A study of Forecasting Methods for the Cross-Straits Trade

Chui-Yen, Chen
Department of Tourism and Leisure Management
Chin-Min Institute of Technology, Instructor
Department of Industrial Engineering and Management
University of Yuan-Ze, Ph.D. student
110, Hsue-Fu Rd., Tou-Fen, Miao-Li 351, Taiwan, R.O.C.
Tel: 886-37-605670 Fax: 886-37-605674
s919507@mail.yzu.edu.tw

Abstract: - Both China and Taiwan have already obtained the WTO membership and officially participated in the international trade system. The economic and trade relationship between China and Taiwan should develop by following the rules of international trade development. Due to the high rate of growth of the economic and trade exchange between China and Taiwan, up until now, Taiwan has relied heavily on the mainland for its exports and vice versa. This study is intended to probe the issue. We established forecast models for the cross-strait trade through the methods of grey forecasting, simple regression, and exponential smoothing. In addition, it tests the accuracy of the forecast models through relevant data, and used MAPE and MSE to evaluate the forecast models. The results indicate that for model selection, it is more correct to perform the forecast on trade volume based on the statistical information released by Taiwan Customs. It can be seen from this model, the cross-strait trade volume in 2008 will exceed USD $73,500 million, with imports into Taiwan above USD $36,373 million. It is hoped to understand the cross-strait trade growth trend in the future with the forecast model established by our research institute and thus providing the government or the agencies concerned with reference information for making their cross-strait policies.

Key-words: - Cross-strait Trade, Grey Forecast, Exponential Smoothing, Simple Regression

1. INTRODUCTION

According to “Management Trend of SMEs”[1], it is indicated that the global economic situation in 2007 was fairly unquiet, mainly because of the U.S. sub-prime problems and the internationally rocketing oil price, with lots of regions and areas affected in depth, and leading to a stir in the global economy.

Looking back at the performance to Taiwan’s exports to China, the cross-strait trade volume in 2007 exceeded USD $70,000 million at the first, and the ratio of export to import reached its highest point ever following a growth pattern of two digits consecutively since 2002. However, it also behaved like a polarizing phenomenon. The growth rate of exports hit its highest point, but imports dropped to the lowest it has been in the last three years, which led the highest trade surplus in history. China is still the first major trade partner of Taiwan, the first major export market, the second major source of import and the biggest source of trade surplus.

Due to the economic and trade exchange between China and Taiwan growing at a high speed, up until now, Taiwan has heavily relied on the mainland for its exports and vice versa. This study intends to discuss the issue of which direction will the cross-strait trade develop towards? This paper establishes a forecast model for the cross-strait trade growth based on the forecast mode, GM (1, 1), of the grey forecast under the grey theory. In addition, as for the application of multiple forecast methods, the data closest to the current time

can represent the future data more accurately than the historical data, and the exponential smoothing method deals with the time related data in the simplest and most logical way [3]. Therefore, this paper also tests the correctness of the forecast model with the exponential smoothing method and the simple regression mode as well as through the related data such as MAPE and MSE.

2. Literatures Review

2.1 Related Literature about Forecast Methods

Zhang[21], with the exponential smoothing method and the Bayes auto regressive analysis method, suggested that in order to reduce the potential inventory cost, using the forecast result obtained by the exponential smoothing method is better than that by the Bayes regression method. Chen[6] found that when forecasting the future price of crude oil and change in the exchange rate with ARIMA, (the auto regressive integrated moving average) using the exponential smoothing method has a better forecast ability for the purpose of increasing profit. Snyder etc.[18] suggested that the exponential method is most commonly used for inventory control to accurately forecast the inventory volume and the lead time demand in order to provide help to inventory management and define the most suitable strategy. Snyder etc.[19] forecasted the lead time demand and calculated the safety inventory with the exponential smoothing method in order to adjust the seasonal demand and peak demand of commodities, and they found out that the safety inventory forecast for the seasonal demand is highly accurate. Zhong and Lin[23]performed a forecast of the Baltic Sea vessel freight index with the exponential smoothing method and grey forecast mode, and they found out that the exponential smoothing method has an excellent forecast ability. Chen[5], performed forecast of the Baltic dry index (BDI) with the exponential smoothing method, ARIMA mode and grey theory, and he found out that the forecast done with the exponential smoothing method can reach an accuracy of higher than 90 %.

Deng[15] proposed the grey theory in 1982, mainly for establishing a grey mode to perform forecast and decision-making. The grey forecast has been extensively employed and has achieved a lot in recent years. Chen[4] and Huang etc. [11], [12] forecasted the goods demand at shipping centers outside Taiwan using the grey theory, analyzed the data of monthly and quarterly shipping volumes from May 1997 to April 1998, and forecasted the monthly and quarterly shipping volumes respectively with the grey mode GM (1,1). Zhong etc. [22] established the BDI forecast mode with the GM (1, 1) in order to understand the trend of freight and chartering rate changes and reduce the shipping market risk effectively. Huang etc. [13], looking at the import and export volumes by container in Taiwan, established GM (1, 1) with the grey theory, constructed a model with the data obtained from different years, performed accuracy comparison among different modes, and found out that the GM (1, 1) is suitable for forecasting seaport container shipping volumes with data for a period of four to ten 0 years. Ma[17] used GM (1,1) for forecasting the growth rates of the economy and shipping volume, number of incoming and outgoing vessels, number of containers loaded and unloaded and goods throughput. It was found out that the grey forecast mode (GM) was reliable and rational. For forecasting with the grey theory, Tseng and Tzeng[20] believed that four sets of data were sufficient to produce excellent forecast results, and could reduce the forecast error significantly. Zhuang[24] forecasted the production value and growth rate for the game market and found out that the best forecast results were achieved with the "**four**" data to generate of GM (1,1).

2.2 Analysis of Cross-strait Trade Situation in 2007[1]

There was little exchange between China and Taiwan before China adopted the reform and opening policy. Since the Taiwan government agreed to conduct trade activities with China via a third region in 1987, the cross-strait trade via Hong Kong has grown at an unbelievably high rate.

Except for the missile trial launching crisis in 1996, which led to a negative growth of the cross-strait trade volume the first time, the trade volume between China and Taiwan, whether according to the statistics done by Hong Kong, Taiwan Customs, or the Customs of China, has been growing at an increasingly high speed.

According to the statistics released by the Bureau of Foreign Trades under the Ministry of Economic Affairs, Executive Yuan of the Public of China, the amount of investment from Taiwan to China from January to August 2007 reached USD $6.23 billion, an increase of 35.81 % over the same period of the previous year. The investment events 693 was a slight increase of 1.61 %, and the amount of each investment tended to increase gradually. As estimated by the Bureau of Foreign Trades under the Ministry of Economic Affairs, the trade volume from Taiwan to China from January to October 2007 reached USD $49.990 billion, an increase of 15.3 % over the same period of the previous year, accounting for 22.4 % of the foreign trade volume of Taiwan.

To classify investments by region, from January to August, the approved investment cases oriented with China were mainly concentrated in the regions such as: Jiangsu Province (accounting for 37.87 %), Shanghai Municipality (18.79 %), Canton Province (18.44 %), Zhejiang Province (6.25 %) and Fujian Province (4.15 %) etc., amounting to about 85.5 % of the total approved investment. When classifying by industry, the five leading industries are the electronics parts and components manufacturing industry (accounting for 28.56 %), the computer, electronic products, and optic products manufacturing industry (15.11 %), the power equipment manufacturing industry (9.73 %), the wholesale and retailing industry (5.15 %) and the plastic products manufacturing industry (4.8 5%), amounting to 63.40 % of the total approved investment for this period.

Taiwan Customs, Hong Kong Customs and the Customs of the Mainland of China have kept their respective trade data in detail. But due to different sampling methods, great differences exist among the data by these three customs. The Amount of Export from Taiwan to Hong Kong done by Taiwan Customs is far higher than that of The Amount of Import to Hong Kong from Taiwan. Therefore, the exports from Taiwan to China will be underestimated if it is only based on the statistics done by Hong Kong Customs.

Therefore, this paper performs analysis on the cross-strait trade based on the data released on the “Monthly Cross-strait Economic Statistics”. According to the results from the related study with the grey theory, it is suggested that grey forecast mode is suitable for performing analysis with short-term data or cases where complete data is unavailable. There has long been high uncertainty in the cross-strait market, and the grey theory has the feature of incomplete information system environment. Therefore, this paper establishes the model with the commonly used four rules of the grey theory to construct the forecast mode for the cross-strait trade growth and explore the growth trend, and it also carries out the accuracy comparison with the exponential smoothing method and the regression mode.

3. MODEL FORECAST AND EVALUATE

3.1 Grey Forecast Method

The grey system theory, proposed by Deng[15], is a system analysis method, under the conditions of incomplete information and uncertain cause-effect relationship. The conventional forecast method requires lots of data, namely, it is limited by the assumptions that the matrix assignment shall follow. Nevertheless, the grey system can overcome all the above limitations, and its most striking feature is that only four sets of data are needed to establish a model, and it is not necessary to make strict assumptions for the assignment of research sample matrix [4]. In the cross-strait market, there has existed a high uncertainty between the supply and demand of vessels and commodities, in conformity with the grey theory’s feature of “the incomplete information system environment”.

GM (1, 1) modeling [15] is a specific example of GM (n,h) modeling when n = 1 and h = 1. The order of the differential equation is one, and there is only one variable, namely series $\mathbf{X}^{(0)}$, in GM (1, 1) modeling sequence. GM (1, 1) modeling values are considered as the center of state in the Grey-Markov chain forecasting model. A group of original data with equal time interval is supposed

$$\mathbf{X}^{(0)} = \{x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(N)\} \quad (1)$$

The first-order accumulated generating operation (1-AGO) of $\mathbf{X}^{(0)}$ is provided. The grey-generated model, based on the series

$$\mathbf{X}^{(1)} = \{x^{(1)}(1), x^{(1)}(2), ..., x^{(1)}(N)\} \quad (2)$$

Eq.(2) is given by the differential equation

$$\frac{d\mathbf{X}^{(1)}}{dt} + a\mathbf{X}^{(1)} = u \quad (3)$$

where *t* denotes the independent variable in the system, *a* represents the developed coefficient, *u* is the controlled variable in the grey model. *a* and *u* are the parameters that required to be determined in the model. **Eq.(3)** is called the first-order grey differential equation and denoted by GM (1, 1), where the first 1 stands for the first-order derivative of the 1-AGO series of $\mathbf{X}^{(0)}$, and the second 1 stands for only 1 series having to do with the grey system.

From **Eq.(2)** and **(3)** and equation-least squares method, coefficient $\hat{a}$ becomes

$$\hat{a} = [a, u]^T = (B^T B)^{-1} B^T Y_N \quad (4)$$

Furthermore, accumulated matrix ***B*** is

$$B = \begin{Bmatrix} -\frac{1}{2}(x^{(1)}(2) + x^{(1)}(1)) & 1 \\ -\frac{1}{2}(x^{(1)}(3) + x^{(1)}(2)) & 1 \\ \cdots & \cdots \\ -\frac{1}{2}(x^{(1)}(N) + x^{(1)}(N-1)) & 1 \end{Bmatrix} \quad (5)$$

The constant vector Y_N is

$$Y_N = [x^{(0)}(2), x^{(0)}(3), ..., x^{(0)}(N)]^T \quad (6)$$

The approximate relationship given below can be obtained by the substitution of in the differential equation and by solving **Eq.(4)**.

$$\hat{x}^{(1)}(k+1) = (x^{(0)}(1) - \frac{u}{a})\exp(-ak) + \frac{u}{a} \quad (7)$$

When $\hat{x}^{(0)}(1) = \hat{x}^{(0)}(0)$, the sequence of one-order inverse-accumulated generating operation (IAGO) is required and the sequence must be reduced to obtain **Eq.(7)**

$$\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1) \quad (8)$$

where $\hat{x}^{(0)}(k)$ is the original series forecasts, $\hat{x}^{(1)}(k)$ is the generated series for the forecasts.

Suppose ***k=2,3, …, N,*** the sequence of reduction is obtained as follows

$$\hat{x}^{(0)} = (\hat{x}^{(0)}(2), \hat{x}^{(0)}(3), ..., \hat{x}^{(0)}(N)) \quad (9)$$

3.2 Exponential Smoothing Methods

The time series is to observe a target object continuously based on fixed time intervals, thus figuring out the rules of the time series with change of time and to evolve the future time series. In many applications, the data closest to the current time can represent the future data more accurately than the historical data, and the exponential smoothing method can deal with the time related data in the simplest and most logical way. The exponential smoothing method, with the change of the α value, can easily obtain a correct answer, while the simple regression mode offers the simplicity of the conventional statistical forecast method.

Forecasting methods using smoothing techniques which weight past observations may be desirable because they reduce the fluctuations due to the irregular component in the observed time series. Averaging methods compute a forecast as an average of

past observations, with equal weighting given to each observation. Alternatively, linear exponential smoothing models can also be applied to obtain forecasts, in which the highest weight is assigned to the most recent observation, with weights decreasing exponentially for more distant observations. Single (or simple) exponential smoothing is the earliest known exponential smoothing technique. It requires the current level of the series to be estimated, which then forms the forecast of the series as "it represents the latest assessment available of the single (constant) predictable element of the time series" [8]. Using the single exponential smoothing method, the forecast for $t+i$ is given by the exponentially smoothed arrivals series in t, which is the weighted average of the actual inbounds in t and the smoothed lag series (namely, the forecast made in the previous period). A single exponential smoothing method, which produces an i-period-ahead forecast at time t (F_t), can be calculated recursively, as follows:

$$F_t = \tilde{A}_t = \alpha A_t + (1-\alpha)\tilde{A}_{t-1} = \alpha A_t + (1-\alpha)F_{t-1}, \quad 0<\alpha<1, \quad i \geq 1 \qquad (10)$$

where A_t =actual arrivals at time t; $\tilde{A}_t$ =smoothed estimate of arrivals at time t; F_t =single exponential smoothing forecast of time t; α=smoothing coefficient.

The forecasts are given by the latest available smoothed value such that, at time t, the previous smoothed estimate, $\tilde{A}_{t-1}$, is updated as the new observation, A_t , becomes available. The new smoothed estimate, $\tilde{A}_t$, is the weighted average of A_t and $\tilde{A}_{t-1}$. The forecast in period t is based on weighting the observation in period t by a smoothing coefficient, α, and the most recent forecast by (1-α). Thus, F_t is a weighted average of all current and past observations, and is a smoothed statistic.

Eq. (10) can be rewritten as:

$$F_t = F_{t-1} + \alpha(A_t - F_{t-1}) \qquad (11)$$

Or

$$F_{t+1} = F_t + \alpha(A_t - F_t) = F_t + \alpha e_t \qquad (12)$$

from which it can be seen that the single exponential smoothing procedure adjusts the forecast by a proportion of the most recent forecast error: if α is close to one, the new forecast would equal the previous forecast and a substantial proportion of the most recent forecast error; if α is close to zero, the new forecast would equal the previous forecast with little influence from the most recent forecast error.

3.3 Simple Regression Method

Statisticians routinely apply regression analysis to fit models to observations. To deal with outliers, we seek for robust and resistant regression procedures. Quite some number of perspectives exists in the literature regarding the definition of robustness. For example, Huber [14] studied robustness from the point of view of minimax variance. Hampel [9],[10] proposed the idea of influence function as an asymptotic tool to study robustness. Breakdown point is another important notion in robust analysis. Huber [14] defined a finite-sample version of breakdown point. Consider the classical linear model

$$y = x\beta + \varepsilon \qquad (13)$$

where $y = (y_1, y_2, ..., y_n)'$, $\beta = (\beta_1, \beta_2, ..., \beta_n)'$, $\varepsilon = (\varepsilon_1, \varepsilon_2, ..., \varepsilon_n)'$ and $X = (x_{ij})_{i=1,...,n,\ j=1,...,p}$.

3.4 Model Evaluation

To achieve correctness in the forecast mode, indicators to evaluate whether the mode is accurate or not are needed. The commonly used evaluating indicators are: Mean Square Error, (MSE), Mean Absolute Value of Error, (MAE) and Mean Absolute Percentage Error (MAPE), and U Statistical Measure. They are expressed as:

$$MSE = \frac{\sum_{i=1}^{n}[X_1^{(0)}(i) - \hat{X}_1^{(0)}(i)]^2}{n} \quad (14)$$

$$MAE = \frac{\sum_{i=1}^{n}\left|X_1^{(0)}(i) - \hat{X}_1^{(0)}(i)\right|}{n} \quad (15)$$

$X_1^{(0)}(i)$: Actual Value

$\hat{X}_1^{(0)}(i)$: Forecast Value

Both MSE and MAE are obtained from equations (1) and (2) are absolute values, not relative values. Although MES exerts a penalty on the error, it will change significantly for different samples and different measuring units. It is irrational that weight $1/n$ is used for each error or square error, because it does not relate to the degree of the value originally observed.

For this study, two indicators as MAPE and U statistical measure are used to evaluate the correctness in the mode:

$$MAPE = \frac{\sum_{i=1}^{n}\left|\frac{X_1^{(0)}(i) - \hat{X}_1^{(0)}(i)}{X_1^{(0)}(i)}\right|}{n} * 100\% \quad (16)$$

$$U = \sqrt{\frac{\sum_{i=2}^{n}(FPE_i - APE_i)^2 / n-1}{\sum_{i=2}^{n}(APE_i)^2 / n-1}} \quad (17)$$

Where:

$$FPE_i = \frac{\hat{X}_1^{(0)}(i) - X_1^{(0)}(i-1)}{X_1^{(0)}(i-1)}$$

Relative change rate of forecast

$$APE_i = \frac{X_1^{(0)}(i) - X_1^{(0)}(i-1)}{X_1^{(0)}(i-1)}$$

Actual relative change rate

MAPE is a relative value, and suitable for comparing the forecast errors from different time units. U statistical measure not only considers to exert a penalty on the error (square term), but also is the combination of the normal forecast method and native method. Meaning, it is to conduct relative comparison by forecasting the value in the next period based on the observed value in this period without performing a forecast. Therefore, when U=0, $\hat{X}_1^{(0)}(i) = X_1^{(0)}(i+1)$, the forecast mode established is a perfect forecast. When U=1, $\hat{X}_1^{(0)}(i) = X_1^{(0)}(i)$, the result forecasted with the mode is the same without a forecast. For the same reason, if U **<** 1 (or U **>** 1), the forecast mode established is superior to (or inferior to) the method without a forecast. Therefore, it can be seen that when U **>** 1, no matter how low MSE, MAE or MAPE value is, the forecasted result is worse than the way without a forecast (has no cost). Therefore by looking at U value, it can decide whether the forecast mode is applicable or not. In this case, the risk affecting the system's operation due to poor forecast results can be reduced. Therefore, it is a good forecast error indicator.

MAPE is mainly used to assess the degree of effect on the terms in the mode which have not been explained. The less the MAPE value, the stronger the ability the forecast mode has to give the correct forecast, and the results from the forecast mode are closer to matching the past data. This paper classifies the forecast ability of the mode into four levels by adapting the forecast ability levels proposed by Lewis according to MAPE value (refer to Table 1). When MAPE is less than 10 %, it means that the forecast ability is highly accurate.

Table 1. Forecast Ability Levels of Mean Absolute Percentage Error

MAPE Value	Forecast Ability
MAPE < 10%	Highly Accuracy
10% ≤ MAPE ≤ 20%	Excellent
20% < MAPE ≤ 50%	Acceptable

MAPE > 50%	Not Correct

The U statistic measurement not only considers the penalty on the relative error (square term), but performs relative comparison for forecasting the value in the next period based on the observed value in this period. As judged by the U statistical measurement, refer to Table 2, it can decide whether the forecast mode is applicable or not in this case and should be able to reduce risk affecting the system's operation due to poor mode forecast results. Therefore, it is a good evaluating indicator for a forecast error [4].

Table 2. Judgment with U Statistics

U Statistics	Whether to Use Forecast Mode
U > 1	Inferior to the results obtained without forecast
U = 1	The same as the results with forecast
U < 1	Superior to the results obtained without forecast
U = 0	Perfect forecast

Table 3. Trade between Taiwan and Mainland China

Unit: US million

Period	Hong Kong Customs Statistics			Taiwan Customs Statistics			Mainland China Customs Statistics		
	Exports	Imports	Total	Exports	Imports	Total	Exports	Imports	Total
1989	2,896.5	586.9	3,483.4	-	-	-	-	-	-
1990	3,278.3	765.4	4,043.7	-	-	-	2,255.0	319.7	2,574.7
1991	4,667.2	1,126.0	5,793.2	0.1	293.2	293.3	3,639.0	594.8	4,233.8
1992	6,287.9	1,119.0	7,406.9	1.1	747.1	748.2	5,881.0	698.0	6,579.0
1993	7,585.4	1,103.6	8,689.0	16.2	1,015.5	1,031.7	12,933.1	1,461.8	14,394.9
1994	8,517.2	1,292.3	9,809.5	131.6	1,858.7	1,990.3	14,084.8	2,242.2	16,327.0
1995	9,882.8	1,574.2	11,457.0	376.6	3,091.3	3,467.9	14,783.9	3,098.1	17,882.0
1996	9,717.6	1,582.4	11,300.0	623.4	3,059.9	3,683.3	16,182.2	2,802.7	18,984.9
1997	9,715.1	1,743.8	11,458.9	626.5	3,915.3	4,541.8	16,441.7	3,396.5	19,838.2
1998	8,364.1	1,654.9	10,019.0	914.9	4,113.9	5,028.8	16,629.6	3,869.6	20,499.2
1999	8,174.9	1,628.1	9,803.0	2,602.1	4,528.9	7,131.0	19,537.5	3,951.7	23,489.2
2000	9,593.1	1,980.5	11,573.6	4,391.5	6,229.3	10,620.8	25,497.1	4,994.9	30,492.0
2001	8,811.5	1,693.3	10,504.8	4,895.4	5,903.0	10,798.4	27,339.5	5,000.2	32,339.7
2002	10,311.8	1,708.1	12,019.9	10,526.9	7,968.6	18,495.5	38,063.1	6,585.9	44,649.0
2003	11,789.4	2,161.1	13,950.5	22,890.8	11,017.9	33,908.7	49,362.3	9,004.7	58,367.0
2004	14,761.9	2,485.4	17,247.3	36,349.4	16,792.3	53,141.7	64,778.6	13,545.2	78,323.8
2005	17,055.9	2,634.5	19,690.4	43,643.7	20,093.7	63,737.4	74,684.4	16,549.6	91,234.0
2006	18,707.2	2,909.8	21,617.0	51,808.6	24,783.1	76,591.7	87,109.0	20,735.2	107,844.2
2007(1-10)	17,467.1	2,414.3	19,881.4	49,990.4	22,967.2	72,957.6	81,822.6	19,039.5	100,862.1

Note: 1. According to the statistics by Taiwan Customs, on export, statistics error has been resulted because manufacturers have not provided the actual destinations (Mainland China), but instead of Hong Kong; On import, in the past, Taiwan restricted the commodity import from the Mainland of China, and some goods made in the Mainland China came to Taiwan through smuggling or counterfeit certificate of origin, therefore, the statistics volume is lower. Only in recent years, Taiwan has eased the restriction on the import of goods made in the Mainland China; therefore, the statistics creditability has been improved.
2. According to the statistics by the Customs of the Mainland China, in the past, the statistics by country of origin and consumer country was not be rigidly conducted (mostly, by incoming county and outgoing country), therefore, statistically, the trade volume with Hong Kong was overestimated, and that with other countries underestimated. Adjustment has been made only from 1993 on; therefore, the reference value of the statistics has been slightly improved.

4. Analysis on Cross-strait Trade Growth Trend

For this study, the data [2] is collected according to the data released in the Monthly Cross-strait Economic Statistics and is summarized in Table 3. As it can be

seen from Table 3, whether according to the statistics results of Hong Kong Customs, Taiwan Customs or the Customs of China, the volume of exports from Taiwan to China greatly exceeds the volume of imports to Taiwan from China, and the economic and trade volume also is growing at a high speed. At present, the degree of reliance of Taiwan on the mainland market becomes deeper. The mainland market is indispensable to the Taiwan market.

4.1 Analysis on Grey Forecast and Simple Regression Results

According to the related studies with the grey theory, it is suggest that the grey forecast mode is suitable for conducting analyses for short periods of time or cases with incomplete data. For as long as there has been high uncertainty in the cross-strait trade, the grey theory has had the feature of incomplete information system environment. It establishes a model with the commonly used four rules of the grey theory to construct the forecast mode for the cross-strait trade growth and to test the accuracy of the mode. The simple regression mode is also one of the commonly used forecast tools in statistics. This study forecasts the trade volumes in 2007 and 2008 with the data from 2003 to 2006. The values are given in Table 4 and 5.

For MAPE mode assessment, the results obtained with the grey forecast are better than those with the regression mode. Taking exports as an example, it is 0.84 %, 0.24 % and 0.25 % respectively for Hong Kong, Taiwan and China. For imports, it is 0.70 %, 0.67 % and 0.55 % respectively. Both the grey forecast and the regression mode, no matter which authority the data is from, are of high accuracy.

Table 4. Forecast Results of Export Volumes between Taiwan and Mainland of China – Grey Forecast and Simple Regression

Exports	**Hong Kong Customs**		**Taiwan Customs**		**Mainland China Customs**	
Period	GM(1,1)	Regression	GM(1,1)	Regression	GM(1,1)	Regression
2003	11,789.4	12,121.5	22,890.8	24,566.0	49,362.3	50,511.7
2004	14,907.0	14,426.2	36,344.0	33,970.7	64,480.0	62,826.3
2005	16,745.0	16,731.0	43,341.0	43,375.5	74,800.0	75,140.9
2006	18,810.0	19,035.7	51,684.0	52,780.3	86,760.0	87,455.5
2007	21,129.0	21,340.5	61,634.0	62,185.1	100,640.0	99,770.1
2008	23,733.0	23,645.2	73,500.0	71,589.8	116,740.0	112,084.6
MAPE	0.84%	2.19%	0.24%	4.09%	0.25%	1.59%
U	0.03	0.04	0.00	0.05	0.01	0.03

Table 5. Forecast Results of Import Volumes between Taiwan and Mainland of China – Grey Forecast and Simple Regression

Imports	**Hong Kong Customs**		**Taiwan Customs**		**Mainland China Customs**	
Period	GM(1,1)	Regression	GM(1,1)	Regression	GM(1,1)	Regression
2003	2,161.1	2,188.4	11,017.9	11,482.2	9,004.7	9,229.3
2004	2,464.3	2,427.9	16,611.0	15,941.9	13,403.0	13,048.9
2005	2,669.2	2,667.5	20,206.0	20,401.6	16,599.0	16,868.5
2006	2,891.1	2,907.0	24,580.0	24,861.3	20,556.0	20,688.1
2007	3,131.5	3,146.5	29,901.0	29,321.0	25,458.0	24,507.7
2008	3,391.8	3,386.0	36,373.0	33,780.7	31,528.0	28,327.2
MAPE	0.70%	1.23%	0.61%	2.78%	0.55%	2.08%
U	0.03	0.05	0.01	0.04	0.01	0.03

4.2 Analysis on Exponential Smoothing Results

In the last ten years, the structure of the cross-strait trade has shown a big and significant fluctuation. In order to know the advantages and disadvantages among the different modes, an α value between 0.2 and 0.8 is employed (refer to Table 6 and 7). To forecast the data in 2007 based on those from 2002 to 2006 when α = 0.2, for exports, MAPE is 27.34 %, 66.87% and 40.90 % respectively for Hong Kong, Taiwan and China. For imports, it is 19.30 %, 44.94 % and 43.67 % respectively. When α=0.8, for exports, MAPE is 17.38 %, 45.28 % and 25.37 % respectively for Hong Kong, Taiwan and China. For imports, it is 11.87 %, 29.68 % and 29.08 % respectively. This suggests that for forecasting and analyzing the cross-strait trade volume, the exponential smoothing method is able to produce excellent or acceptable forecast accuracy. Comparing it with the results above mentioned, its forecast ability has reduced significantly. Therefore in this case, it is suggested not to perform the forecast with the exponential smoothing method.

Table 6. Forecast Results of Export Volumes between Taiwan and Mainland of China – Exponential Smoothing Method

Period	Hong Kong Customs			Taiwan Customs			Mainland China Customs		
α =	0.2	0.5	0.8	0.2	0.5	0.8	0.2	0.5	0.8
2002	8,811.5	8,811.5	8,811.5	4,895.4	4,895.4	4,895.4	27,339.5	27,339.5	27,339.5
2003	9,111.6	9,561.7	10,011.7	6,021.7	7,711.2	9,400.6	29,484.2	32,701.3	35,918.4
2004	9,647.1	10,675.5	11,433.9	9,395.5	15,301.0	20,192.8	33,459.8	41,031.8	46,673.5
2005	10,670.1	12,718.7	14,096.3	14,786.3	25,825.2	33,118.1	39,723.6	52,905.2	61,157.6
2006	11,947.2	14,887.3	16,464.0	20,557.8	34,734.4	41,538.6	46,715.8	63,794.8	71,979.0
2007	13,299.2	16,797.3	18,258.6	26,807.9	43,271.5	49,754.6	54,794.4	75,451.9	84,083.0
MAPE	27.34%	21.64%	17.38%	66.87%	54.64%	45.28%	40.90%	31.94%	25.37%
U	0.56	0.40	0.30	0.42	0.34	0.28	0.58	0.41	0.30

Table 7. Forecast Results of Import Volumes between Taiwan and Mainland of China – Exponential Smoothing Method

Period	Hong Kong Customs			Taiwan Customs			Mainland China Customs		
α =	0.2	0.5	0.8	0.2	0.5	0.8	0.2	0.5	0.8
2002	1,693.3	1,693.3	1,693.3	5,903.0	5,903.0	5,903.0	5,000.2	5,000.2	5,000.2
2003	1,696.3	1,700.7	1,705.1	6,316.1	6,935.8	7,555.5	5,317.3	5,793.1	6,268.8
2004	1,789.2	1,930.9	2,069.9	7,256.5	8,976.9	10,325.4	6,054.8	7,398.9	8,457.5
2005	1,928.5	2,208.2	2,402.3	9,163.6	12,884.6	15,498.9	7,552.9	10,472.0	12,527.7
2006	2,069.7	2,421.3	2,588.1	11,349.7	16,489.1	19,174.7	9,352.2	13,510.8	15,745.2
2007	2,237.7	2,665.6	2,845.5	14,036.3	20,636.1	23,661.4	11,628.8	17,123.0	19,737.2
MAPE	19.30%	15.17%	11.87%	44.94%	36.35%	29.68%	43.67%	35.46%	29.08%
U	0.46	0.34	0.28	0.49	0.37	0.29	0.49	0.37	0.29

5. Conclusions and Suggestions

The cross-strait trade volumes of both import and export have been analyzed based on the statistical data. Meanwhile, the forecast modes have been established through the grey forecast, simple regression and exponential smoothing methods. The following are important conclusions and suggestions after summing up:

5.1 Conclusions:

1. Among the forecast modes established for this study, the grey forecast performs best, and the simple regression mode follows immediately. Both methods exhibit a comparatively better forecast ability than the rest.
2. As for the data, regarding the exports trade volume, the grey forecast mode established based on the statistical data from Taiwan Customs provides better results. Regarding the imports trade volume, the grey forecast mode established based on the statistical data from Taiwan Customs and the Customs of China provides better results.
3. If the forecast is performed based on the statistical data from Taiwan Customs, the cross-strait trade volume in 2008 will exceed USD $73,500 million for exports from, and USD $36,373 million for imports to Taiwan, a significant growth over 2006.
4. As it can be seen from the data, the degree of reliance of Taiwan on China has been becoming heavier and heavier year after year, resulting in a risk issue. But in a market previously having strong competitive force, if the market share of Taiwan decreases, and there are no other markets to take its place, it means that the overall competitive force weakens. In this case, we should think over whether or not Taiwan faces a deeper security risk.

5.2 Suggestions:

1. Through comparison and analyses with the models established with the extensively used grey forecast, this study can almost say completely positive things about the forecast ability of the grey theory in a short-term grey situation. For continued study, more complete trade volume data needs to be gathered in order to forecast the development trend of the cross-strait trade more perfectly.
2. In this study, the social and economic variants have not been included into the forecast modes. It is suggested for continued study, that lots of social and economic data in both the mainland and Taiwan should be collected. Also, the GM (1, n) forecast mode or re-regression mode could be established in order to observe and analyze the effects of the forecast modes.
3. Facing the high growth of the cross-strait economic and trade exchange in 2007, the government authority should consider adjusting the policies toward China to create a new Taiwan Miracle again on both sides of Taiwan Strait and in these three regions.

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