Forecasting the Market Size of Vietnam's Retail Sales Industry Using Time Series and Grey Model

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Abstract
With the rapid growth rate on economic development in recent decades, Vietnam has become a potential market for retail sales industry, understanding the trend of retail sale can help the foreign and domestic investors have correct business strategies. Accuracy estimating the market size of this industry is an important step of business procedures. Therefore, aim to find out a high precision forecasting model for this industry, in this paper, two forecasting approaches namely traditional time series forecasting and grey forecasting have applied to construct the forecasting model using the annual data of Vietnam’s retail sales from 1997 to 2012. The results show that the forecasted accuracy of ARIMA (0, 2, 0) model is 94.91%, it higher than the other traditional time series models and grey model. Therefore the next seven years of this industry have forecasted by ARIMA (0, 2, 0) model. According to forecasting results, the market size of Vietnam’s retail sales will reach to Billion VND 4,396,380.3 in 2019. The trend of this industry presents quickly increase in the next few years.

Key Words: retail sales; forecasting; traditional series model; Grey model
1. Introduction

Nine years after joining the World Trade Organization (WTO), Vietnamese retail market is evaluated one of the most attractive markets in the world. More of international retail groups entered this market in the past decade. That has opened good opportunities for domestic businesses as well as providing more and more options for consumers, besides that it also created intensely competitive challenges for domestic companies as well. Along with the rapid growth rate on economic development in recent decades, Vietnam has become a potential market for retail sales industry, understanding the trend of retail sale can help the foreign and domestic investors have correct business strategies. Accuracy calculating the market size of this industry is an important step of business procedures. In this paper, the retail sales data has collected from 1997 to 2012 by General Statistics office of Viet Nam., On-line, 2016 and Ministry of Industry & Trade Web Portal., On-line. Data have been constructed the forecasting model by grey model (the GM(1,1) model) and some traditional time series models including the ARIMA(0,2,0) model, the single exponential smoothing model, the double exponential smoothing model, respectively. The mean of average percentage error of each model has been carried out to evaluate the accuracy of prediction models. The highest precision of forecasting model will be employed to forecast the future value of Vietnam’s retails sales industry in the next seven years. The obtained results are also presented and discussed.

2. Research Methodology

2.1 Traditional Prediction Method

In the study, three models of quantitative forecasting method have used Single Exponential Smoothing, Double Exponential Smoothing, and ARIMA model. Exponential Smoothing’s function is \( \hat{x}_{t+1} = \hat{x}_t + \alpha (x_t - \hat{x}_t) \), where \( \alpha \) denotes weight index, \( 0 < \alpha < 1 \). \( x_t \) is the observation value of period \( t \) and \( \hat{x}_t \) is the predicting value of period \( t \).

ARIMA model is generally denoted ARIMA(\( p, d, q \)) where parameters \( p, d, q \) are non-negative integers, \( p \) is the order of the Autoregressive model, \( d \) is the degree of differencing, and \( q \) is the order of the Moving-average model by SAS Institute., On-line, 2016 (https://support.sas.com-Notation for ARIMA Models. Time Series Forecasting System.)

ARIMA models form an important part of the Box-Jenkins approach to time-series modeling.

2.2 Grey model

Grey system theory was developed by Professor Deng in 1989 (Deng, J.L., 1989) and focused on the relation between the analytical model construction and for circumstances such as no certainty, multi-data input, discrete data, and insufficient data through predicting and decision-making. The most commonly used grey forecasting is GM (1,1), the Grey forecasting model GM(1,1) is a time series prediction model encompassing a group of

$$\hat{x}^{(0)}(k) = \left[ x^{(0)}(1) - \frac{b}{a} \right] (1-e^{a})e^{a(k-1)},$$

\(K=2, 3, ..., n\), Where a or b is estimated using OLS.

### 2.3. Evaluating Performance of the Forecasting Accuracy

To evaluating the accuracy of prediction models, two standard error measures were used in this paper. First, relative percentage error (RPE) measures the size of error and forecast value. RPE is defined as following:

$$RPE = \frac{\sum_{k=1}^{n} \left| x^{(0)}(k) - \hat{x}^{(0)}(k) \right|}{\sum_{k=1}^{n} x^{(0)}(k)} \times 100\%$$

Where the actual value is \(x^{(0)}(k)\) and the predicted value is \(\hat{x}^{(0)}(k)\). Second, mean of average percentage error (MAPE) is the average relative size of forecast error. The MAPE’s formula is:

$$MAPE = \left( \frac{1}{n} \sum_{k=1}^{n} \frac{\left| x^{(0)}(k) - \hat{x}^{(0)}(k) \right|}{x^{(0)}(k)} \right) \times 100\%$$

Forecast accuracy or precision rate is calculated by 1 minus MAPE. (Ying-Fang Huang, Chia-Nan Wang, Hoang-Sa Dang, Shun-Te Lai., 2015)

### 3. Results and Discussions

In this section, three traditional time series models including the ARIMA(0,2,0) model, the single exponential smoothing model, the double exponential smoothing model, respectively and the GM (1,1) have been constructed by the data of Vietnam’s retail sales from 1997 to 2012. And then, the performance of each model has been compared to confirm which the best model is. According that, the highest prediction model has been employed to forecast the future value of Vietnam’s retail sales in the next seven years. The obtained results have been presented as showed in the Table 1. The real values and predictive values of four models have been compared for calculating the relative errors and the accuracy. The results also indicated that the MAPE value of ARIMA (0, 2, 0) prediction model is 5.09%, meaning precision rate is reached to 94.91%. Comparing the precision rate with the rest three models, the ARIMA (0, 2, 0) model is more accurate than the others. Based on the above analysis, we concluded that the ARIMA (0, 2, 0) model presented the best performance among all of the proposed forecasting model. The result can be noticed more clearly in Figure 1.

As noted above, the ARIMA (0, 2, 0) model has employed to forecast the future trend of Vietnam’s retail sales. The predicted results for the market size of Vietnam’s retail sales
industry in the next seven years have been illustrated in Table 2. The future trend of this industry has represented in Figure 1. Furthermore, the market size of Vietnam’s retail sales industry has predicted a quick increase in the next few years.

Table 1: Model Value and Prediction Error of Vietnam’s Retail Sale

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Value (VND Billion)</th>
<th>Traditional Time Series models</th>
<th>Grey Model</th>
<th>GM(1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Predicted</td>
<td>RPE(%)</td>
<td>Predicted</td>
<td>RPE(%)</td>
</tr>
<tr>
<td>1997</td>
<td>161,899.70</td>
<td>14.64%</td>
<td>161,899.70</td>
<td>14.64%</td>
</tr>
<tr>
<td>1998</td>
<td>185,598.10</td>
<td>8.27%</td>
<td>201,955.10</td>
<td>0.51%</td>
</tr>
<tr>
<td>1999</td>
<td>185,598.10</td>
<td>0.08%</td>
<td>201,955.10</td>
<td>0.51%</td>
</tr>
<tr>
<td>2000</td>
<td>245,315.00</td>
<td>3.35%</td>
<td>239,897.50</td>
<td>2.26%</td>
</tr>
<tr>
<td>2001</td>
<td>280,884.00</td>
<td>4.61%</td>
<td>268,502.38</td>
<td>2.61%</td>
</tr>
<tr>
<td>2002</td>
<td>333,809.30</td>
<td>18.86%</td>
<td>313,487.48</td>
<td>6.48%</td>
</tr>
<tr>
<td>2003</td>
<td>398,524.50</td>
<td>19.41%</td>
<td>382,351.80</td>
<td>4.23%</td>
</tr>
<tr>
<td>2004</td>
<td>480,293.50</td>
<td>20.54%</td>
<td>461,368.75</td>
<td>4.10%</td>
</tr>
<tr>
<td>2005</td>
<td>596,207.10</td>
<td>24.16%</td>
<td>558,698.09</td>
<td>6.71%</td>
</tr>
<tr>
<td>2006</td>
<td>746,159.40</td>
<td>18.86%</td>
<td>703,424.29</td>
<td>6.08%</td>
</tr>
<tr>
<td>2007</td>
<td>888,667.02</td>
<td>13.34%</td>
<td>703,424.29</td>
<td>6.08%</td>
</tr>
<tr>
<td>2008</td>
<td>1,007,213.50</td>
<td>12.40%</td>
<td>896,111.70</td>
<td>12.40%</td>
</tr>
<tr>
<td>2009</td>
<td>1,238,145.00</td>
<td>22.96%</td>
<td>1,238,145.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>2010</td>
<td>1,614,078.40</td>
<td>30.39%</td>
<td>1,487,388.32</td>
<td>8.52%</td>
</tr>
<tr>
<td>2011</td>
<td>2,079,523.50</td>
<td>30.39%</td>
<td>1,950,765.17</td>
<td>6.60%</td>
</tr>
<tr>
<td>2012</td>
<td>2,369,130.60</td>
<td>30.39%</td>
<td>2,524,651.01</td>
<td>6.16%</td>
</tr>
</tbody>
</table>

- **MAPE (%)**: 19.85% 5.63% 5.09% 26.07%
- **Precision (%)**: 80.15% 94.37% 94.91% 73.93%
- **Predicting level**: Unqualified Good Good Unqualified

Figure 1: The Forecasting Results of Vietnam’s Retail Sales Industry by Four Proposed Models
Table 2: Forecasted Value of Vietnam’s Retail Sales Industry from 2013-2019

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Value of retail sales (Bilion VND)</td>
<td>2,658,737.70</td>
<td>2,948,344.80</td>
<td>3,237,951.90</td>
<td>3,527,559.00</td>
<td>3,817,166.10</td>
<td>4,106,773.20</td>
<td>4,396,380.30</td>
</tr>
</tbody>
</table>

4. Conclusions

This paper predicted the future development of Vietnam’s retail sales industry by applying the grey forecasting model GM(1,1) and several traditional time series models based on the annual data of Vietnam’s retail sales from 1997 to 2012. The results show that the performance of the ARIMA (0,2,0) model is better than other three models. Thus, the ARIMA (0,2,0) model has utilized to predict value of Vietnam retail sales from 2013 to 2019. The forecasting values indicated that, Vietnam’s retail sales industry will grow to Billion VND 4,396,380.30 in 2019. The trend of this industry would quickly increase in the next few years.

References

Ying-Fang Huang, Chia-Nan Wang, Hoang-Sa Dang, Shun-Te Lai., (2015)., Predicting the trend of Taiwan Electronic Paper Industry by an Effective combined Grey Model. Sustainability, 7,10664-10683