Application of a Mixed Regression Model

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Abstract. The forecast of volumes of import and export containers is one of the most important issues for government transportation departments and seaport organizations. Although a number of studies focus on the subject of forecast of import and export containers in the past, most of these studies do not consider the forecast error due to the “non-stationary” relationship between the volumes of import and export containers and the economic variables. Thus this article attempts to fill this gap in the current literature by establishing a modified non-linear regression model. An empirical study in Taiwan is conducted to demonstrate the effectiveness of the proposed modified non-linear regression model. Finally, this paper compares the accuracy of this modified non-linear regression model, the traditional linear regression model and the traditional non-linear regression model for forecasting the volumes of Taiwan’s import containers. The comparison results show that the proposed modified non-linear regression model in this paper exhibits higher prediction accuracy than previous models.

Keywords: Forecast, regression, non-linear, international trade, economy
1 Introduction

Forecasting of the volumes of import and export containers is central to the planning and the operation of seaport organizations and government transportation departments at both the micro and macro levels. At the seaport organization level, forecasts of container volumes are needed as the essential inputs to many decision making activities in various functional areas such as building new container terminals, operation plans, marketing strategies, as well as finance and accounting. Whether new container terminals should be built is a controversial issue in Taiwan. One reason for this is the huge and irreversible investment in new container terminals and related infrastructure. Another reason is the different ways of forecasting the volumes of containers, which lead to quite different conclusions. At the government transportation department level, forecasts of containers volumes also provide basis for regional and national transportation plans.

A number of studies focus on the subject of forecast of volumes of export and import containers from/to Taiwan. For example, the Ministry of Transportation and Communications of Taiwan publishes forecasts of the volumes of import and export containers for the international container ports in the Taiwan area every 2-3 years. Their forecast results are the only available data and, thus, highly influential in the planning of future development of the ports. Unfortunately, the forecast errors made by the Ministry of Transportation and Communications were quite substantial and investment decision based on their forecasts is on shaky grounds.
Thus, this paper proposes a modified non-linear regression model for forecasting the volumes of import containers to reduce this forecast error produced by the non-stationary relationship between the volumes of import containers and the macro-economic variables and, more importantly, to provide policy makers a higher accuracy forecast.

This article is organized as follows. A brief problem description is provided in Section 1. Section 2 is the literature review. A modified non-linear regression model for forecasting the volumes of import containers are proposed in Section 3 and the comparison of forecast accuracy between this modified non-linear regression model, the traditional linear and non-linear regression models is also shown. Finally, conclusions are given in Section 4.

2 Literature Review

Empirical studies of the relationship between the international trade container volume and the economic growth have nearly always specified linear economic models of the form

\[ y = a_0 + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n, \]  

where \( y \) is the foreign trade volume. And \( x_1, x_2, \ldots, x_n \) are the economic variables, e.g. the population, gross domestic product, gross national product, capital stock, labor force, international trade value, index of price and industrial production index.

Researchers who have applied regression models similar to Eq. (1) are Dollar (1992), Edwards (1992), Feder (1982), Greenaway and Nam (1988), Kavoussi (1984), Moschos (1989), Ram (1985, 1987),

In addition, the government departments and researchers in Taiwan who also have applied regression models similar to Eq. (1) are Ministry of Transportation and Communications (1993, 1996, 1997, 1998, 1999, 2000), Port of Taichung (1989), and Port of Keelung (1992).

Chou et al (2008) proposed a modified linear regression model for forecasting the volumes of Taiwan’s import containers to reduce the forecast error produced by the non-stationary relationship between the container volumes and the macro-economic variables. The results show that the proposed modified linear regression model exhibits higher prediction accuracy than previous models.

Thus, this study further proposes a modified non-linear regression model for forecasting the volumes of import containers to reduce the forecast error produced by the non-stationary relationship between the container volumes and the macro-economic variables.
3 Methodology

In Section 3.1, this paper first proposes a modified non-linear regression model for forecasting the volumes of Taiwan’s import containers. And then a traditional linear regression model and a traditional non-linear regression model are also proposed in Sections 3.2 and 3.3, respectively. Finally, a comparison of forecast results for these three regression models are shown in Section 3.4.

3.1 Forecasts Using Modified Non-linear Regression Method

A modified non-linear regression method is proposed and applied to forecast the volumes of Taiwan’s import containers. The computational procedure for this modified non-linear regression is summarized as follows.

Step 1. Summarize the economic data in Taiwan.
Step 2. Calculate the correlations between different economic variables.
Step 3. Build the modified non-linear regression model.

3.2 Forecast Using the Traditional Linear Regression Method

In this section, we will forecast the volumes of import containers by using a traditional linear regression model. The computational procedure is summarized as follows.

Step 1. Summarize the economic data in Taiwan.
Step 2. Calculate the correlations between different economic variables.
Step 3. Build the traditional linear regression model.
3.3 Forecasts Using the Traditional Non-linear Regression Method

A traditional non-linear regression model, which does not consider the forecast error produced by a non-stationary contribution coefficient, is also built in this section.

3.4 Comparison of Forecasts

In order to compare the modified non-linear regression model with the traditional linear regression model and the traditional non-linear regression model, this paper calculates and places the errors of the three models in the columns (12), (13) and (14) of Table, respectively. The total forecast error of the proposed modified non-linear model for the 1st -11th years is 338,620 TEU. The total forecast error of the traditional linear model is 575,910 TEU. The total forecast error of the traditional non-linear model is 782,330 TEU. We can find that the proposed modified non-linear regression model in this paper produced lower errors (338,620 TEU) than the traditional linear regression model (575,910 TEU) or the traditional non-linear regression model (782,330 TEU).

The forecasts of the volumes of containers for the 12th year and the 13th year are shown in the rows (13) and (14) of Table respectively, by using the modified non-linear regression model, the traditional linear regression model and the tradition non-linear regression model. The total forecast error of the modified non-linear model for the 12th year and the 13th year is 178,517 TEU. The total forecast error of the traditional linear model is 231,982 TEU, and the total forecast error of the traditional non-linear model is 238,193 TEU. The proposed modified non-linear model in this paper produced lower errors (178,517 TEU) than the traditional linear
model (231,982 TEU) or the traditional non-linear regression model (238,193 TEU). Finally, the proposed modified non-linear regression model in this paper is used to forecast the volume of import containers for the 23rd year. The forecast volume of containers for the 23rd year is 3,013,529 TEU.

4 Conclusions

Although a number of studies focus on the subject of forecast of import and export containers in the past, most of these studies do not consider the forecast error due to the “non-stationary” relationship between the volumes of international trade containers and the economic variables. This article attempts to fill this gap in the current literature by establishing a modified non-linear regression model. A modified non-linear regression model is proposed in this paper and then the proposed modified non-linear regression model is tested by a Taiwanese case. This paper also compares the proposed modified non-linear regression model with the traditional linear and non-linear regression models. The results show that the total forecast error of this proposed modified non-linear regression model is lower than those of the traditional linear and non-linear regression models without considering and modifying the forecast errors produced by the non-stationary relationship between the volumes of containers and the macro-economic variables.
References


Table 1 Forecast of the container volume using the modified non-linear regression

<table>
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<tr>
<th>Year</th>
<th>(1) Actual volumes of import containers</th>
<th>(2) Industrial production index</th>
<th>(3) Actual volumes of containers ÷Industrial production index</th>
<th>(4) Modified coefficient</th>
<th>(5) Adjusted volume</th>
<th>(6) Forecast of adjusted volume</th>
<th>(7) Year series</th>
<th>(8) Forecast of modified non-linear regression</th>
<th>(9) Forecast of traditional linear regression</th>
<th>(10) Errors of traditional linear regression</th>
<th>(11) Errors of modified non-linear regression</th>
<th>(12) Errors of traditional regression</th>
<th>(13) Errors of modified regression</th>
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The estimated industrial production index data for the 23rd year is from the Department of Statistics, Ministry of Economic Affairs, Taiwan.