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The Relevance of Freight Rates in Forecasting Cargo Port Volume: A Study of the Guangzhou, China Port

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Abstract

We study historical data of the cargo going through the Guangzhou (GZ) port and related research the relationships between cargo shipments through the GZ port and its relation to domestic and international shipping prices (rates).In turn, we develop a regression based forecasting model based on the data of the GZ cargo port. The second task is to introduce the GZ port, the international dry bulk shipping market; the Chinese coast bulk freight index (CCBFI); and the Baltic dry index (BDI) which reflect domestic and international freight rates respectively. The third task is to make use of the data of the GZ cargo port, CCBFI and BDI from January 2004 to February 2010. The developed model establishes a multi-linear regression to relate the impact of the previous month BDI and CCBFI on the current GZ port cargo and determine the magnitude of the effect. Second, we establish a time series-regression forecasting model. This requires us to observe and consider including historical data of BDI, CCBFI and GZ cargo and come to a conclusion that relates the impact of BDI and CCBFI on the GZ cargo port. Finally, by developing a two parameter exponentially weighted moving average (EWMA), we obtain forecast with high predictive accuracy.

Keywords: Port handling capacity; Dry bulk freight rates; EWMA; CCBFI; BDI

Introduction

In this paper, we analyze the data of the GZ cargo port cargo, CCBFI and BDI from January 2004 to February 2010 by using a variety of models. There are two main research purposes. First, through data analysis, we study the relationships between Guangzhou cargo port and domestic and international shipping prices. Second, by establishing a Guangzhou cargo port cargo forecasting model, we obtain an accurate prediction of the magnitude of the activity of the Guangzhou cargo port cargo

The GZ Port is a window of foreign trade for this region of the People's Republic of China (PRC). The cargo port is a weathervane of the international trade activity level of the port and its regional environment. Through the forecast of the cargo port activity, we, in addition, also determine the trends of international trade in the Pearl River Delta. For the long term, predicting the cargo port activity with great accuracy is of great importance in designing a reasonable and scientific port layout; the basic scale of investment, business strategy; and developing strategies for integrated transport planning.

Previous research

The cargo port activity is statistically a time series with random fluctuations which is affected by political, economic and natural and other factors. Cargo port activity forecasting systems are complex. There is not a universal technique applied for this system up to now. More commonly, we use linear regression, nonlinear regression, and time series prediction method, logistic function fitting method, exponential curve fitting method, gray system prediction method and elastic coefficient method and many other methods to solve this system.

Currently, the researches on the port throughput forecast focus on three areas [1,2].

First, making local improvements on the existing prediction methods, so we can obtain the prediction result which is closer to the true value. By adjusting the inflection point of the Logistic curve, researching the methods of blur compensation and estimation of optimism and pessimism on production trends including Logistic curve prediction methods.

Second, some experts predict the cargo port handling activity by referring to methods from other applications including the use of econometrics, control theory and related methods. Others have produced dynamic PHQDF models to predict the cargo port activity, which systematically combines the historical trend of cargo activity, the socio-economic development of the hinterland, politics, policy, and psychological and technical factors. The example tests show that the model has higher prediction precision and better prediction results than the models suggested above.

Third, have the raw data processed. And through selecting appropriate explanatory variables from a plurality of explanatory variables, we may obtain better forecast results. Regression models to predict the cargo port activity are not uncommon. As results often indicate, when one utilizes mathematical models to predict, the most critical aspect is that the accuracy of the model, relationship of the response variable and predictor's variables and the quality of data is most important. The complexity of the model, especially in the case of only having small amounts of historical data is of lesser importance. Some examples of forecasting port activity include Wang [3], Xu et al. [4], Hui et al. [5], Yuan and Xie [6], Chen et al. [7], Lam et al. [8] Sun and Wang [9] Sun and Zheng [1]. In each application, they use very large amounts of data to predict port capacity, tonnage and other measures of activity.

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In this paper, by using large amounts of historical data and establishing multi-linear regression model and time series regression model, we study the impact of the domestic and international shipping freight on the current GZ cargo port activity the In addition. We construct a two parameter exponentially weighted moving average model (EWMA), we develop a better model for forecasting activity for the major port in the PRC.

GZ Port and Dry Bulk Shipping Market; Overview

According to the Harbor Law of the PRC, a port refers to a region consisting of landside area and waters and with the functions as ships entering and leaving, mooring, berthing, passengers leaving and entering the ship, cargo handling, storage and other functions containing the corresponding terminal facilities. Ports are the assembly point and hub of the water and land transportation, and also they are collecting and distributing centers of the industrial and agricultural products and the import and export goods. The port is a natural interface linking the hinterland with maritime transport, and as a result, ports are a special node of international logistics.

According to the locations, ports can be divided into the estuary ports, harbors and river ports. Estuary ports are located in estuaries or the segments of tidal estuaries and can also serve for both seagoing vessels and riverboats. Large cities are the basis for convenient transportation. The inland waterways are often extend to the vast economic hinterland, undertaking a lot of goods traffic. As a result, many of the ports around the world are built near the estuary, such as the Ports of Rotterdam, London, New York, Leningrad, and Shanghai. Estuary ports are characterized by terminal facilities arranged along the river bank, the distance between the port and the sea is short and do not need to build breakwaters. Besides, if the length of shoreline is not enough, you can add the excavated basin. GZ Port belongs to the estuary port grouping.

Harbors are located on the coast or in the bay or lagoon, but also some are built on the deep sea which is far from the coast. The ports located in the open sea shore or in the bay lacking of natural reserve ports are usually required to build the considerable size breakwater, such as the Port of Dalian, Qingdao Port, and the Port of Lianyungang, the Port of Keelung, the Port of Genoa and others. The single point or multi-point mooring docks served berthing for supertankers and ore ships belong to the harbors off the coast having no screenings, such as Marsa el Brega (Libya), the Port of Sidon (Lebanon) and others. In addition, there are also large seaports rely entirely on natural cover, such as the ports of Tokyo, Hong Kong, and Sydney.

River ports are located on the natural rivers or canals, including lake harbors and reservoir ports. Lake harbors and reservoir ports have broad surface and sometimes large waves. Therefore, there are many similarities with the harbors, for example, they often need to build breakwaters. The ports built on the Kuibyshev, Tsimlyansk and other large reservoirs in Russia, St. Louis, Memphis and Philadelphia in the United States and the small ports built on the Hongze Lake in the PRC belong to the river port group.

Ports, especially the coastal ports, make a good connection between hinterland and overseas transportation. With economic development as a goal and international division of labor, these ports play an important role in the development of the hinterlands in many aspects. A Port is a junction point of sea and land transportation where a combination of the waterway transport, road transport and rail transport merge. These ports achieve the ability of multimodal transport. Goods coming from other countries or regions will be transported by road transport to inland areas. Also, a Port is an industrial base designed to reduce transportation costs of raw materials or finished products, many manufacturing companies including steel industries, petrochemical industries, shipbuilding industries and other heavy industries have chosen to set up factories in the surrounding area of the port to carry out industrial activities. In addition, the enterprises processing imported materials then exporting also tend to set the plant at the bonded area around the port. The Port is an integral part of the "Supply Chain," from raw materials to end user products.

The Port is an integrated logistics center with the purpose of building international logistics nodes. The ports carry out activities including not only the traditional logistics warehousing and transport operations but also customs clearance, freight forwarding, shipping agency, buyer groupage, distribution processing, container leasing and other activities.

Excellent ports provide cities with a window for external development, in which a city makes full use of its own superior resources in the international division of labor to gain profit from the international trade and promote urban development. Developing cities with their harbor and port development is not a new idea, but is a mature method for creating wealth and the movement of goods and services.

Port handling capacity refers to the total amounts of goods imported and exported to the port by water transport and after handling operation in a certain time. The unit of the dry bulk cargo throughput is ton. The unit of container port is TEU (Twenty-foot equivalent units). Port handling capacity is the important quantity index of the results of the operating activities reflects of the port and the size of the port. The flow structure, quantitative structure and physical classification structure of the port handling capacity are the most direct expression of status, role and impact at the international and regional water transport chain, but also a statistical measure of national, regional and urban construction and development.

Factors that affect the port handling capacity are complex and can roughly divided into two parts; one is objective regional factors, such as the size of the hinterland, the level of production development, export-oriented economic development and the quantity of import and export commodities. The other portion refers to its own conditions for constructing harbors which include natural conditions and socio-economic factors. When we obtain the above conditions the, the level of labor organization and management, the quantities of handling machinery, technical level, ship type, vehicle type, hydrological and meteorological conditions, seasonal characteristics of the industrial and agricultural production, the balance of ships and vehicles travel to the port, as well as the varieties and quantities of goods through the port handling are all likely to become important factors affecting the port handling capacity. The most direct and critical factor is the size of the ability of berth, that is, the maximum tonnage limit of the port for berthing ships.

GZ Port development

GZ Port is located in the Pearl River estuary and the center of the Pearl River Delta where the export-oriented economy is most active for PRC China. It is near the South China Sea, adjacent to Hong Kong and Macao. The East River, West River and North River flow into the sea at this point. Through the water system of the Pearl River, the GZ Port communicates with major cities in the Pearl River Delta, i.e.,

Figure 1: Geographical location map of GZ Port.

Hong Kong and Macau, and meeting the southwest of PRC by the West River. Through the seaward channel of the Ling ding Sea, the GZ Port can communicate with coastal harbors in the PRC and the harbors all over the world. The geographical location of GZ is shown in Figure 1.

GZ Port has a long history and is an important port for ancient Chinese foreign trade, one of starting points of "Marine Silk Road". In Tang-Song period, "Guangzhou Marine Silk Road" is the world's longest ocean routes. In Qing Dynasty, GZ Port became the only external port and the largest foreign trade port. Since China carried out reform and open policy, the rapid socio-economic development make GZ Port an important hub of integrated transport system and an important foreign trade port in southern China. It is one of China's container shipping transport arteries and the largest bulk cargo (energy, raw materials, etc.) transshipment port and container transportation trunk port in southern China.

GZ Port is divided into the Inner Harbor, Huangpu Port, Xinsha Port, Nansha Port and the Pearl River estuary. The inner harbors based on the original eight inland waterways of GZ mainly offer energy, raw materials, food, bulk cargo and container handling and passenger transport services for the region of GZ and the Pearl River Delta. The Huangpu Port mainly undertake the coastal and offshore, container transportation and the bulk cargo transport including food, coal, chemical fertilizer, refined oil. The Xinsha Port focuses on container, coal, ore, petrochemical, food, chemical fertilizer and other materials transport. Both the Nansha Port and the Pearl River Estuary water area are the integrated ports, the work area of Shazai Island focuses on the Ro-Ro and general cargo transportation, the main work of Xiaohu operation area is the energy, liquid chemical transportation, Lu Wan operation area mainly works for general cargo transportation, Nansha operation area dominated by foreign trade container transportation develops the bonded function, logistics function, commerce function and other functions, and develops and undertakes large bulk cargo transportation combining harbor industry.

GZ Port has a number of advanced facilities such as the large containers and the specialized deepwater docks for coal, grain, oil and chemical, as well as the largest ro-ro ship pier in the south region of China. As of 2008, Guangzhou Port has 631 quay berths of all kinds, 88 anchorages, 23 buoys, 59 big tonnage berths; and the maximum tonnage is 300,000 tons.

GZ as a transportation hub in southern China has developed waterways, rail and road transport. There are crisscrossing waterways in the Pearl River Delta. Shipping resources are in excellent condition. The harbor district has five special railway lines where Beijing-Guangzhou, Beijing-Kowloon, Guangzhou-Shenzhen, Guangzhou-Zhanjiang and Guangzhou-Meizhou-Shantou railway intersect. Highways extend in all directions. Highways of each port connect with expressways, highways and national highways. "Nansha Port Express" through to the Nansha harbor district. On the basis of the sound infrastructure of land and water transportation, the hinterland of GZ Port not only cover the Pearl River Delta which heart was Canton but also extend to the Pan-Pearl River Delta region, which make the circulation of goods more substantial.

Entering the 21st century, on the basis of sustained and rapid economic growth of the hinterland, GZ Port developed rapidly. Beginning in 2004, for three consecutive years, the growth of the cargo throughput of the GZ port is at the speed of 50 million tons per year. In 2009, cargo throughput of GZ Port is 364 million tons, ranked fourth in the country and the container throughput is 11.2 million TEUs, ranked third in the country and sixth in the world. Two main indicators are among the world's top ten ports. At present, GZ Port connects with more than 350 ports in more than 80 countries and regions around the world and more than 100 domestic ports. GZ port cargo in the last 10 years is shown in Figure 2.

Dry bulk shipping market and major freight index

Narrow shipping markets refer to all kinds of shipping exchanges such as the London Shipping Exchange, Baltic Exchange, Shanghai Shipping Exchange and others. Generalized shipping market refers to the trading relationships of the shipping industry. Transaction object is shipping products, namely all the services that is offered by shipping enterprises for the shipping market to meet the needs of the displacement of people and goods to and connect with shipping tools and equipment. According to the shape and packaging of goods, the transported goods across oceans are classified as three categories including liquid cargo, dry bulk and general cargo by maritime sector. Liquid cargoes include oil, refined oil, liquefied gas, liquid chemicals and other liquid cargo. Dry bulk includes a variety of primary commodities, raw materials. On the basis of the size of bulk transport, bulk cargo is divided into two types as large bulk cargo and minor bulk cargo. The large bulk cargoes mainly include coal, metal ores and grain. Minor bulk cargoes include steel, wood, chemical fertilizer, cement, etc. General cargoes mainly include mechanical and electrical equipment,

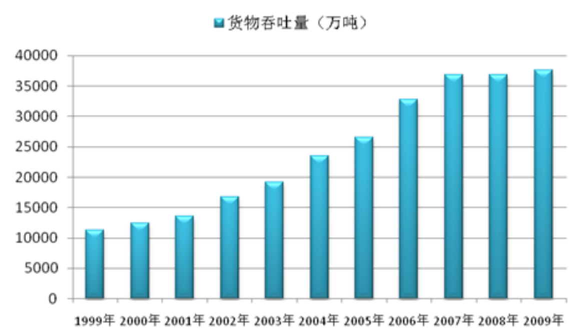

Figure 2: Histogram of the Guangzhou port cargo from 1999 to 2009..

chemicals, pharmaceuticals and other light industrial products, farm products and pasture products, fishery products and so on. Dry bulk shipping market refers to the trading relationships of all the services that are offered by shipping enterprises for the shipping market to meet the needs of the displacement of dry bulk cargoes among different countries and regions and connect with shipping tools and equipment.

The Relation between Supply and Demand in Dry Bulk Shipping Markets

Dry bulk shipping markets include two main elements, the demand for dry bulk shipping and dry bulk shipping capacity. Demand for dry bulk shipping refers to the quantity of dry bulk cargoes transported by sea among countries and regions at a certain period of time, which is a demand factor of the shipping market. Dry bulk shipping capacity refers to the total transport capacity of dry bulk carriers including Handymax bulk carriers, Panamax, Capsize bulk carriers and the Lake bulk carriers in the current dry bulk shipping market, which is a supply factor of the shipping market.

In the dry bulk shipping market, if dry bulk shipping capacity cannot meet the demand for dry bulk shipping, dry bulk shipping freight rates will rise. Meanwhile, if dry bulk shipping capacity significantly exceeds demand for dry bulk shipping, dry bulk shipping freight rates will decline. In addition, commodity price changes result in changes in supply and demand. Holding other factors constant, price rise leads to reduced demand and prices fall leads to increased demand. Similarly, price rise causes increased supply and price fall leads to reduced supply. Specific performance in the dry bulk shipping market, the rise in dry bulk freight rates will lead to a decline in demand for dry bulk shipping, while the fall in freight rates will promote the rise in demand for dry bulk shipping. In contrast, the rise in dry bulk freight rates will lead to the rise in dry bulk shipping capacity, while the decline in freight rates will promote a decline in dry bulk shipping capacity.

Price fluctuations by adjusting supply and demand, so that tends to balance, but in the shipping market, because demand for shipping derived resistance, potential, and long life cycle marine, construction costs are high, long construction period and other reasons, often entice shipping bullwhip effect occurred in the market, resulting in the shipping market supply and demand imbalance.

For Chinese ports, being able to reflect the dry bulk shipping market there are two tariff indexes, respectively, to reflect the international shipping market, the Baltic Dry Freight Index, as well as dry bulk shipping market reflecting domestic freight China coastal (bulk) freight index.

Baltic Dry Index (BDI) [2-10], is an index of economic activity in the shipping industry, including dry bulk shipping industry, trading volume changes, known as the international trend of the overall dry bulk market barometer. BDI is composite index being composed of Capsize, Panamax and Handysize vessels, each occupying third of the weight of the index. It was weighted according to the spot freight of twelve major routes to reflect the current market price. Therefore, the change of shipping price will result in a change in the index. For the index to be fair its manager, the Baltic Exchange, has very strict rules on calculating this freight index. These rules include:

(1) The selection of routes requires geographical balance, the route reflects the trade of both the Atlantic and Pacific, as well as the inter-oceanic trade (Maintaining the balance of round-trip routes). The weight of each route does not exceed 20%.

(2) The routes including in the calculation of the index have a certain turnover, or important relevant routes. Seasonal routes are not considered.

(3) There is a reasonable amount of accurate transaction reports. The routes potential or actual rented or controlled by one or a few charterers are not considered.

(4) 20 brokerage firms which are internationally renowned, reputable, representative, consisting of three groups, each responsible for calculating the day of the ship freight index.

China Coastal Bulk Freight Index (abbr. CCBFI) as a "barometer" of the coastal shipping market, reflects the trends of price movements of coastal shipping market without delay and help shipping companies, shippers, trade enterprises, ports, agents and other related businesses gain market information and grasp the market dynamics.

(1) The base period. China coastal bulk freight index takes January 2000 as the base period. The base index is 1000 points.

(2) Sample route selection. Based on the importance of the selection, it takes top five kinds of goods in our coastal port cargo throughput as samples of goods of coastal freight index, including coal, crude oil, refined oil, metal ores and grain. Based on the volume size, taking regional coverage and future trends of routes into consideration, it selects 21 samples of domestic coastal routes.

(3) Tariff information collection. Currently, there are 27 major incoming units to provide tariff information.

(4)Release mode. Shanghai Shipping Exchange prepares and publishes China Coastal Bulk Freight Index, sub-indices and the index of 21 routes every Wednesday.

GZ Cargo Port Forecasting Models

This section utilizes three models to predict GZ port cargo activity by making use of the collected historical data of the GZ cargo port freightage and domestic and overseas dry bulk freight. First, taking the last BDI and CCBFI as the explanatory (predictor) variables and the current GZ port activity as response variable, we build a multi-linear regression model to study the relationship of these two indices on the GZ port activity. In turn, we introduce the time series of GZ cargo port to build a model to predict the GZ port activity, test the validity of the model and estimate the influence of dry bulk freight activity. Finally, using the historical data of GZ port activity, we aim at building a forecasting model having predictive accuracy by making use of the two-parameter exponential smoothing method. The multi-linear by OLS regression results is the following;

$$Y_{t+1} = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t}$$

Where,

$$Y_{t+1} = 2626.134 + 0.0366 X_{1t} - 0.044 X_{2t}$$

$Y_{t+1=}$period ahead prediction of GZ cargo port activity,

X_{1t} =BDI, the mean monthly value

X_{2t} =CCFBI (mid-monthly value)

Table 1 contains the output of EVIEWS® (multi-linear regression software). [For complete discussion of Regression modeling see Fahrmeir, Kneib, Leib and Marx, 2013]. Observe the coefficient of determination, R^2 =0.0196 and the adjusted coefficient, $\overline{R}^2 = -0.0088$. These coefficients indicate that the regression of port activity is largely

Variable	Coefficient	Std. Error	t-Statistic	Prob.
β_0	2626.134	349.2942	7.518401	0.0000
X_{1t}	2626.134	0.047248	0.774825	0.4411
X_{2t}	-0.043952	0.300456	-0.146285	0.8841
R-squared	0.019585	Mean dependent var		2718.985
Adjusted R-squared	-0.008833	S.D. dependent var		547.8405
Durbin-Watson stat	0.349792	Prob (F-statistic)		0.505416

Table 1: Output of the multiple regression analysis.

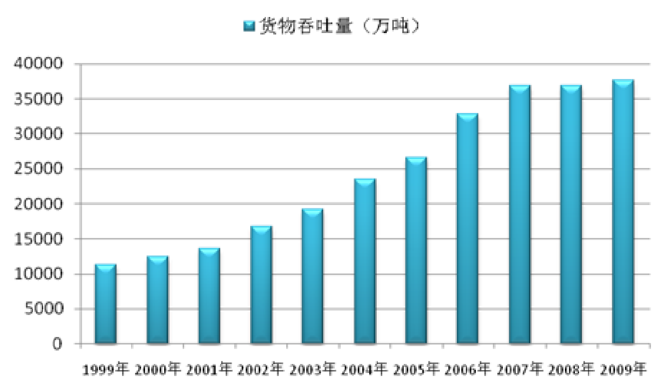

Figure 3: The residuals, actuals and fitted values are shown in one scatterplot.

unexplained by the multi-linear regression on the variation in the two freight indexes, BDI and CCBFI. In addition, significance tests would not reject the hypothesis that there is no relation between the response variable and the two predictors, BDI and CCBFI.

In addition, Table 1 indicates that tests for the significance of the individual predictors result in not rejecting the hypotheses that each predictor taken individually is related to the response variable. The p-values for both t-tests are large, that is, $p - value > \alpha$.

The output is shown in Table 1 based on 73 sets of corresponding data.

The residuals indicate that there may be a trend in their values. This appears corroborated by comparison of the actuals and fitted values. Hence, one may conclude that improvements can and will be made to the forecasting model.

In summary, the previous monthly mean values of BDI and the mid-monthly values of CCBFI may influence the current GZ port handling capacity. However, other factors not included in the multi-linear regression probably influence the GZ port handling capacity. These factors may have a time dimension.

In the linear regression model, we failed to take into account that international dry bulk shipping prices and domestic coastal bulk shipping price as influencing factors.Shipping rates for both international and domestic cargo due tend to increase over time especially for the shipping industry because rates are reflected in long term contract between the shippers and haulers. One method is to include a surrogate variable for time. Hence, by including a time series component in the forecasting model perhaps will improve our forecasting model (Figure 3).

In the next section, we consider the use of combinations of time series and regression analysis model.

Autoregressive forecasting model

An objective of time series methods is to discover a pattern in the historical data, develop a forecasting model and then extrapolate the pattern into the future. Time series method is often used to provide predictions of future by taking advantage of the chronological data. Autoregressive prediction model refers to the establishment of a regression equation for prediction by making use of the existing association in the individual observations of an historical time series. Regression and time series model refers to the model combining of the time series analysis and regression analysis and taking the influence of the time series and other factors on the time series into account. In this application the modeler selects the predictor variables and may express the model as follows:

$$Z_t = \alpha X_t + \beta Y_t + \eta_0 + \eta_1 Z_{(t-1)} + \eta_2 Z_{(t-2)} + \eta_3 Z_{(t-3)} + \cdots + \eta_n Z_{(t-n)}$$

On the basis of the 74 sets of data in Appendix 1, we make use of time series analysis and eliminating several sets of data in January 2004, we analyze the residual values including the monthly mean value of BDI, the mid-monthly value of CCBFI and the monthly cargo handling capacity of the GZ port.

We use Z_t to identify the response variable of the GZ port cargo handling capacity, X_{t-2}, X_{t-2}, X_{t-3} … to identify the monthly mean value of BDI of each period and , Y_{t-2}, Y_{t-3} … to identify the mid-monthly value of CCBFI of each period. In turn, the multiplicative autoregressive model is expressed as follows:

$$Z_t = \alpha_1 X_{(t-1)} + \alpha_2 X_{(t-2)} + \alpha_3 X_{(t-3)} + \cdots + \alpha_j X_{(t-j)} + \beta_1 Y_{(t-1)} + \beta_2 Y_{(t-2)} + \beta_3 Y_{(t-3)} + \cdots + \beta_m Y_{(t-m)} + \eta_1 Z_{(t-1)} + \eta_2 Z_{(t-2)} + \eta_3 Z_{(t-3)} + \cdots \eta_n Z_{(t-n)} + \phi$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ϕ	757.0150	319.8731	2.366611	0.0214
$X_{(t-1)}$	0.020419	0.028933	0.705738	0.4833
$Y_{(t-1)}$	0.042297	0.251350	0.168278	0.8670
$Y_{(t-2)}$	-0.253484	0.220607	-1.149029	0.2554
$Z_{(t-1)}$	0.561794	0.139947	4.014328	0.0002
$Z_{(t-2)}$	-0.020117	0.166008	-0.121181	0.9040
$Z_{(t-3)}$	-0.041358	0.16967	-0.247700	0.8053
$Z_{(t-4)}$	0.074706	0.166727	0.448077	0.6558
$Z_{(t-5)}$	0.099610	0.169451	0.587841	0.5590
$Z_{(t-6)}$	0.161814	0.141661	1.142267	0.2582
R-squared	0.644852	Mean dependent var		2813.638
Adjusted R-squared	0.587775	S.D. dependent var		479.5500
Durbin-Watson stat	1.884267	Prob(F-statistic)		0.000000

Table 2: Output of analysis on regression-time series forecasting model.

Where $j,m,n < t \quad j,m,n \in Z$.

For changing values of j,m,n, we present the outputs of $\bar{R}^2$ in Appendix 2. $\bar{R}^2$ is maximum value when $j=1, m=2, n=6$.

When $j=1, m=2, n=6$, the value of $\bar{R}^2$ get to maximum $\bar{R}^2 = 0.588$. The outputs are shown in Table 2.

The regression equation is

$$Z_t = 0.0204X_{(t-1)} + 0.0423Y_{(t-1)} - 0.2535Y_{(t-2)} + 0.5618Z_{(t-1)} - 0.0201Z_{(t-2)}$$
$$-0.0414Z_{(t-3)} + 0.0747Z_{(t-4)} + 0.0996Z_{(t-5)} + 0.1618Z_{(t-6)} + 757.015$$

[For greater information of multi-linear regression time series modeling [11].

The multiple coefficient of determination $R^2 = 0.645$. The adjusted multiple coefficient of determination $\bar{R}^2 = 0.588$. The Durbin-Watson Statistic is 1.884 indicating that there is no evidence of autocorrelation in the residuals. The F-test for overall regression indicates that for the regression, taken together the predictor variables are related to the response variable. Further, the scatterplots of the residuals, actual and fitted values are all shown in Figure 4.

We observe that there is no trend or pattern in the scatter of the residual which corroborates the results of the Durbin-Watson statistic. Also, the patterns in the fits and actual observations indicate that the forecast contain a much smaller amount of error (magnitude of residuals) than in the first multi-linear regression model.Application of

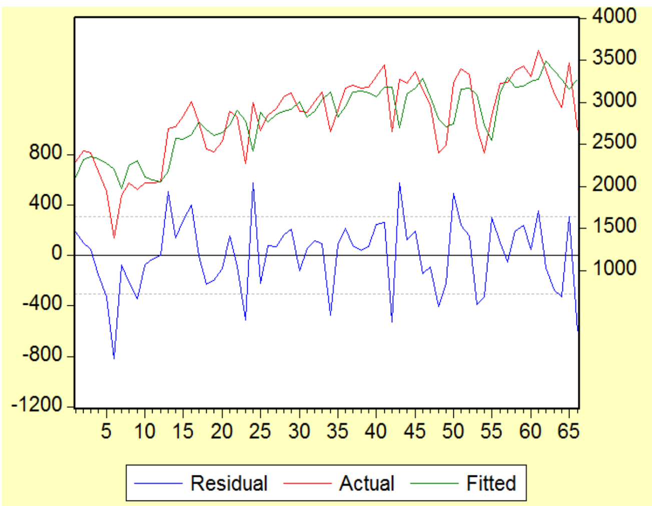

Figure 4: Scatterplots of residuals, fits and actual values.

月份	BDI	CCBFI	Volume in 10k tons)
2009年9月	——	——	3616.29
2009年10月	——	——	3388.27
2009年11月	——	——	3097.17
2009年12月	——	——	2938.37
2010年1月	——	1678.61	3469
2010年2月	2677.85	1255.95	2662

Table 3: Partial Data Table of BDI, CCBFI and cargo handling capability in 2009.

the forecasting model. Hence in Table 3, we observe the implementation of the model in predicting cargo handling capacity.

To forecast, we substitute the values of BDI, CCBFI and cargo handling capability into the fitted regression as follows:

$$Z_t = 0.0204X_{(t-1)} + 0.0423Y_{(t-1)} - 0.2535Y_{(t-2)} + 0.5618Z_{(t-1)} - 0.0201Z_{(t-2)}$$
$$-0.0414Z_{(t-3)} + 0.0747Z_{(t-4)} + 0.0996Z_{(t-5)} + 0.1618Z_{(t-6)} + 757.015$$

From the results, we know that the GZ port cargo handling capability is almost 28,975,500 tons. From statistics of the Guangzhou Port Authority (GPA), we find the actual value of the GZ cargo was 31.98 million tons in March 2010 and the percentage error is 9.39%.

From the results, we conclude that there is little relationship among the Guangzhou cargo port handling capacity, the international dry bulk shipping freight rates and coastal dry bulk shipping freight rates. However, there is better relationship between cargo handling capacity and its own historical data.

Based on the observation of the international shipping market and taking the analysis of the actual situation in GZ port into consideration, we can conclude that the dry bulk shipping freight rates have little effects on the GZ cargo port handling capacity. The possible factors that lead to this conclusion are as follows:

First, in international trade, with cargo ships becoming larger in scale and the rapid development of information technology, the proportion the transportation costs account for a much smaller percentage of cargo value. In the United States, transport costs of shipping account for 4% in 1997 whereas the proportion around 8% in 1974. By 2007 this percentage dropped 100% in three decades [12].

Second, there is little flexibility in transport costs for the majority of GZ Port's cargo strategic supplies such as grain, energy and raw materials. The import and export goods of the four main harbor districts of GZ port are mostly grain, coal, petroleum, iron ore and other necessities of life and the production or industrial raw materials. Regardless of the level of transport costs, these import and export goods cannot at present change radically.

In view of this conclusion, we will remove BDI and CCBFI from our forecasting model and include the time series of GZ port handling capacity to predict.

Two parameter exponentially weighted moving average (EWMA forecasting model)

EWMA models assume smoothing parameters weight previous observations of the variable to be predicted [12,13].

The simple exponential smoothing is to "smooth out" the irregular fluctuations in the time series, which is adjusted for the stationary time series, i.e. the time series without trend, cyclical and seasonal component. Two parameter EWMA models should be employed when a trend component exists in a time series. Two parameter models improve forecasting results by adjusting the single EWMA by including and adding the trend component in the model. The equations for two parameter EWMA forecasting are given by the following equations.

$$F_t = \alpha Y_t + (1-\alpha)(F_{t-1} + R_{t-1})$$
$$R_t = \beta(F_t - F_{t-1}) + (1-\beta)R_{t-1}$$

Where,

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F_t = *forecast of the time series for period* $t+1$

Y_t = *actual value of the time series in period* t

F_{t-1} = *forecast of the time series for period* t-1

R_t = *the best estimate of the trend at time* t

α = *smoothing constant*$(0 \le \alpha \le 1)$

β = *the trend smoothing factor*$(0 \le \beta \le 1)$

Although any value of α and β between 0 and 1 are acceptable, however they yield different results. Often forecasters choose the mean squared error [12] and/or the mean absolute deviation (as a measure of forecast accuracy. The smaller the MSE or MAD value is, the better is the forecast accuracy. Figure 5 below shows the scatterplot of the linear trend in the GZ port handling capacity.

The GZ port handling capability indicates a linear growth in the port capacity. Hence, the two parameter EWMA model appears useful in the prediction of the port capacity. According to the time series combined by 74 sets of data of the GZ port cargo capacity from January 2004 to February 2010, we do predict an accurate short-term multi-period ahead model.

For different values of α and β, the associated and calculated values of **MAD** and **MSE** are shown in Appendix 3. If $\alpha = 0.9, \beta = 0.1$; **MAD** and MSE are at minimum values, $MAD = 24.56209$, and $MSE = 1067.885$; or at the optimal prediction accuracy for the sampled data. If one draws the fits and actual values on a single plot as shown in Figure 6, the two plots are nearly coincident, indicating that the prediction model has great accuracy.

On the basis of the two parameter exponential smoothing prediction formula for period *t+i*; $\hat{F}_{t+i} = F_t + iR_t \quad 0 < \alpha \le 1$, and according to the data of the actual and smoothed values, and the

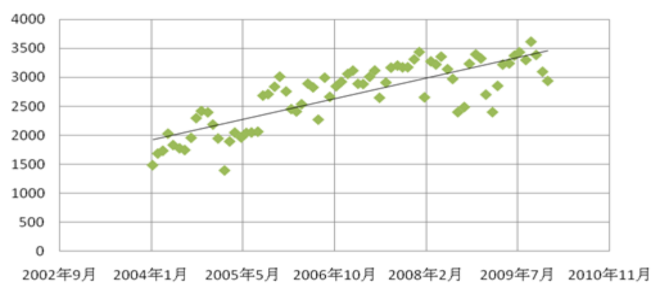

Figure 5: Trend chart of the GZ port handling capability from 2004 to 2009.

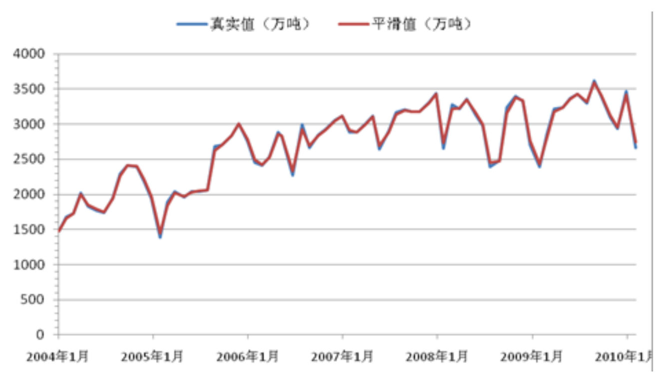

Figure 6: Chart of smoothing values of the GZ cargo port cargo capacity.

Month	Actual value	Smoothing value	Trend term	predicted value	Average of predicted value (Ten thousand tons)
May. 2009	3241.72	3237.717	27.47169	3512.434	3406.823
Jun. 2009	3373.94	3363.065	37.25929	3698.398	3395.088
Jul. 2009	3434.15	3430.767	40.30361	3753.196	3357.175
Aug. 2009	3299.92	3317.035	24.90002	3491.335	3300.6
Sept.2009	3616.29	3588.855	49.59196	3886.406	3268.811
Oct. 2009	3388.27	3413.288	27.07608	3548.668	3145.292
Nov. 2009	3097.17	3131.489	-3.81136	3116.244	3044.448
Dec. 2009	2938.37	2957.301	-20.8491	2894.754	3020.516
Jan. 2010	3469	3415.745	27.08026	3469.906	3083.397
Feb. 2010	2662	2740.083	-43.194	2696.889	2696.889
Mean value					3171.904

Table 4: Partial data table of the Guangzhou port cargo throughput in March 2010.

trend terms of the GZ port capacity from May 2009 to February 2010 (Schedule D) respectively, we forecast the GZ port capacity in March 2010 and draw the predicted results based on the data of each month. On this basis, we calculate the mean values of the predicted results over the past 10 months, 9 months, 8 months ... and 1 month respectively. Finally, we calculate the average of 10 mean values and make it the final predictions of the GZ port capacity in March 2010. Calculating the arithmetic mean of the mean values is equivalent to placing different weights on different months, the closer the months is to predict the greater are the weights. By this method, the predicting outcomes of the GZ port capacity in March 2010 are shown in Table 4.

According to the above method, we can draw the conclusion that the GZ cargo is 31,719,040 tons in March 2010. From the statistics of GZ Port Authority, we know that the actual cargo capacity of the GZ port is 31.98 million tons in March 2010 and the error is 0.816%, achieving very high prediction accuracy.

In the same way, we can predict that the Guangzhou port capacity is 32,579,840 tons in April 2010. From the statistics of Guangzhou Port Authority, we know that the actual value of the Guangzhou cargo is 34.44 million tons in April 2010 and the error of the prediction is 5.40%.

Tests on the prediction of the GZ port in March 2010 and April 2010, we can conclude that the two parameter EWMA model has greater prediction accuracy for the Guangzhou port than the other methods employed before, and ,hence, the best choice the forecasting models studied for short-term prediction on the samples data.

Comparison between the GZ cargo port capacity and dry bulk freight

In the last section, we make use of three mathematical models in turn to establish the forecast model for the GZ cargo port. Based on the multi-linear regression forecasting model and regression and time series forecasting model, taking the values of CCBFI and BDI reflecting the domestic and international dry bulk freight as predictors, we obtained the relationship of the two indexes to GZ cargo handling capacity. In turn we estimated the magnitude of the relations the coastal dry bulk freight and international shipping dry bulk freight affect the GZ cargo port handling capacity.

In the multiple linear regression model, taking the BDI and CCBFI for last period as variables for prediction, we study effects which the dry

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X_{2t}	0.036609	0.047248	0.774825	0.4411
X_{2t}	-0.043952	0.300456	-0.146285	0.8841

Table 5: Partial data table of the operational report of the multiple regression model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$X_{(t-1)}$	0.020419	0.028933	0.705738	0.4833
$Y_{(t-1)}$	0.042297	0.251350	0.168278	0.8670
$Y_{(t-2)}$	-0.253484	0.220607	-1.149029	0.2554

Table 6: Part of operational data.

bulk freight for last period have on the GZ port cargo throughput. The part of the operational report after running EViews® is shown in Table 5, where X_{1t} and X_{2t} denote the values of BDI and CCBFI for period t respectively and Y_{t+1} represents the Guangzhou port cargo throughput for period t +1.

If the significance value, $\alpha = 0.05$ the $p-\text{value}$ corresponding to the coefficient of X_{1t} for the t test is, suggests that X_{1t} have on Y_{t+1} are not related. Meanwhile the $p-\text{value}$ corresponding to the coefficient of X_{2t} for the t test is $p-\text{value}=0.884>\alpha$, also suggests that X_{2t} and Y_{t+1} are not related. Therefore, we may conclude from the multiple linear regression analysis that the international dry bulk freight and coastal dry bulk freight for last period have little relation to the GZ port cargo activity.

In the analysis of regression and time series model, we can take the values of BDI, CCBFI and the GZ port cargo throughput in the past several periods as variables to predict, and study the effects the domestic and international dry bulk freights in the past several periods have on the Guangzhou port cargo throughput. We select periods have the best goodness of fit. The part of the operational report (using EViews® software) was shown in Table 6.

Where

$X_{(t-1)} = value\ of\ BDI\ for\ period\ t-1$

$Y_{(t-1)} = value\ of\ CCBFI\ for\ period\ t-1$

$Y_{(t-2)} = value\ of\ CCBFI\ for\ period\ t-2$

$Z_t = value\ of\ the\ Guangzhou\ port\ cargo\ throughput\ in\ period\ t$

If $\alpha = 0.05$, the $p-\text{value}$ corresponding to the coefficient of $X_{(t-1)}$ for the t test is $Y_{(t-1)}$, which suggests that $Y_{(t-1)}$ and Z_t are not related. Similarly, the $p-\text{value}$ corresponding to the coefficient of $Y_{(t-1)}$ for the t test is $p-\text{value}=0.867>\alpha$, indicating that $Y_{(t-1)}$ and Z_t are not related. The $p-\text{value}$ corresponding to the coefficient of $Y_{(t-2)}$ for the t test is $p-\text{value}=0.2554>\alpha$, which suggests that $Y_{(t-2)}$ and Z_t are not related. Therefore, we may conclude that the international dry bulk freight and coastal dry bulk freight in the past several periods have little effects on the GZ cargo port handling capacity.

Since the coefficient estimates for the multi-linear regression and the time series regression cannot reject the null hypothesis that they are zero, or the past several periods that the domestic and international dry bulk freight rates in all have little effects on the cargo activity of the GZ port and cannot afford a significant role.

Implications and Summary

When making development strategies and policies Guangzhou port, we must give sufficient consideration to the conclusion that the international and domestic dry bulk freight rates have little effect on estimatingGZ cargo port capacity. Thus, despite the changing environment in the international shipping market, we see little effect of the activity in the GZ port development. The GZ port can continue to develop on the basis of improving its own port facilities. If the port meets the growing demand for cargo handling capacity, then growth will occur. Port conditions include waterway facilities, berthing facilities and harbor management level. Waterway is the lifeline of the port. The ship channel depth is related directly to whether the ship can reach the harbor. The port channel of the GZ port is 115 kilometers, which easily get accumulation of silt, we must attach great importance to deepening sea routes and improving port conditions. Wharfs, especially the size and number of berths, are important factors in determining the port handling capacity. GZ Port must pay attention to the construction of new berths and increasing port handling capacity so as to meet the growing demand for cargo throughput. Port management level affects not only the utilization efficiency and economic efficiency of the port, but also affects the level of service and the images of port companies which cannot be ignored similarly.

Opening up new routes and friendly ports is a means of broaden services scope at home and increasing supplies. Therefore, it is an integral part of development strategies of the port. On the one hand, we can open up new routes having development potential through the cooperation with shipping companies (Appendix 4).

For the purpose of forecasting handling capacity, in this study we determined that good and accurate prediction is warranted for future planning. In turn, the results of our study indicate that a simple two parameter EWMA model may prove extremely accurate, easy-to-use and an important model in predicting future needs. Conclusion

At first, in this paper we use 74 sets of data of the Guangzhou cargo port, BDI and CCBFI from January 2004 to February 2010 to establish the multiple linear regression model. The analysis on the regression results shows that the BDI and CCBFI have little effects on the GZ port cargo throughput for next period. According to the preliminary judgment, there are two reasons for this result. One is the lag on the effects that the dry bulk shipping freight have on the GZ port cargo throughput and another is the effects of other factors [13,14].

Then, according to the above analysis, we introduce the data of the BDI, CCBFI and the time series of the GZ cargo port in the past several periods and analyze the effects the above three kinds of series have on the GZ cargo port by making use of the regression and time series model. We conclude that dry bulk freight rates in international shipping market and the Chinese coastal shipping market have little effects on the GZ cargo port, while the time series is of great help for us to predict the GZ cargo port. In addition, the prediction accuracy of the model is not large [15].

In addition, two parameter EWMA requires use of only the historical time series of the GZ port for the purpose of forecasting. By example tests on the Guangzhou port cargo in March 2010 and

April 2010, we can conclude that the two parameter EWMA resulted in the best forecasts. Future modeling should consider ARIMA and Multivariate ARIMA models. The second set of these models may aid in long-term forecasting. Further, these models should be considered in the light of studies of the practice of forecasting [19-21].

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