

## The Application of R Software in the Calculation of Volatility

CUI Yujie<sup>1,\*</sup>; WEN Zheng<sup>1</sup>; CUI Luyun<sup>1</sup>; TIAN Tian<sup>2</sup>

<sup>1</sup>School of Science, North China Of Technology University, Beijing 100144, China

<sup>2</sup>College of Economics and Business Administration, North China Of Technology University, Beijing 100144, China

\*Corresponding author.

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### Abstract

With a rapid development of the economy, change, as an essential nature, has become the most important feature of financial markets. In this regard, the position of volatility is second to none, since it can reflect changes of indicators of financial markets. Volatility calculation of the real issues, complicated and significant, often relies on computer softwares, among which R software, free and open, belonging to GNU system, is one of the powerful statistical software packages developed rapidly during these years. Combined with some examples for authentication, this paper studies how to use R software in programming in order to implement the calculation of volatility, and analyzes the results while giving suggestions based on this research. The paper illustrates that R software can quickly and easily accomplish calculations of volatility with high accuracy, and this is benefitable for sensitive markets. At the same time, the paper demonstrates the usefulness of R software, which exerts obvious advantages in data processing and computing.

**Key words:** R Software; Volatility; Financial Simulation

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With advances of science and technology, precise calculations of volatility become increasingly vital to economic prosperity, because volatility reflects the fluctuation of asset values. The accurate historical volatility is the premise to correctly reflect the information contained in the past financial data, and provides favorable dependence for financial forecasts.

### 1. R DESCRIPTION

During the most commonly used statistical softwares, such as SPSS, SAS, STAT, R, and etc., R shows powerful statistical analyzing and mapping capabilities. Despite all these, R software is completely free, in comparison to the expensive prices of other softwares.

In actual application, R software also provides a platform for designing and computing, which allows users try the built-in function that comes with its own, or download from the Internet corresponding analysis package. Based on that, users could programme by themselves for a function targeted to solve specific practical problems.

### 2. VOLATILITY

#### 2.1 Definition of Volatility

A variable volatility  $\sigma$  is defined as the variable's standard deviation of continuous compounding rate of return. When volatility is used for option pricing, and the time unit is usually defined as one year, volatility is the standard deviation of one-year continuous compounding rate of return. When volatility is used to control risk, and the time unit is usually one day, this volatility corresponds to the standard deviation of daily continuous compounding rate

of return.

In general,  $\sigma$  is equal to the standard deviation of the variable  $\log\left(\frac{P_t}{P_0}\right)$ , where  $P_t$  is the market price of the variable at time T,  $P_0$  is the current market price of the variable, and the expression  $\log\left(\frac{P_t}{P_0}\right)$  equals to the variable's continuous compounding rate of return at time T, (The return rate here does not correspond to the return rate per unit time). When  $\sigma$  corresponds to the daily volatility, T should be calculated in days; when  $\sigma$  corresponds to the annual volatility, T should be calculated in years.

## 2.2 Trading Days and Calendar Days

Researchers have proved that volatility data are much larger when the exchange starts than those when the exchange is closed. So when volatility is estimated based on historical data, analysts often ignore the number of days that exchange closed, and assume there are 252 trading days in a year.

## 3. THE ESTABLISHMENT OF VOLATILITY MODELS

The "volatility" about warrants we talk about is generally the volatility of targeted stock return, that is, standard deviation in statistics. There are two commonly used volatility: historical volatility and implied volatility. Historical volatility is calculated based on historical prices of the targeted stock, and it reflects the volatility of that stock in the past. Implied volatility takes the market trading price on the warrants into warrant theoretical price model, and is introduced to counter the volatility values. We focus on the former. When we estimate the volatility based on historical data, the observation time interval is usually a fixed time zone (such as day, week, or month).

Definition:

$n+1$ : the number of observations

$P_i$ : the variable price at the end of  $i$ -th time period  
 $i=0, 1, \dots$

$t$ : length of unit time interval

That return of the  $i$ -th interval is defined as

$$u = \log\left(\frac{P_i}{P_{i-1}}\right) \quad (1)$$

Where,  $i=1, 2, \dots, n$

The usual estimator of standard deviation of  $u$  is:

$$s = \sqrt{\frac{\sum u^2}{(n-1)} - \frac{(\sum u)^2}{n(n-1)}} \quad (2)$$

$\sigma$  is the standard deviation of  $u$ , where  $\sigma$  is the volatility of a variable rate. Therefore, the variable  $s$  is the estimated value of  $\sigma$ ,  $\sigma$  is approximately  $a$ :

$$a = \frac{s}{\sqrt{t}} \quad (3)$$

when the unit of measurement is year, the calculated

volatility corresponds to the annual rate of change; when the unit of measurement is day, the calculated volatility corresponds to the daily rate of change.

## 4. THE MODEL SIMULATION

From the model of volatility we can observe that the calculation of volatility is very complicated, and the manual calculation could hardly guarantee accuracy and timeliness of data. Under this circumstance, if we apply the R software's design and computing platforms to the solution process of volatility, it is possible to resolve this problem conveniently. We take the following problem of stock volatility's calculation as an example.

Problem: The following table shows the stock price series in consecutive trading days.

**Table 1**  
**Stock Price Series**

Days	Closing price of the stock	$P/P_{i-1}$	Daily rate of return $u = \ln\left(\frac{P}{P_{i-1}}\right)$
0	20.00		
1	20.10	1.00500	0.00499
2	19.90	0.99005	-0.01000
3	20.00	1.00503	0.00501
4	20.50	1.02500	0.02469
5	20.25	0.98780	-0.01227
6	20.90	1.03210	0.03159
7	20.90	1.00000	0.00000
8	20.90	1.00000	0.00000
9	20.75	0.99282	-0.00720
10	20.75	1.00000	0.00000
11	21.00	1.01205	0.01198
12	21.10	1.00476	0.00475
13	20.90	0.99052	-0.00952
14	20.90	1.00000	0.00000
15	21.25	1.01675	0.01661
16	21.40	1.00706	0.00703
17	21.40	1.00000	0.00000
18	21.25	0.99299	-0.00703
19	21.75	1.02353	0.02326
20	22.00	1.01149	0.01143

The results are as follows:

$$\sum u = 0.09531, \sum u^2 = 0.00326$$

Standard deviation of daily return is estimated as:

$$s = \sqrt{\frac{0.00326}{19} - \frac{0.09531^2}{380}} = 0.01216$$

After this 1.216% has been obtained, we could calculate daily volatility, which means when  $t=1$ , volatility is 1.216%; when we calculate the annual volatility,  $t = \frac{1}{252}$ , according to data given in the above to estimate the volatility:

$$a = \frac{s}{\sqrt{t}} = 0.01216 * \sqrt{252} = 0.193$$

## 5. DESIGN OF R PROGRAMME

```

i=sort.list(p)+1
n=length(p)-1;n
a=p[i]/p[i-1]
a
a[length(a)]=0
a
u=log(a)
u
u[length(u)]=0
u
b=sum(u);b
c=sum(u^2);c
s=sqrt( c/(n-1)-b^2/(n*(n-1)) );s
bdl<-function(t){
s/sqrt(t)
}
bdl=bdl(t);bdl

```

## 6. SUMMARY

The program starts with the practical application of the data,

```
p=c(20.00,20.10,19.90,20.00,20.50,20.25,20.90,20.90,
20.90,20.75,20.75,21.00,21.10,20.90,20.90,21.25,21.40,2
1.40,21.25,21.75,22.00)P
```

When we calculate everyday volatility, 1 replace t and the result is 0.01215933. When we calculate the annual volatility, we replace t with  $\frac{1}{252}$  and the outcome is 0.1930234. Using R software to calculate volatility can save computing time, and simultaneously obtain a more accurate volatility data by setting different parameters.

## CONCLUSION

Volatility is a sensitive indicator to reflect the economic changes in the market. It can be seen from the results of R software programming that it has great expansive space

in the future. It addresses the issue of volatility more conveniently, as long as replacing P's data with the data demanded and replacing the t with the unit time interval length needed, and others do not need to change .

Comparing the results given above with the problem given with the manual calculation, we come to a conclusion that the results of each step are similar because the accuracy is not the same, whereas the R software can calculate other parameters to facilitate the inspection check, and all these fully demonstrated the advantages of the R software.

On the other hand, R's development cycle is short, which means increasingly updating frequency, and a lot of extension packages can be used, which are also constantly updated. Not only could it easily solve the problem in volatility, but also could make outstanding contributions to descriptive statistics and inferential statistics. It could be said that as a member of the field of statistics, mastering R software is equivalent to possess a tremendous asset.

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