

# The Stock Analysis and Forecast Base on the Company of China Duty Free Group

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**Abstract.** China Duty Free Group is crucial to the duty-free market in China. The study base on heterogeneous autoregressive (HAR) theory and establishes the HAR-RV model to analyse the volatility for China Duty-Free Group on market by combining structural destruction and weekday effects, thereby establishing new heterogeneous autoregressive (HAR) models. It shows that the weekday effect contained much predictive information about the duty-free market forecast. Moreover, we apply regression analysis to predict the future market. According to the survey, the phenomenon we found is that the Day-of-the-week effect has a significantly negative influence on duty-free market futures' price volatility, moreover stock price has grown rapidly after mid-2020.

**Keywords:** Price, volatility, change.

## 1. Introduction

China's duty-free industry originated in 1980 and has a 40-year history of development. The first duty-free shop in China was a duty-free shop in Shenzhen, which was established in January 1980. In recent years, with the relaxation of tax-free policies and the liberalization of the qualifications of tax-free operators, China's tax-free market has gradually developed due to the return of overseas consumption. At the same time, with the popularization of smartphones, duty-free companies are also actively deploying online business to increase passenger flow. Among the six companies with duty-free licenses, China Duty Free Group occupies an absolute dominance. China Duty Free Group is a duty-free company with complete domestic licenses. It has the airport, port, port entry and exit duty-free licenses, Hainan outlying island duty-free licenses, and city departure tax-free licenses, covering the entire business form of the duty-free industry.

The China Duty Free Group are mainly based on online sales and offline stores, with an efficient trade system to form a nationwide duty-free distribution system. Sales channels cover major domestic hub airports such as Beijing Airport, Shanghai Airport, Guangzhou Airport, Hangzhou Airport, Asia-Pacific international airports such as Hong Kong Airport and Macau Airport, and International Duty-Free City, providing tax-free goods services for nearly 200 million domestic and foreign tourists every year. The company has established long-term cooperative relationships with about 300 world-class luxury brands around the world.

Because of its high dependence on the characteristics of import goods, which means that it can be influenced by the government's import policy. Moreover, as a company that for selling duty-free goods, it will also be very sensitive to transportation conditions, International relationship, and exchange rates. Because of its sensitivity and internationality, in order to avoid great losses, it becomes particularly important to analyze the future market. Therefore, it is of great significance to improve the forecasting ability for the price volatility of China Duty Free Group for the duty-free market. The main purpose of this essay is the research the volatility forecasting of China Duty Free Group.

In this paper, several HAR-type models are used for volatility forecasting in the China Duty Free Group's market. The study include regression analysis and the day-of-the-week effect to predict the future market for Three Squirrels.

## 2. background

The HAR type model has attracted much in-depth research due to its high prediction accuracy, which contributes to its rapid development. Andersen and Bollerslev (1998) [1] proposed the use of Realized based on high-frequency data Volatility (RV), as a surrogate variable for volatility, is the first study of problems related to forecasting.

Andersen, Bollerslev and Huang [2] decomposed RV into continuous sample path variance and discontinuous jump variance, and proposed HAR-RV model with jump variance (HAR-RV-J model) and continuous sample path variance and non-jump Poor performance (HAR-CJ model), therefore, improving the prediction accuracy of the model.

According to the research that comes from Corsi [3] who proposed a heterogeneous autoregressive model with realized volatility. Besides that, Andersen, Bollerslev, and Huang decomposed the RV into continuous sample path variance and discontinuous jump variance [1,2]. The proposed the HAR-RV model with jump variance (HAR-RV-J model) and the HAR model with continuous sample path variance and jump variance (HAR-CJ model), the HAR-CJ model with the day-of-the-week effect (HAR-CJ-SW model), the HAR-RV model with historical trading volume and volatility of China Duty Free Group. Both improving the accuracy of the prediction for the model.

After that, 5-minute high-frequency data is applied between January 2<sup>nd</sup> 2018 to April 2<sup>nd</sup> 2021, and then the close price is used to calculate the volatility by using the HAR-RV-model to forecasting the China Duty Free Group's stock volatility. Two graphs of price change over time and RV change over time are made. It has been shown that the stock price is kept constant before June 2020 and after that has a sharply increase and gradually fluctuate decline, what's more, some significant changes in RV are concentrated after 2020, and then the linear regression is used to consider factors like day-of-the-week effect. Since the day of the week, the effect is extremely common in financial markets. Considering the day of the week, the effect can improve the accuracy of our forecasting model and provide some enlightenment for the mechanism of Duty-Free's future market. This article considers the day of the week effect. Therefore, high-frequency data is used to make predictions. Including more market information, and can more accurately reflect the daily, weekly and monthly information in the market. In order to improve the prediction accuracy, some HAR models with better performance are proposed. Based on the 5-minute high-frequency data of the duty-free futures market, several HAR-type models are proposed, the weekday effect of which can improve the accuracy of predicting duty-free futures price fluctuations.

The whole paper is organized as follows: Section 2 describes the sample and data; Section3 introduce the HAR-RV model in our analysis, research includes the day-of-the-week effects, trading volume, and volatility for China Duty Free Group. Section4 is our data analysis. In final, Section5 is our conclusion for this paper.

## 3. data

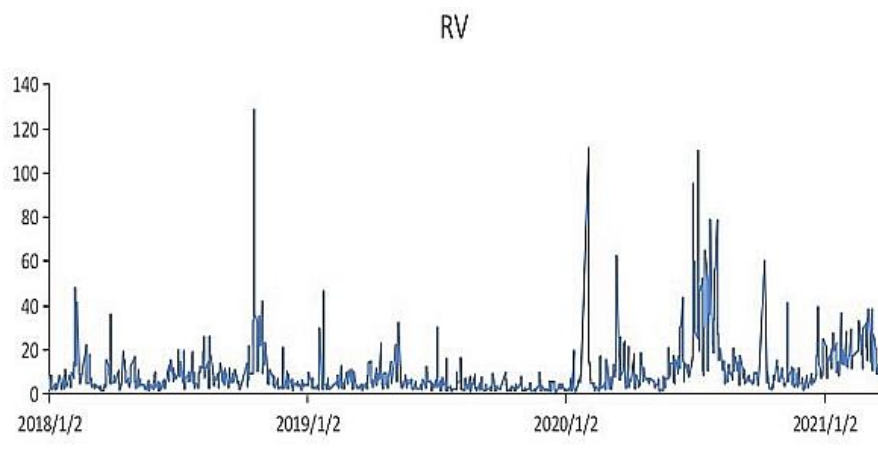
The sampling frequency has an important impact on the volatility prediction in financial markets. If the sampling frequency is too high, it will lead to microscopic noise [4]. If it is too low, it will not contain all the information of the daily volatility [5]. According to the same research[6], the 5-minute sampling frequency is one of the most accurate data. Therefore, the everyday open price, close price and trading volume are collected, then the 5-minute-frequency trading data are selected to chart it out measure the price volatility of the stocks of the China Duty Free Group (CDF) and the RV changed over time. The sample period starts from January 2, 2018, and ends on April 2, 2021, with 37921 items of data on CDF. After calculating the RV and eliminating the vacancy value, the data of nearly

880 trading days are collected from January 2, 2018, to April 2, 2021, which get rid of the weekend days. Fig. 1 shows that the trend of China Duty Free group stock price is a light increase between 50-100RMB in January 2018 to December 2019, after that the price had slightly decreased during the half-year of 2020, and then the volatility sharply and fluctuating increase. After June 2020, the stock price sharply increases to about 250RMB in August 2020 and it's remains fluctuating around 225RMB for about three months and gradually decrease to 180RMB in December 2020. However, from the beginning of 2021, the stock price started to grow rapidly to around 400RMB in February 2021 then decline to 300RMB and remain in slight fluctuation. According to the graph, China Duty Free Group's stock prices continue to rise before 2021, which is closely related to China's development and government policies. As mentioned in the previous article, the Chinese government is continuously reducing restrictions on duty-free industries. In addition, the development of China has also led to the development of tourism. Outbound travel is one of the important leisure options for Chinese people, and the number of outbound tourists is increasing year by year. According to data released by the Ministry of Culture and Tourism, the number of Chinese citizens traveling abroad reached 155 million in 2019, an increase of 3.3% over the same period in 2018. All this has led to the development of the duty-free industry, but with the arrival of the epidemic, the shrinkage of the tourism industry has also had a considerable impact on the duty-free industry. Reflecting the close connection between the duty-free market and the international situation and the tourism industry, because China control of the epidemic had been remarkably effective, after June 2020, the tourism market is basically open, more and more tourist came to Hainan for vacation so it boosts the stock price again, that may be a reason that after June 2020, the price has increased faster than ever.



**Fig. 1** The graph of price change over the time

Fig. 2 shows the change in RV over time. It is clear to find that volatility aggregation and volatility asymmetry exists in the silver futures market, and we can also see the volatility. it over remained between 0-40. However, there is a big fluctuation in around October 2018, and it quickly returns to the original range which is 0-40 and steadily remains in 2019 for a whole year. After 2020, the change in volatility is very significant, and it fluctuating mainly concentrated in the first quarter and the middle of the year, though the RV is finally reduced, it still remains to fluctuate unsteadily.



**Fig. 2** The graph of RV change over time

## 4. methods

### 4.1 HAR-RV model

According to the method for calculating the RV, presented by Andersen and Bollerslev [1], the trading day is divided into M segments, The RV of the trading day is denoted as, which can be expressed

$$RV_h^d = \sum_{t=1}^n r_{t,h}^2 \quad (1)$$

where denotes the logarithmic rate of return for the  $i$ th period of the trading day  $t$ . is magnified 100 times for easy observation; this can be expressed as

$$r_{t,h} = (\ln P_{t,h} + \ln P_{t,h-1}) \times 100 \quad (2)$$

Therefore, the weekly RV and the monthly RV of the trading day denoted as RVtw and RVtm1, respectively, are defined as follow.

$$RV_t^d = \frac{RV_t^d + RV_{t-1}^d + \dots + RV_{t-4}^d}{5} \quad (3)$$

$$RV_t^M = \frac{RV_t^d + RV_{t-1}^d + \dots + RV_{t-21}^d}{22} \quad (4)$$

The average RV from the day to  $(h+H)$  is defined as

$$RV_{h+I} = \frac{1}{I} \sum_{h=1}^I RV_{h+1}^d \quad (5)$$

In addition, Andersen found that the logarithmic form of the HAR model performs better than does the linear HAR model [1]. Therefore, using the logarithmic form to forecast the price volatility of stocks. The logarithmic form of the HAR-RV model is expressed as

$$\ln RV_{t+H} = \beta_0 + \beta_d \ln RV_t^d + \beta_w \ln RV_t^w + \beta_m \ln RV_t^m \quad (6)$$

## 5. sample analysis

According to the following descriptive statistical analysis (Table 2) that forecasting duty-free futures' price volatility at three different horizons (daily, weekly, monthly) of the main variables, the volatility of China Duty Free Group futures' prices ranges from 7.56 to 128.39. The mean is 7.7727 and the Standard deviation is equal to 5.3478. In table1 For RVd, compared to one day and one month, the impact is the largest in a week, reaching the maximum value of 0.062. For RVw, unlike RVd, it has the largest impact in one day, followed by a week, and the smallest in a month. Finally, for RVm, the biggest impact is on one month, and the smallest influence is on one week.

Therefore, according to these data and the 1-day model. Values of  $\beta_0$  and RVd are both equal to negative numbers, which means that they do not have a strong influence on RVd+1, the value of tomorrow. However, in the 1-day model, the value of RVw is equal to 1.2151. It is clearly shown that RVw has a typical influence on RVd+1. One unit of RVw will increase 1.2151 for RVd+1. For the last value of RVm. It just like RVd that does not have a strong influence on RVd+1.

**Table 1.** for RV

| Variable | Mean   | Std.dev | Min    | Max      |
|----------|--------|---------|--------|----------|
| RV       | 7.7727 | 5.3478  | 7.5629 | 128.3891 |

**Table 2.** Descriptive Statistical Analysis

|              | HAR-RV     |            |            |
|--------------|------------|------------|------------|
|              | 1-day      | 1-week     | 1-month    |
| $\beta_0$    | -0.0279*** | -0.1090*** | 0.0640***  |
| $\ln RV_t^d$ | -0.1780*** | 0.047454** | -0.0031*** |
| $\ln RV_t^w$ | 1.2151     | 0.750423   | 0.0153**   |
| $\ln RV_t^m$ | -0.037***  | 0.235066   | 0.9792     |

## 6. conclusion

This research is based on the 5-minute trade data for China Duty Free Group in these three years. The purpose is to study the volatility for the Three Squirrels' market and predicts future data. Base on the HAR-type models. In this research, both the influence that comes from the day-of-the-week effect and regression analysis are considered to estimate Three Squirrels' future market.

Firstly, the study consider the attribute for the China Duty Free Group's production itself and other influences, for example, the influence that comes from the government's policy and historical trading volume. Secondly, based on the HAR-RV models, this paper studies the day of week effects and do the regression analysis. The characteristics of the duty-free market itself are also considered, further factors, such as historical trading volume, price volatility. Both are brought into the models. The improved HAR model in this paper includes the structural fracture and the day of the week effect, thereby significantly improving the effectiveness of the prediction. Therefore, HAR-RV models are built, which is already used in sample analysis and predict the future market for the China Duty Free Group .

However, the paper is still inadequate. We cannot further decompose the volatility component to better capture the characteristics of China Duty Free Group's futures volatility, which will cause a decrease in forecast accuracy to a certain extent. Currently, many researchers consider the impact of leverage, spillover effects and geopolitical risks on price fluctuations. In the future, the leverage effect of the model will be combined with geopolitical risks to predict the price volatility of China Duty Free Group's futures market.

## 7. References

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