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Stock Valuation using Monte Carlo Simulation and Statistical Analysis

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Abstract - Stock valuation is a tool that helps us make empirical decisions based on stock trading. It is a technique that determines the value of a company's stock by using standard formulas. It values the fair market value of a financial instrument at a particular time. Stock valuation is an important factor for the investors to time their sales or purchase of investments by analyzing the stock value or potential market prices. The stock valuation fundamentals aim to value the "Intrinsic" value of the stock that shows the profitability of the business and its future market value. Stock valuation is usually divided into two groups:

- Absolute Valuation.
- Relative Valuation.

Absolute valuation is used to find the "intrinsic" value of the financial instrument. This method only focuses on the fundamental strengths of the company as the dividends, cash flow, and the growth rate for a single company.

The methods used under Absolute Valuation are:

Dividend Discount Model (DDM): This is one of the basic calculations of the Absolute Valuation model. It calculates the true value of the company by assessing its dividend payout to its shareholders. According to this method, the dividend is the representation of the actual cash flow of the company. It shows the true value of the company's share.

Discounted Cash Flow model (DCF): This method is suitable for companies that do not make regular dividend payments to its shareholders. The method uses the discounted future cash flow of the company to calculate its market value. The method is applicable for companies that pay a dividend or do not pay a dividend to their shareholders.

1. Introduction

The car business is essential for Europe's flourishing. The car area gives immediate and circuitous positions to 13.8 million Europeans, speaking to 6.1% of all out European work. 2.6 million individuals work in direct assembling of engine vehicles, speaking to 8.5 % of European work in assembling. The European is among the world's greatest makers of engine vehicles and the area speaks to the biggest private speculator in innovative work (R&D). To fortify the intensity of the EU car industry and safeguard its worldwide mechanical authority, the European Commission upholds worldwide innovative harmonization and gives subsidizing to R&D.

The statistics and facts shown above very well gives anyone a good reason to invest into the European Automotive sector. Therefore, this paper displays a case study where a middle- class European investor invest his money into the Automotive sector into 3 different classes of vehicle, and how he should distribute his capital to gain the most out of it.

1.1. Statistical Analysis

It is the study of gathering information and revealing examples and patterns. After gathering data, you can analyse it to:

- Sum up the Information
- Discover key proportions of area
- Ascertain proportions of spread
- Make future predictions based on past conduct
- Test an experiment's hypothesis

1.2. Analysis of Variance

- Examination of variance (ANOVA) is an analysis tool used in statistics that splits an observed aggregate variability found inside a data set into two parts: systematic factors and random factors. The systematic factors impact the given informational collection, while the random components don't. Experts utilize the ANOVA test to decide the impact that free factors have on the reliant variable in a relapse study. ANOVA is also called the Fisher analysis of variance, and it is the extension of the t- and z-tests.

- The ANOVA test permits a correlation of multiple gatherings simultaneously to decide if a relationship exists between them. The aftereffect of the ANOVA equation, the F measurement (likewise called the F-proportion), considers the investigation of various gatherings of information to decide the variability among tests and inside examples.

- If no real difference exists between the tested groups, which is called the null hypothesis, the result of the ANOVA's F-ratio statistic will be close to 1.

1.3. Chi- Square Test (χ^2)

- A chi-square ($\chi 2$) statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of events or variables.

- $\chi 2$ depends on the size of the difference between actual and observed values, the degrees of freedom, and the samples size.

- $\chi 2$ can be used to test whether two variables are related or independent from one another or to test the goodness-of-fit between an observed distribution and a theoretical distribution of frequencies.

1.4. Hypothesis Testing

A Hypothesis is a claim or statement about a population parameter.

- Hypothesis testing is used to assess the plausibility of a hypothesis by using sample data.

- The test provides evidence concerning the plausibility of the hypothesis, given the data.

- Statistical analysts test a hypothesis by measuring and examining a random sample of the population being analysed.

1.5. Monte Carlo Simulation

- A Monte Carlo simulation is a model used to foresee the likelihood of various results when the intercession of arbitrary factors is available.

- Monte Carlo simulation help to clarify the effect of risk and uncertainty in expectation and anticipating models.

- A variety of fields utilize Monte Carlo simulations, including finance, engineering, supply chain, and science.

- The basis of a Monte Carlo simulation involves assigning multiple values to an uncertain variable to achieve multiple results and then to average the results to obtain an estimate.

- Monte Carlo simulations assume perfectly efficient markets.

2. Problem Statement

A middle-class European investor wants to invest his money in the Automobile industry for March'20 as it is the most promising market in the European sector. He decides to go with the share market and buy stocks to maximize his profits. He prefers a versatile market in this sector and therefore has chosen the following three companies that is the premium segment, middle segment and the lower segment with respect to the consumers buying it. Rolls-Royce (Premium), Audi (Middle) and Volkswagen (Lower) are considered by him. The Assignment focuses on using Statistical Analysis on the Share market price of the three companies of Feb'20 for the latest trend. Analysis tools like ANOVA, Chi-square test and Monte-Carlo Simulation are used for the analysis.

2.1. Data of Share Price

	Rolls- Royce		***Audi***		***Volkswagen***	
Date	High	Low	High	Low	High	Low
28- Feb- 20	644	620	812	812	152.5	148.58
27- Feb- 20	617.59	600.6	820	812	153.08	148.82
26- Feb- 20	619.8	616.6	820	820	157.5	155.66
25- Feb- 20	630.8	609.4	830	822	159.68	155.3
24- Feb- 20	634.2	628.4	848	834	160.86	157
21- Feb- 20	666.6	645.6	850	850	170.52	166.02
20- Feb- 20	675	664.6	842	842	172.78	169.44
19- Feb- 20	678.4	662.2	840	840	171.4	170.12
18- Feb- 20	679.6	675	842	832	172.18	169.36
17- Feb- 20	683.6	683	856	848	174.4	172.52
14- Feb- 20	686.2	677.2	848	848	173.48	170.46
13- Feb- 20	711	667.4	830	826	172.86	172.54
12- Feb- 20	702.8	699	836	836	173.56	173.14
11- Feb- 20	697	697	826	826	168.58	167.44
10- Feb- 20	693	692	826	826	167.22	164.38
07- Feb- 20	696	687	824	824	169.38	166.42
06- Feb- 20	704.6	693.6	828	826	173.72	170.4
05- Feb- 20	688.8	686.6	826	824	172.28	170.64
04- Feb- 20	685.4	685.4	836	818	167.56	167.08
03- Feb- 20	680.6	675.2	816	816	163.48	162.8

2.2. ANOVA (Analysis of Variance)

Closing price of share of three companies for the month of Feb'20 is considered.

It is observed that mean of closing share price is same for each company is same. To conduct the analysis two different types of hypothesis are assumed.

- H0 (Null Hypothesis) = mean of closing value of shares of all the three companies are same (Xa=Xb=Xc).
- H1 (Alternate Hypothesis) = at least one of them is not equal (Xa!=Xb=Xc).

To get the result, ANOVA is performed as shown below:

		Closing Values of Stocks		
Sr No.	Date	Rolls- Royce	Audi	Volkswagen
1	28- Feb- 20	620	812	148.58
2	27- Feb- 20	600.6	812	148.82
3	26- Feb- 20	616.6	820	155.66

4	25- Feb- 20	609.4	822	155.3
5	24- Feb- 20	628.4	834	157
6	21- Feb- 20	645.6	850	166.02
7	20- Feb- 20	664.6	842	169.44
8	19- Feb- 20	662.2	840	170.12
9	18- Feb- 20	675	832	169.36
10	17- Feb- 20	683	848	172.52
11	14- Feb- 20	677.2	848	170.46
12	13- Feb- 20	667.4	826	172.54
13	12- Feb- 20	699	836	173.14
14	11- Feb- 20	697	826	167.44
15	10- Feb- 20	692	826	164.38
16	07- Feb- 20	687	824	166.42
17	06- Feb- 20	693.6	826	170.4
18	05- Feb- 20	686.6	824	170.64
19	04- Feb- 20	685.4	818	167.08
20	03- Feb- 20	675.2	816	162.8

Average between groups = 552.432

Source	*Sum of Squares*	*f*	*Ms*	*F*
Between group (SSB)	4780221.581	2	2390110.79	
Within group (SSW)	22798.33728	57	399.970829	59.75

For – of numerator 2 and – denominator as 57, the F value from the F table for - = 0.05 is 3.16.

From the calculations it is found that that:

Fcal = 59.75 & Fcritical = 3.16, i.e is **Fcal > Fcritical**.

It is concluded that we do not have enough data to prove the null hypothesis, i.e. the mean of closing value of shares of all the three companies is not the same. Thus, the average profit of the shares per company is not the same.

2.3. CHI Square Test

Now as we know that the average of all the three stocks is not the same, we now take the share price of Rolls Royce as its value lies between the remaining two. Considering the Stock price of Rolls- Royce it is seen that the highest share price is equal to the closing share price for the respective day to get maximum profit to the shareholders.

In this case again two different types of hypothesis are assumed.

- H0 (Null Hypothesis): Highest share price = Closing share price (X_a=X_b)
- H1 (Alternate Hypothesis): Highest price ≠ Closing share price (X_a!=X_b)

	Expected	***Observed***			
Date	Highest	Closing	O-E	$(O-E)^2$	$(O-E)^2/E$
28-Feb-20	644	620	-24	576	0.89441
27-Feb-20	617.59	600.6	-16.99	288.6601	0.467398
26-Feb-20	619.8	616.6	-3.2	10.24	0.016521
25-Feb-20	630.8	609.4	-21.4	457.96	0.725999
24-Feb-20	634.2	628.4	-5.8	33.64	0.053043
21-Feb-20	666.6	645.6	-21	441	0.661566
20-Feb-20	675	664.6	-10.4	108.16	0.160237

19-Feb-20	678.4	662.2	-16.2	262.44	0.386851
18-Feb-20	679.6	675	-4.6	21.16	0.031136
17-Feb-20	683.6	683	-0.6	0.36	0.000527
14-Feb-20	686.2	677.2	-9	81	0.118041
13-Feb-20	711	667.4	-43.6	1900.96	2.673643
12-Feb-20	702.8	699	-3.8	14.44	0.020546
11-Feb-20	697	697	0	0	0
10-Feb-20	693	692	-1	1	0.001443
07-Feb-20	696	687	-9	81	0.116379
06-Feb-20	704.6	693.6	-11	121	0.171729
05-Feb-20	688.8	686.6	-2.2	4.84	0.007027
04-Feb-20	685.4	685.4	0	0	0
03-Feb-20	680.6	675.2	-5.4	29.16	0.042845
				SUM	**6.549341**

X = ∑ (Observed – Expected)2/Expected

Xcal = 6.55

From the chi square table, for the degree of freedom = 19 and p = 0.05, the value of chi square is 27.59

i.e. Xobserved = 27.59

So, Xcalculated < Xobserved, hence we accept the null hypothesis H0. Hence, the null hypothesis is that the highest value of the share price is equal to the closing vale of the share price for that day.

Hence one should consider the closing value of the following data while deciding whether no buy a certain stock at a particular rate.

2.4. Monte Carlo Simulation

The Monte Carlo simulation is used for calculating risk for investing in a particular share. It helps investors assess their portfolios and make investment decisions. However, it is important to remember that the simulator does not take into consideration real world events such as stock market crash or any unexpected events. Reality can differ from the simulator but it is still a powerful tool in understanding the trade – off between risk and upside. As an investor, the price of the share for the respective stock will be most important.

Monte Carlo Simulation is applied to in predicting the future value of the stock price of Rolls- Royce as it best fits into the model. From the simulation, investor will see whether to invest in the company by buying the stocks or not. For this, the share price of Feb'20 of Rolls Royce is used as supporting data. With the use of this data, its Mean & Std. Dev is calculated and 120 simulations are performed to predict whether the share price value increases or decreases for the next four months which are as follows:

Rolls-Royce

Date	High	*Close*
28-Feb-20	644	*620*
27-Feb-20	617.59	*600.6*
26-Feb-20	619.8	*616.6*
25-Feb-20	630.8	*609.4*
24-Feb-20	634.2	*628.4*
21-Feb-20	666.6	*645.6*
20-Feb-20	675	*664.6*
19-Feb-20	678.4	*662.2*
18-Feb-20	679.6	*675*
17-Feb-20	683.6	*683*

14-Feb-20	686.2	*677.2*
13-Feb-20	711	*667.4*
12-Feb-20	702.8	*699*
11-Feb-20	697	*697*
10-Feb-20	693	*692*
07-Feb-20	696	*687*
06-Feb-20	704.6	*693.6*
05-Feb-20	688.8	*686.6*
04-Feb-20	685.4	*685.4*
03-Feb-20	680.6	*675.2*
	AVG	***663.29***
	STD DEV.	***30.86101***

Mean and Std. Deviation is calculated for the closing price of share on each day.

Total 120 trials are taken.

TRIALS	SHARE VALUE	41	695.073389	81	649.9219496
1	669.5765472	42	714.2078941	82	667.7058307
2	673.2376055	43	649.189933	83	682.1989547
3	653.3127113	44	676.1971272	84	663.8521953
4	670.392331	45	650.9616477	85	669.1076945
5	635.4162659	46	659.2898631	86	604.0704062
6	630.6650391	47	697.9096195	87	677.3928703
7	642.0544536	48	656.1491454	88	611.7224941
8	691.5598115	49	649.6798336	89	681.9107549
9	683.0380694	50	631.6243365	90	666.8866689
10	669.7805505	51	676.5127774	91	658.9043293
11	668.0958912	52	702.452002	92	638.7652787
12	680.2246179	53	643.6143478	93	655.6595678
13	625.1799896	54	655.5929243	94	697.2880484
14	633.9995681	55	711.2518081	95	644.4358516
15	655.8225217	56	720.0625891	96	655.6922702
16	664.7011018	57	667.0546802	97	644.6872278
17	686.467714	58	647.9937449	98	654.3072466
18	634.2310132	59	672.4559158	99	631.2271937
19	682.0263429	60	637.9617155	100	654.4703062
20	636.1383624	61	680.6048005	101	663.4607058
21	697.4073596	62	707.5354889	102	614.2006858
22	688.8891311	63	690.5042241	103	655.1956908
23	660.4090997	64	656.4254704	104	722.4156582
24	667.9201045	65	622.5237613	105	668.9646075
25	689.8171083	66	635.654028	106	654.9321561
26	676.2236349	67	664.1135532	107	638.7338151
27	714.1164534	68	669.5902779	108	662.3363971
28	666.6761877	69	610.4262507	109	698.8926295
29	619.9170132	70	638.0727177	110	646.1075694
30	662.1519855	71	642.3759652	111	702.5604046

31	643.2032645	72	690.4808351	112	699.5846764
32	657.3603313	73	668.0043444	113	629.0394555
33	699.0598659	74	610.700389	114	691.4599393
34	655.3364886	75	657.2743714	115	671.2691472
35	676.3024407	76	630.5250704	116	641.8744926
36	661.2202458	77	645.6496166	117	630.8245524
37	632.30157	78	620.9039512	118	685.3185351
38	681.167076	79	696.1447961	119	617.5536494
39	758.4207729	80	636.1644821	120	621.3487622
40	678.6790845				

2.4.1. Monte Carlo Simulation Analysis

MEAN VALUE OF SHARE PRICE	663.29
STD. DEV.	30.86
FIRST SIMULATION	669.57655

AFTER SIMULATION	
MEAN VALUE OF SHARE PRICE	667.60153
STD. DEV.	30.890218
MINIMUM VALUE	593.93279
MAXIMUM VALUE	754.13408
% OF PROFIT	54.166667

The risk of loss is calculated by taking the criteria as;

= COUNTIF(SHAREVALUE,">663.29")/120. i.e. Future share price value should be greater than 663.29 to earn the profit.

First the simulation is obtained by keeping random probability and considering respective values of mean and Standard deviation. For the Simulation analysis, it is concluded that in 54.16% chance the share price of the Rolls-Royce company will increase. From this analysis, it is beneficial for the investor to buy the shares of the company.

3. Conclusions

1. From ANOVA it is concluded that the mean share price of all the three companies is different & hence the profit earned by each of the company is different.
2. From CHI-SQUARE test it is concluded that the highest share value of the Rolls-Royce company is nearly equal to the closing value of the share.
3. From the MONTE-CARLO SIMULATION it is concluded that it is beneficial for the investor to invest in an Automobile company such as Rolls-Royce without incurring any loss.

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