

Value at Risk (VaR) using statistical method

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Abstract: The Value at Risk (VaR) is a technique that is used in risk management to measure the amount of risk associated with an investor's or a company's portfolio within a specified time frame. This research concludes that the VaR is an extremely important, but fragile risk measure. It is also important for decision-making process for proper implementation and precision of estimates. It has proven to be an effective and intuitive risk measure with convenient properties when calculated and used appropriately to the market conditions and risk management needs. Here in this paper, we will try to understand how the techniques are working actually by making certain experiments on data. The data is taken from www.yahoofinance.com of Mc Donald's from 1st January 2000 to 31st December 2015 on monthly basis. The data is first tested for Normality with chi-square test and the different characteristics are validated by different graphs. The necessary parameters are estimated by taking the help of Minitab and Excel. The main aim is to calculate the VaR by specifying the confidence intervals, time period, the mean and the standard deviation and the behavior of the VaR using the Anderson-Darling statistic...

Keywords: Value at Risk (VaR), Mc Donald's, Chi square test, Anderson-Darling statistic.

I. INTRODUCTION

Risk is a chance that an actual return on any investment will be lower than the expected return. It can also define as the degree of uncertainty about the future return. There are lots of methods to control the future risk such as: probability of default [16], credit default risk, loss given default, VaR etc. The VaR has become the standard measure in order to measure the risk. Value at risk (VaR) is a part of the evolution of the risk management and it is an accepted methodology for quantifying market risk. VaR is also known as new science of risk management. "It is the maximum loss that a person can occur with (say 97.5%) level of confidence over a holding period of n days". For example, if VaR is Rs 100 at 97.5% confidence level, this means that duration a period there is only 2.5% chance that a person can lose in the next period greater than Rs 100 [7][5]. There are many models which are used to find VaR such as historical Simulations, linear model, quadratic model, but our focus is restricted to a statistical model. VaR measures market risk. VaR can be estimated through parametrically or non-parametrically [3, 1]. Non-parametric model to discuss and estimating the VaR [9]. The number of portfolio strategies for predicting VaR [8]. In 2012 Mc Kinsey report that 85% banks are using historical simulation [10]. The Monte Carlo methods are used approximately 15%. The main aim of risk management is to keep away a portfolio that may suffer greater losses in investment. The VaR is a basic model for modeling the market risk, the Basel Committee (Banking Supervision) recommended. VaR does not satisfy the sub-additively axiom and it is not a coherent risk measure [12]. It means that the VaR is inconsistent with the financial principle that diversification decreases the risk. The coherent risk model is a conditional

value at risk that constitutes the average loss lower the VaR [4]. Rockafellar and Uryasev explained the conditional value at risk for a continuous distribution and defined it for a general distribution [13, 14]. Topaloglou et al. applied multistage Stochastic programming with the conditional VaR to an international portfolio [11]. Stochastic programming is a measure for modeling optimization problems involving unreliability. Deterministic optimization problems are typically formulated by using known parameters [2]. Thomas and Pearson explained the concept of VaR and compute it with the delta normal method, historical simulation, and Monte-Carlo Simulation [15].

The main aim of this paper is to study Chi square test and VaR. The data have taken from Mc Donald's (close price) on monthly basis used in this paper from www.finance.yahoo.com. Calculated the return of the Mc Donald's and different characteristics of data have been showing by plotting various graphs of data vs. time like closing price, returns with the help of Excel. In order to check whether the return of Mc Donald's follows a normal distribution i.e., X follows $N(\mu, \sigma^2)$ by using Chi-square test.

The VaR model assume that the price (return) of a firm follows normal distribution with mean (μ) and standard deviation (σ) but in this paper it is shown that how the return follows normal distribution with mean (μ) and standard deviation (σ). "VaR assesses the potential losses on a portfolio over a given future time period with a given degree of confidence". For example, if a person adopt a 97.5% confidence limit, the VaR is an amount of loss that will be exceeded only one time in a hundred over a given time period and he would need to find "t" such that $P(X < t) = p$.

Note that VaR is a "loss amount". Therefore:

- a negative t (a positive VaR) indicates a loss
- a positive t (a negative VaR) indicates a profit

VaR is a measure of the worst expected loss that a firm may suffer over a period of time that has been specified level of confidence. It is measured in a number of ways, using a statistical model or by computer simulation but our model is based on statistical measure. Every investor thinks that how much I can lose on investment? This is a question that almost every investor who is investing in risky assets at some point in time. VaR provides an answer of above question within reasonable boundaries. Finally, the behavior of VaR is shown by using Anderson-Darling statistic.

1.1. Objectives of the study

- To know how to use chi-square test for normality.
- To know the procedure for calculating the VaR using statistical method.
- To know how the VaR follows a certain distribution with the help of Anderson-Darling statistic.

II. DATA ANALYSIS

Over view

The data have taken from the historical data of prices of Mc Donald’s corporation equity-NYSE of 15 years starting from 1st January 2000 to 31st December 2015. The expected value and standard deviation have been estimated from this historical data. All the calculations are done in Minitab and Excel and different graphs of stock price to analyze its behavior.

Behavior of stock price

Fig. 1 shows some characteristics of stock price

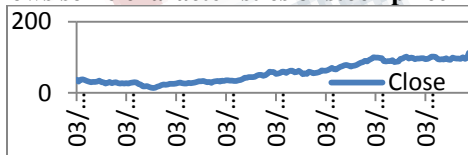


Fig. 1: close price vs. Time

Visualizing the Fig. 1 the following observations have been made about stock price

- Stock prices never reach the zero value
- Stock prices are continuous everywhere
- Stock prices are never negative
- Stock prices show randomness
- stock prices increase in long run
- Stock price follows some distribution

Fig. 2 is plot of return

Return is calculated as: $\{S_t - S_{(t-1)}\} / S_{(t-1)}$

Where S_t is price at time t and $S_{(t-1)}$ is price on previous stock price

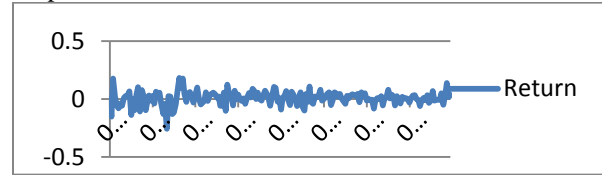


Fig. 2: Returns vs. Time

From the Fig. 2 where x-axis represent days and y-axis represent return, it is shown that the return is showing ups and downs but the return is also increasing with number of days. It is a random walk. By using the Chi-square test we are going to prove how the return follows normal distribution.

III. CHI SQUARE TEST FOR NORMALITY

In this paper, the χ^2 test is using for normality. In order to check whether the return of close price is following a normal distribution with mean (μ) and standard deviation (σ), here we have data of Mc Donald’s on monthly basis from 1st January 2000 to 31st December 2015.

Total number of data is 192(n=192). For test the data specific steps are required that are:

1. Determine specific distribution to be fitted to the data, in this paper the distribution is normal.
2. Hypothesis or estimate the values of each parameters of a selected probability
3. distribution (such as mean and standard deviation)
4. Finally, use χ^2 test statistic

The χ^2 (Chi square) test statistic is

$$\chi^2_{n-k-1} = \sum_{i=1}^n (f_o - f_e)^2 / f_e$$

Where, f_o = Observed frequency, f_e = expected frequency, k = number of parameters estimated from the data and n = number of classes remaining after combination classes. We have a sample of Mc Donald’s and need to find down that X (return) follows normal distribution. By using the sample of Mc Donald’s on monthly basis from 1 January to 31st December 2015, we will show how it works.

The null and alternative hypotheses are as follows:

H_0 : The return follows a normal distribution.

H_1 : The return does not follow a normal distribution

We are going to divide the normal distribution into 8 equal parts and each having equal probability 1/8 as shown in Fig.3.

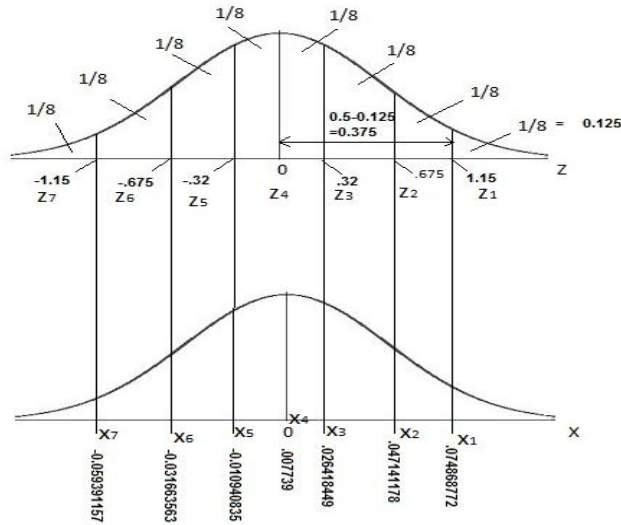


Fig. 3: Normal distribution

So, how we find Z, the upper tail is equal to $1/8=0.125$ and the area from central line Z_4 to $Z_1 = 0.5 - 0.125 = 0.375$ as shown in Fig. 3. See the normal distribution table and find the value of Z's. In the normal table we can easily find the value of $Z_1 = 1.15$. Repeat this process for each one of Z's that is $Z_2, Z_3 \dots \dots Z_7$. Given in the Fig. 3 above.

There are two parameters, the mean μ and the standard deviation σ in the case of the normal distribution, If we don't know the mean and standard deviation of the data then we will use the sample data (return) to calculate the sample mean (μ) and standard deviation (σ).

Mean (μ) = 0.007739 and Standard deviation (σ) = 0.058374

Now we know that: $Z = \frac{X-\mu}{\sigma} \dots \dots (1)$

From Eq (1) the value of X: $X = \mu + z * \sigma \dots \dots (2)$

Now, each one of Z's we would like to find the corresponding X's in our distribution. The upper side of Fig. 3 is a standard normal distribution and lower Fig. 3 is distribution of the given data (return).

From Eq (2) we can easily find X's.

So, for $Z_1 = 1.15$

$X_1 = 0.007739 + 1.15 * 0.058374 = 0.074868772$

(Mean (μ) = 0.007739 and Standard deviation (σ) = 0.058374)

For $Z_2 = 0.675$

$X_2 = 0.007739 + 0.675 * 0.058374 = 0.047141178$

So, we will do the same for all X'S and find the values of $X_3, X_4 \dots \dots X_7$ given in the above Fig. 3.

The idea of this test is to find that the data (return) is following normal distribution. Sort the data and calculate

how many are fall in the 8 intervals i.e. the observed frequency.

Now we will calculate expected frequency

We know that

$$H_0 = p_1 = p_2 \dots \dots p_8 = \frac{1}{8} = 0.125$$

$H_1 =$ Aleast one of the probabilities is not equal to $\frac{1}{8} = 0.125$

Now remember that for goodness of fit the expected value is

$$E_1 = n * p_1 = 192 * 0.125 = 24$$

$$E_2 = n * p_2 = 192 * 0.125 = 24$$

All the expected frequencies are same because of our null hypothesis.

We are going to do chi square test

The χ^2 (Chi square) test statistic is:

$$\chi^2_{n-k-1} = \sum_{i=1}^n ((f_o - f_e)^2 / f_e)$$

Table 1: Chi square test

INTERVALS	f_o	f_e	$(f_o - f_e)^2$	$(f_o - f_e)^2 / f_e$
≤ -0.059391157	17	24	49	2.0416667
-0.059391157 to -0.031663563	23	24	1	0.0416666
-0.031663563 to -0.010940835	21	24	9	0.375
-0.010940835 to 0.007739	29	24	25	1.0416666
0.007739 to 0.026418449	28	24	16	0.6666666
0.026418449 to 0.047141178	35	24	121	5.0416667
0.047141178 to 0.074868772	24	24	0	0
≥ 0.074868772	25	24	1	0.0416667
TOTAL	192	192		8.9124993

Note: The minimum value of expected frequency should be greater or equal to 5.

$$\text{So, } \chi^2_{\text{calculated}} = \frac{\sum_{i=1}^n (f_o - f_e)^2}{f_e} = 8.9124993$$

$$\chi^2_{\text{calculated}} = 8.9124993$$

Now we have to find rejection region

To find the critical value, we need degree of freedom and confidence interval.

The degree of freedom is $n - k - 1$

Where n is total number of intervals (classes) and k is the number of parameters we estimated. Here we estimated mean (μ) and standard deviation (σ).

That means $k = 2$

We know that there are 8 class intervals as shown in table 1 i.e. $n=8$.

So degree of freedom is

$$8 - 2 - 1 = 5$$

Suppose confidence interval is 95%.

With $\alpha = 0.05$ and degree of freedom is 5.

We can see the chi square distribution table and find the value of it.

$$\chi^2_{5,0.05} = 11.0705$$

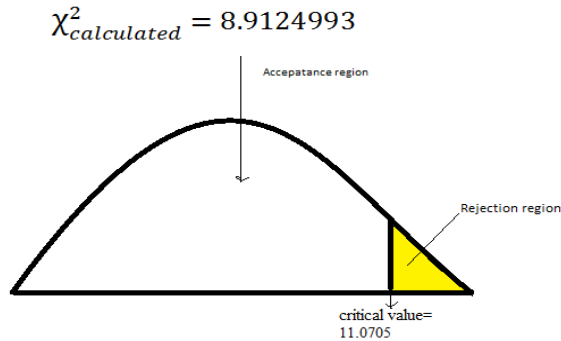


Fig. 4: Rejection level

We can see that X does not fall in the rejection region as shown in Fig. 4.

We fail to reject H_0 that means we have insufficient evidence to reject the null hypothesis.

Therefore the data (return) follows the normal distribution.

IV. VALUE AT RISK (VaR)

Value at risk (VaR) has been developed by JP Morgan and made it available publically in 1994. VaR is defined as “the maximum potential loss expected on a portfolio over a given period of time, using a statistical method to calculate confidence level”. It is used widely in portfolios managers, financial institute, and regulators to forecast potential loss [6]. VaR has main four uses that are: financial reporting, financial control, computing regulatory capital and risk management. Sometimes it is uses in non-financial industry also. It is applied to the portfolio, using methods and statistical methods to measure what is the probability that the value of a certain portfolio will decay below a given value.

E.g. one of my friends asked me a question what’s the maximum amount of money I can lose in MC Donald’s in one month.

First, collect past year’s closing price of MC Donald’s after that find the maximum gain percentage or loss percentage changes in a day by company t day’s price with t-1 day price (return).The maximum gain% and loss% we can calculate with the help of excel

- Maximum loss = 25.6734%
- Maximum gain=18.25726%

So if he is really unlucky the maximum loss he can get is 0.256734 and that happened only once in (15 yrs) that is probability of that happening is $\frac{1}{192} = 0.005208$

e.g. $VaR_{97.5\%} = Rs\ 100$

It means that there is 97.5% of chance that in a normal market Conditions Company will not suffer on the investment loses greater than Rs 100.

Or there is 5% of chance that in a normal market conditions company will lose on the investment more than Rs 100.

Here in this paper our data is following normal distribution

So, we start by finding "t", where

$$P(X < t) = p, \text{ where } X \sim N(\mu, \sigma^2)$$

μ is expected return

σ is standard deviation of return

Standardizing gives:

$$P\left(Z < \frac{t-\mu}{\sigma}\right) = p,$$

Where, $p = (1 - \alpha)$ and α is confidence interval

The expected return and standard deviation of return of the MC Donald’s-NYSE is:

$$\mu = 0.007739, \sigma = 0.058374$$

Now we will calculate the VaR over one month with a 97.5% confidence limit for a share price of the MC Donald’s. We know that the return of the share price follows Normal distribution with mean (μ) and standard deviation (σ).

So, we start by finding "t", where

$$P(X < t) = 0.025$$

Where $X \sim N(0.007739, 0.05834^2)$

Standardizing gives:

$$P\left(Z < \frac{t - 0.007739}{0.05834}\right) = 0.025$$

$$\Phi\left(\frac{t - 0.007739}{0.05834}\right) = 0.025$$

Note: $\Phi(-1.96) = 0.025$ is given in normal distribution table.

So,

$$\Phi\left(\frac{t - 0.7739}{5.834}\right) = \Phi(-1.96)$$

Now

$$\frac{t - 0.007739}{0.05834} = -1.96$$

$$t = -1.96 * 0.05834 + 0.007739 = -0.1066074$$

$$t = -10.66074\%$$

Since t is a percentage investment return per month, the 97.5% VaR over one month on a 37.375 (close price at 1/3/2000 shown in table 2) portfolio is $37.375 * 10.66074\% = 3.98445$ this means that, we are 97.5% certain that we will not lose more than 3.98445 over the next month. The same method is used to calculate the values of all 192 months as shown in table 2.

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 11, November 2017

Table 2: Value at risk (VaR)


m/d/v	Close	Return	VaR(97.5%)	m/d/v	Close	Return	VaR(97.5%)
1/3/2000	37.375		3.98445158	1/2/2008	53.58	-0.09048	5.712024705
2/1/2000	31.75	-0.1505	3.38478495	2/1/2008	54.11	0.009892	5.768526521
3/1/2000	37.375	0.177165	3.98445158	3/3/2008	55.77	0.030678	5.945494698
4/3/2000	38.0625	0.018395	4.05774416	4/1/2008	59.58	0.068316	6.351669105
5/1/2000	35.8125	-0.05911	3.81787751	5/1/2008	59.32	-0.00436	6.323950968
6/1/2000	32.9375	-0.08028	3.51138124	6/2/2008	56.22	-0.05226	5.993468135
7/3/2000	31.6875	-0.03795	3.37812199	7/1/2008	59.79	0.063501	6.374056553
8/1/2000	29.8906	-0.05671	3.18656118	8/1/2008	62	0.036963	6.6096588
9/1/2000	30.1875	0.009932	3.21821089	9/2/2008	61.7	-0.00484	6.577676687
10/2/2000	31	0.026915	3.3048294	10/1/2008	57.93	-0.0611	6.175766682
11/1/2000	31.875	0.028226	3.39811088	11/3/2008	58.75	0.014155	6.26318475
12/1/2000	34	0.066667	3.6246516	12/1/2008	62.19	0.058553	6.629914099
1/2/2001	29.35	-0.13676	3.12892719	1/2/2009	58.02	-0.06705	6.183561348
2/1/2001	29.4	0.001704	3.13425756	2/2/2009	52.25	-0.09945	5.57023665
3/1/2001	26.55	-0.09694	2.83042636	3/2/2009	54.57	0.044402	5.817565818
4/2/2001	27.5	0.035782	2.9317035	4/1/2009	53.29	-0.02346	5.681108453
5/1/2001	30.28	0.101091	3.22807218	5/1/2009	58.99	0.106962	6.288770739
6/1/2001	27.06	-0.10634	2.88479614	6/1/2009	57.49	-0.02543	6.128859639
7/2/2001	29.14	0.076866	3.10653953	7/1/2009	55.06	-0.04227	5.869803551
8/1/2001	30.03	0.030542	3.20142033	8/3/2009	56.24	0.021431	5.995600389
9/4/2001	27.14	-0.09624	2.89332473	9/1/2009	57.07	0.014758	6.084084318
10/1/2001	26.07	-0.03943	2.77925492	10/1/2009	58.61	0.026984	6.248259821
11/1/2001	26.84	0.029536	2.86134262	11/2/2009	63.25	0.079167	6.74291805
12/3/2001	26.47	-0.01379	2.82189777	12/1/2009	62.44	-0.01281	6.656565949
1/2/2002	27.18	0.026823	2.89758913	1/4/2010	62.43	-0.00016	6.655499982
2/1/2002	26.1	-0.03974	2.78245314	2/1/2010	63.85	0.022745	6.806882277
3/1/2002	27.75	0.063218	2.95835535	3/1/2010	66.72	0.044949	7.112845835
4/1/2002	28.4	0.023423	3.02765016	4/1/2010	70.59	0.058004	7.52541594
5/1/2002	29.94	0.054225	3.19182566	5/3/2010	66.87	-0.0527	7.128837158
6/3/2002	28.45	-0.04977	3.03298064	6/1/2010	65.87	-0.01495	7.022229758
7/1/2002	24.75	-0.13005	2.63853315	7/1/2010	69.73	0.0586	7.433734322
8/1/2002	23.76	-0.04	2.53299182	8/2/2010	73.06	0.047756	7.788736431
9/3/2002	17.66	-0.25673	1.88268668	9/1/2010	74.51	0.019847	7.943317587
10/1/2002	18.11	0.025481	1.93066012	10/1/2010	77.77	0.043752	8.290857178
11/1/2002	18.5	0.021535	1.97223469	11/1/2010	78.3	0.006815	8.34735974
12/2/2002	16.08	-0.13081	1.71424699	12/1/2010	76.76	-0.01967	8.183184237
1/2/2003	14.24	-0.11443	1.51808938	1/3/2011	73.67	-0.04026	7.853766945

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12/2/2002	16.08	-0.13081	1.71424699	12/1/2010	76.76	-0.01967	8.183184237
1/2/2003	14.24	-0.11443	1.51808938	1/3/2011	73.67	-0.04026	7.853766945

4/3/2006	34.57	0.006112	3.68541782	4/1/2014	101.38	0.034173	10.80785789
5/1/2006	33.17	-0.0405	3.53616724	5/1/2014	101.43	0.000493	10.81318838
6/1/2006	33.6	0.012964	3.58200843	6/2/2014	100.74	-0.0068	10.73962926
7/3/2006	35.39	0.053274	3.77283578	7/1/2014	94.56	-0.06135	10.08079553
8/1/2006	35.9	0.014411	3.82720587	8/1/2014	93.72	-0.00888	9.991245655
9/1/2006	39.12	0.089694	4.17048138	9/2/2014	94.81	0.01163	10.10744738
10/2/2006	41.92	0.071575	4.46898199	10/1/2014	93.73	-0.01139	9.992311922
11/1/2006	41.97	0.001193	4.47431268	11/3/2014	96.81	0.03286	10.32066218
12/1/2006	44.33	0.056231	4.72590626	12/1/2014	93.7	-0.03212	9.98911306
1/3/2007	44.35	0.000451	4.72803798	1/2/2015	92.44	-0.01345	9.854788269
2/1/2007	43.69	-0.01488	4.6576772	2/2/2015	98.9	0.069883	10.54347207
3/1/2007	45.05	0.031128	4.80266326	3/2/2015	97.44	-0.01476	10.38782527
4/2/2007	48.28	0.071698	5.14700517	4/1/2015	96.55	-0.00913	10.29294479
5/1/2007	50.55	0.047017	5.38900396	5/1/2015	95.93	-0.00642	10.22684788
2/2/2004	44.2471	-0.12469	4.71706986	6/1/2015	95.07	-0.00896	10.13516552
3/1/2004	44.7371	0.011075	4.76931068	7/1/2015	99.86	0.050384	10.64581507
2/2/2004	45.2272	0.010954	4.82155151	8/3/2015	95.02	-0.04847	10.12983483
3/1/2004	45.7172	0.010835	4.87379233	9/1/2015	98.53	0.03694	10.50402702
4/1/2004	46.2072	0.010719	4.92603315	10/1/2015	112.25	0.139247	11.96668065
5/3/2004	46.6973	0.010605	4.97827398	11/2/2015	114.16	0.017016	12.17030121
12/3/2007	58.91	0.26153	6.28024193	12/1/2015	118.14	0.034863	12.59459813

The table 2 simply shows the value of VaR at 97.5% confidence interval

V. BEHAVIOUR OF VALUE AT RISK (VaR) OF A MCDONALD'S

Fig. 5 shows probability plot of VaR at 95% Confidence interval (CI)

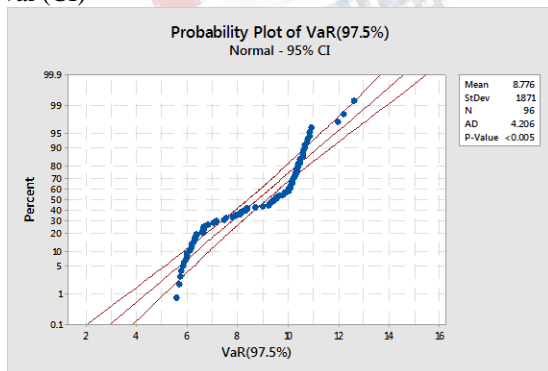


Fig. 5: Probability plot of VaR at 95% CI

Interpreting the results

A distribution with a mean 8.776 of and a standard deviation of 1.871 appears to fit your sample data fairly well:

- The plotted points form a reasonably straight line.
- The plotted points follow the fitted distribution line fairly closely.
- The p-value for the Anderson-Darling test is below 0.005

5.1 Fitted distribution line

Use to determine how well sample data follows a specific distribution. Minitab generates a fitted distribution line using parameter estimates derived from a sample or user inputted historical values. These distribution lines are generally overlaid with the actual data so you can directly compare the empirical data to the hypothesized distribution. Fitted distribution lines can appear in Histograms, Probability Plots, and Empirical CDF plots.

Now we will investigate the strength of our VaR of Mc Donald's. As an initial step, you would like to determine if our response data follow a normal distribution. To do this, we generated the following histogram Fig. 6 with the fitted normal distribution.

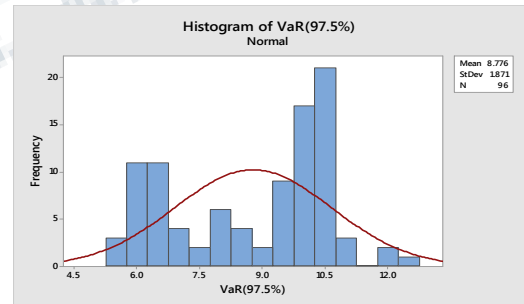


Fig. 6: VaR vs. Frequency

A visual inspection reveals that the fitted normal distribution is not a perfect fit. There are more data than expected to the left of the tail and in the right tail. In order to test for normality we can use the Anderson Darling statistic on Probability Plots to quantitatively test how well the data follow a particular distribution.

5.2 Anderson-Darling statistic

The Anderson-Darling statistic measures how well the data follow a particular distribution. For a specified data set and distribution, the better the distribution fits the data, the

smaller this statistic will be. For above data, we can use the Anderson-Darling statistic to determine whether data meets the assumption of normality for a t-test.

The hypotheses for the Anderson-Darling test are:

H_0 : The data follow a normal distribution

H_1 : The data do not follow a normal distribution

Use the corresponding p-value (when available) to test if the data come from the chosen distribution. If the p-value is less than a chosen alpha (usually 0.05), then reject the null hypothesis that the data come from that distribution. Minitab does not always display a p-value for the Anderson-Darling test because it does not mathematically exist for certain cases but our p-value for the Anderson-Darling test is below 0.005 and our alpha value 0.05. it conclude that we don't have sufficient evidence to reject the null hypothesis H_0 . Therefore the values of VaR(97.5%) follows a normal distribution. We can also use the Anderson-Darling statistic to compare the fit of several distributions to determine which one is the best. However, in order to conclude one distribution is the best, its Anderson-Darling statistic must be substantially lower than the others. When the statistics are close together you should use additional criteria, such as probability plots, to choose between them.

VI. CONCLUSION

VaR is a necessary tool for financial institutes in the last number of years. While the notion of VaR is simple- we are $\alpha\%$ certain that we will not lose more than V amount in the next period. There are so many models to measure the VaR but in this paper, we focused only a statistical model. The return of the MC Donald's follows a normal distribution with mean (0.007739) and standard deviation (0.05834) which we showed with the help of chi square test. The portfolio was a hedge fund then modeling the return using a normal distribution may not be appropriate.

One approach to calculating VaR is a statistical method. The probability distribution of return follows a normal distribution and there is a standard formula for VaR is:

$$P\left(Z < \frac{t-\mu}{\sigma}\right) = p$$

VaR shows a random behavior, but has certain characteristics and tends to follow some pattern. Most probably it follows a normal distribution. On the 1st date (1/3/2000) we are 97.5% certain that we will not lose more than 3.98445 over the next month as shown in table 2 and that information every investor wants to know. It means that

we can easily use the statistical method to calculate the VaR and it reduces the future loss. As per Anderson-Darling statistic test, the VaR follows a normal distribution. The Excel and Minitab are used to draw the different Figures and gave a fairly comparative answer.

REFERENCES

- [1] A Brown, "The Unbearable Lightness of Cross Market Risk", Wilmot Magazine, 2004.
- [2] A. Shapiro, D. Dentcheva, A. Ruszczyński, "Lectures on Stochastic Programming: Modelling and Theory", SIAM-Society for Industrial and Applied Mathematics, 2009.
- [3] Dowd, Kevin, "Measuring Market Risk", John Wiley & Sons, ISBN 9780470013038, 2005.
- [4] G. Pflug, "Some remarks on the value-at-risk and the conditional value-at-risk", in: S. Uryasev (Ed.), Probabilistic Constrained Optimization: Methodology and Applications, Vol. 49 of Non convex Optimization and Its Applications, Springer US, pp. 272–281, 2000.
- [5] Holton, Glyn A, "Value at Risk: Theory and Practice", (<http://valueatrisknet>) second edition, ebook, 2004.
- [6] Hull J: Options, "Futures and other derivatives", Pearson education inc. 5th edition. prentice-Hall, New York Jersey, 2009
- [7] Jorion, Philippe, "Value at Risk: The New Benchmark for Managing Financial Risk", (3rd ed.). Mc Graw Hill, 2006.
- [8] Kuester, Keith; Mittnik, Stefan; Paoletta, Marc, "Value at Risk Prediction: A Comparison of Alternative Strategies", Journal of Financial Econometrics. 4: 53–89, 2006.
- [9] Markovich, N, "Nonparametric analysis of univariate heavy tailed data", Wiley, 2007.
- [10] McKinsey & Company, "McKinsey Working Papers on Risk, Number 32.
- [11] N. Topaloglou, H. Vladimirov, S. A. Zenios, "A dynamic stochastic programming model for international portfolio management", European Journal of Operational Research 185 (3) 1501–1524, 2008

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 11, November 2017

[12] P. Artzner, F. Delbaen, J.-M. Eber, D. Heath, “Coherent measures of risk”, *Mathematical Finance* 9 (3) 203–228, 1999.

[13] R. T. Rockafellar, S. Uryasev, “Optimization of conditional value-at-risk”, *Journal of Risk* 2 (3) 21–42, 2000

[14] R. T. Rockafellar, S. Uryasev, “Conditional value-at-risk for general loss distributions”, *Journal of Banking & Finance* 26 (7) 1443–1471, 2002.

[15] Linsmeier. T and Pearson. N. D, Value at risk, *Financial Analysts journal*, 56(2), 47-67, 2000.

[16] Amir Ahmad Dar, N. Anuradha, “Probability Default in Black Scholes Formula: A Qualitative Study”, *Journal of Business and Economic Development*. Vol. 2, No. 2, 2017, pp. 99-106. doi: 10.11648/j.jbed.20170202.15

