehensive after-sales services to maintain their customers, and at the same time, the government should also introduce relevant policies and provide certain loan support to protect the enterprises through the difficult period.

5 Conclusion

In this paper, the prosperity index model of international crude oil shipping market is constructed by choosing the prosperity index compilation method. In order to verify the forecasting function of the sentiment index model, the RBF neural network is used to validate the sentiment index model, i.e., the consistent sentiment index is forecasted and compared with the prior sentiment index to conclude that the prepared sentiment index model is scientific and reasonable.

References

[1] Ning, Xiaolin, Zhao, Yifei, Chen, Feier. Research on global shipping prosperity index[J]. Journal of Shanghai Jiaotong University,2013,47(03):417-422+427.DOI:10.16183/j.cnki.jsjtu.2013.03.016.

[2] Wang LEL, Zhen H, Zhou DQ. Research on the early warning system of shipping market prosperity light[J]. Journal of Jimei University (Natural Science Edition),2010,15(03):199-203.

[3] Li Jing, Tang Yu, Huang Xisen. Early warning analysis of container shipping market prosperity[J]. Water Transport Management,2021,43(10):43-48.DOI:10.13340/j.jsm.2021.10.011.

[4] Qing Qian, Zhao Yifei. The establishment and research of global dry bulk shipping market prosperity index[J]. Journal of Southwest University for Nationalities: Natural Science Edition, 2012, 38(2):6.

[5] Song Ziming. Research on the Prosperity Index System of the Service Industry in Shaanxi Province [J]. China Management Informatization, 2022,25 (14): 179-182

[6] Yang Yue Research on the Prediction of Yunda Express Business Volume Based on RBF Neural Network [D]. Harbin University of Technology, 2022. DOI: 10.27063/d. cnki. ghlgu.2022.000660