ME317 Statistical Methods in Risk Management

Project Report

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Goal

The goal of this project is to use techniques we learned in class to analyze stock price data during the 2007-08 financial crisis. Probabilistic and statistical techniques that we learned will help us understand what indeed happened from different perspective.

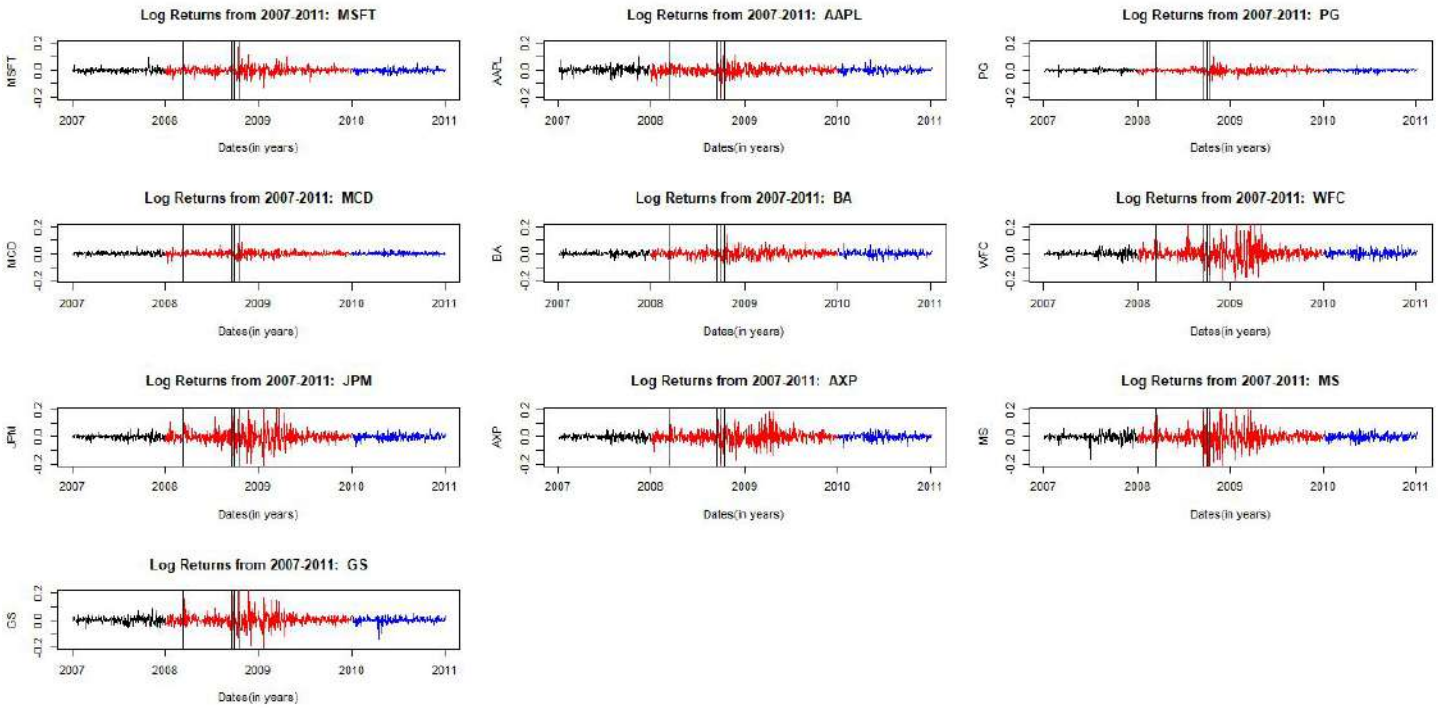
Portfolio Composition

No	Company	Sector	PERMNO	STARTDATE	ENDDATE
1	Microsoft (MSFT)	Technology	76221	2007-01-03	2015-12-31
2	Apple (AAPL)	Technology	11850	2007-01-03	2015-12-31
3	P&G (PG)	Consumer Defensive	18163	2007-01-03	2015-12-31
4	The Boeing Company (BA)	Industrials	13901	2007-01-03	2015-12-31
5	Wells Fargo & Co (WFC)	Financial Services	52978	2007-01-03	2015-12-31
6	McDonald's Corp (MCD)	Consumer Defensive	55976	2007-01-03	2015-12-31
7	JP Morgan Chase & Co (JPM)	Financial Services	69032	2007-01-03	2015-12-31
8	American Express Co (AXP)	Financial Services	86868	2007-01-03	2015-12-31
9	Morgan Stanley (MS)	Financial Services	38703	2007-01-03	2015-12-31
10	The Goldman Sachs Group, Inc. (GS)	Financial Services	70519	2007-01-03	2015-12-31

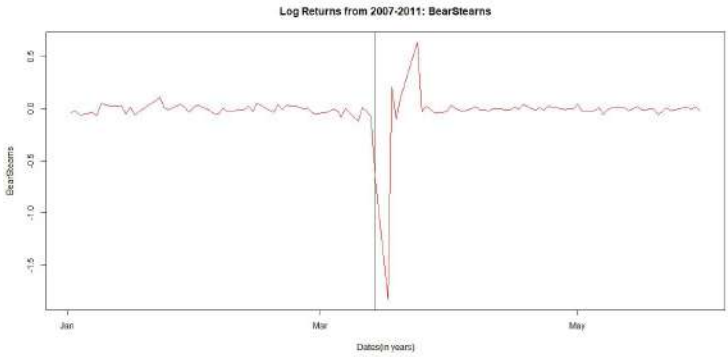
The portfolio comprises of stocks from technology, industrial and financial sectors. I believe that such a diverse portfolio will help me assess the results much better.

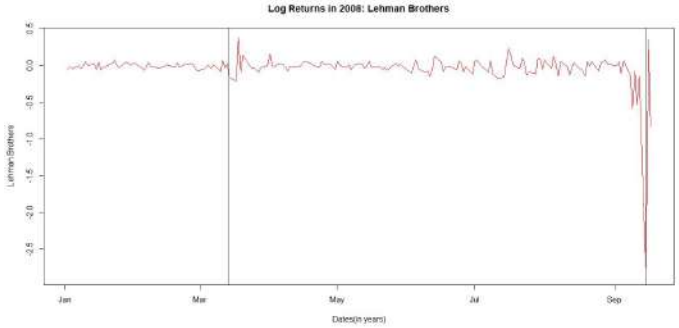
Analysis

Following are the Log Returns graphs from 2007-2011.



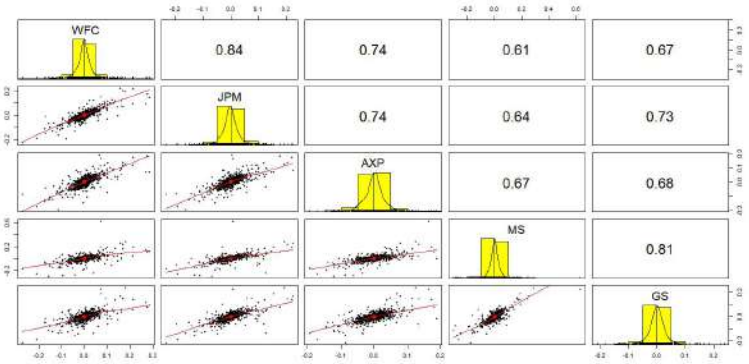
From this figure, we can see that during the year, 2007-2008(black), the markets in the financial sector became volatile when compared to other sectors. On 14th of March 2008, JPM provided Bear Stearns with funding for 28 days. If we look at the log returns of Bear Stearns, the black line indicates the 14ht of March, 2008. As Bear Stearns was a well known hedge fund, the impact of it's falling prices affected all of the stocks. If we look at all the stocks in figure above, we can see that from around the period of March, the market had become more volatile. On 15th of September 2008, heavily exposed to the sub-prime mortgage market, the American bank Lehman Brothers files for



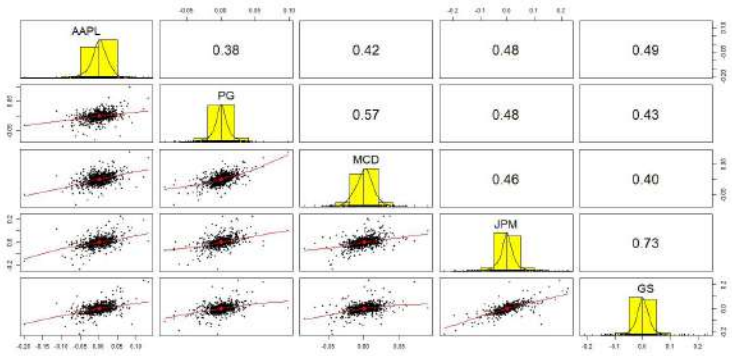


bankruptcy, prompting worldwide financial panic. This can be seen in the huge negative spike of the log returns of the Lehman Brothers. If we observe the stocks from the portfolio, we can see a much variance in the log returns in the stocks of the financial service sectors. We can conclude that the global markets are going to fall hence. To support this argument, if we move further in time period towards the end of September, we see a crazy variance in the log returns of the prices. Even the markets in Europe crashed showing that financial crisis has come.

Interestingly, when compared to financial services sectors, the technology sectors (MSFT and AAPL) do not show much of variance. Similarly, the consumer sector (PG and MCD) show the same trends as that of the technology sector. The industrial sector(BA), also follows the same trends. From the presented stocks and their data, we can say that these companies were not much affected by the crisis.



Financial Sectors
(Pearson Values)



Mixture
(Pearson Values)

From the above diagram, we can see that the financials companies are strongly correlated with pearson values larger that 0.6. However, for the other sectors, we see that the correlation amongst other sectors is not so high. This also tells us that the downfall of one financial organization led to downfall of the other financial organization, just like a domino effect. However, this is not true for the other sectors.

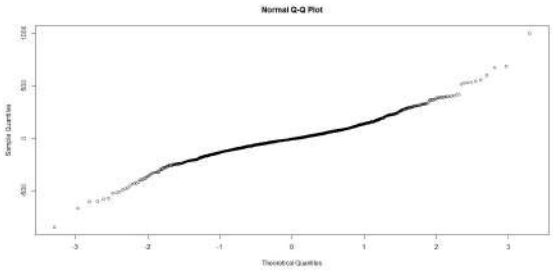
One interesting feature we can notice is the correlation between the consumer stocks(PG and MCD). They both have a fairly high correlation. This might be due to both of the stocks belonging to the same sector.

Value-at-Risk 95%

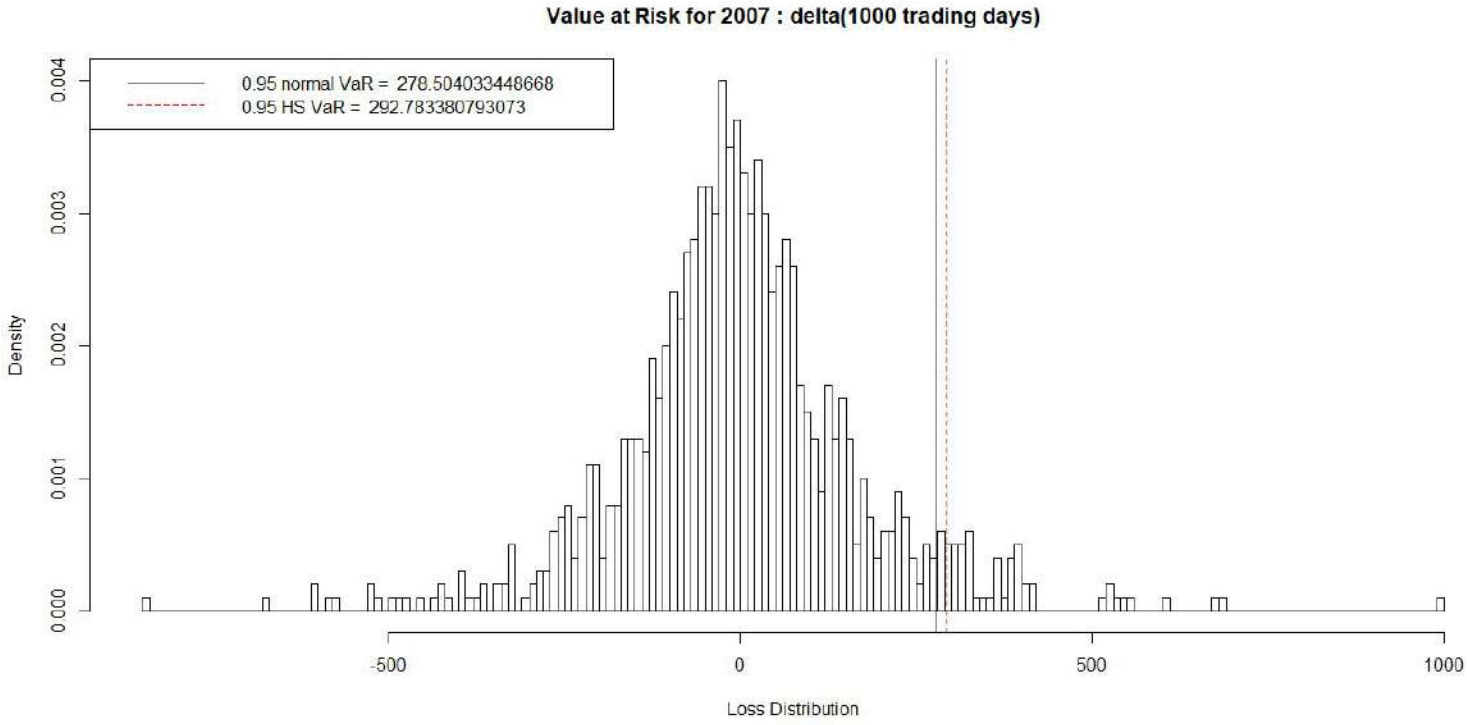
As per the question, I invest 1000$ in each stock at the start of period(Jan, 2007). The following VaR(95%) is for 1000 trading days.

Distribution	Normal Distribution	
Skewness 0.17 Kurtosis 3.22	**Jarque Bera Test**	**Mardia Test**
p-value for daily losses	0.023	0

With the p-values for test of normality for **daily losses** is 2% in 1000 trading day period. The graph of QQNORM shows a slight curvature signifying the presence of high extreme values. However, given the plot, we can assume normal distribution to a fair estimate



Assuming normal distribution, the results are as follows:



VaR Confidence Level	Nonrejection region for number of exceptions N		
	T = 255days	T = 510 days	T = 1000days
99%	N < 7	1 < N < 11	4 < N < 17
97.5%	2 < N < 12	6 < N < 21	15 < N < 36
95%	6 < N < 21	16 < N < 36	37 < N < 65
92.5%	11 < N < 28	27 < N < 51	59 < N < 92
90%	16 < N < 36	38 < N < 65	81 < N < 120

Table 5.1 Model back testing, 95% nonrejection test confidence regions

Source: Jorion (page 136)

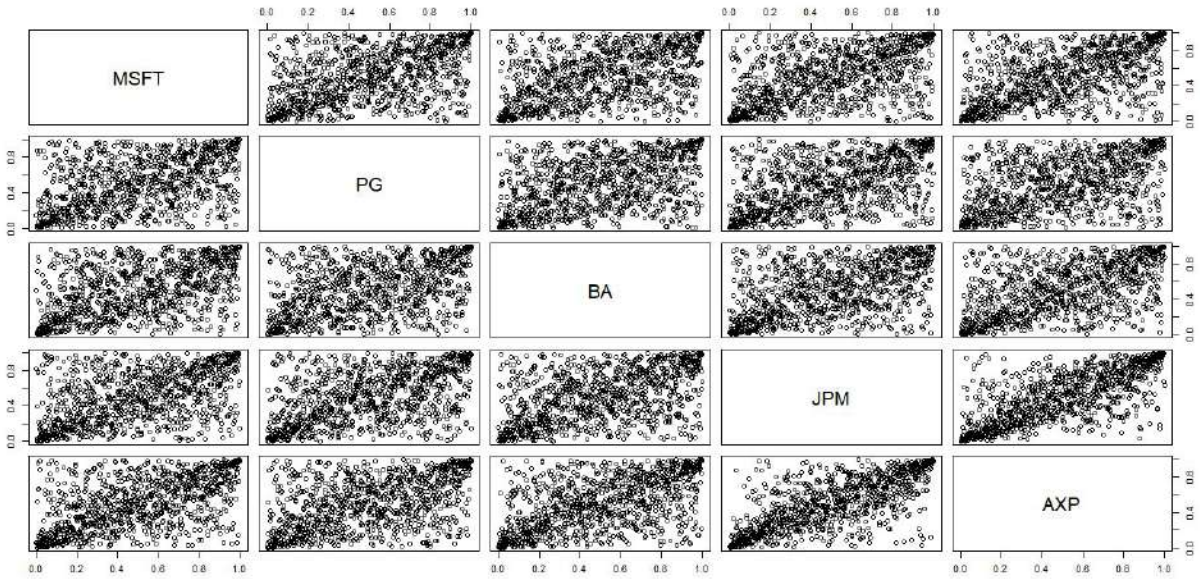
VaR Confidence Level	Nonrejection region for number of exceptions N		
	T = 255 days Start: 2007	T= 510 days Start: 2007	T= 1000 days Start: 2007
99%	7	9	16
97.5%	13	16	30
95%	16	26	59
92.5%	18	38	72
90%	24	48	93

The model holds true for 510 and 1000 trading days, however, it fails at the 255 trading period.

My Predicted VaR(95%) on 2010-12-21 is 278.5. Keeping my composition of the portfolio same, my Predicted VaR(95%) according ot model is 275.2638.
The number of violations for the VaR(95%) during period 2008 to 2012 (1000 trading days) is 62.
Hence, I hold my prediction true since the violations is within the acceptable range.

Copula

The scatter plot for the pseudo copulas show a heavy tail dependence on both the tails.



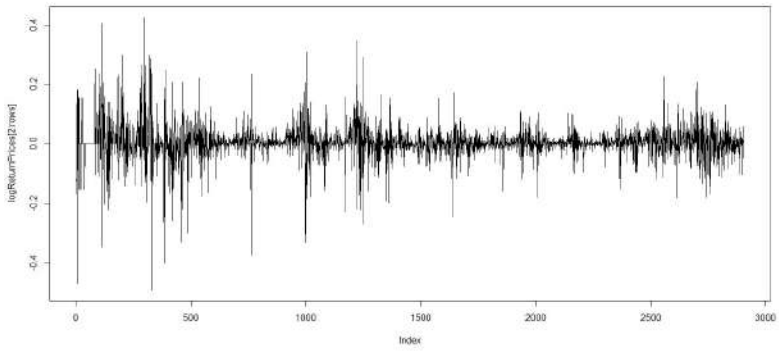
My approach to estimate the best copula amongst the gaussian and t copula is as follows:

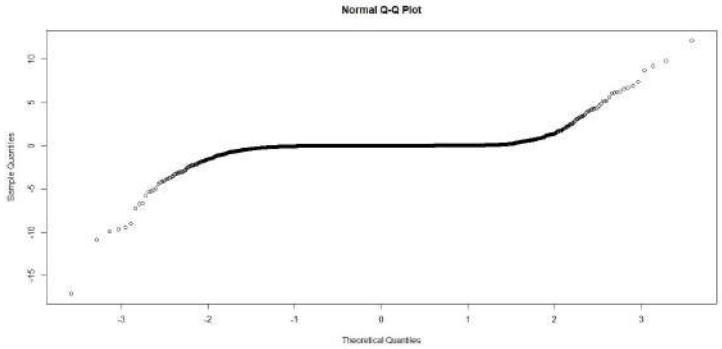
1) Calculate the the Spearman's Rho of the pseudo copula which is made using the empirical data
2) Compare the correlation matrices of both with Spearman's rho and check which one is close to the correlation.

I found out that the gaussian copula best fit the data, which was my guess at first.

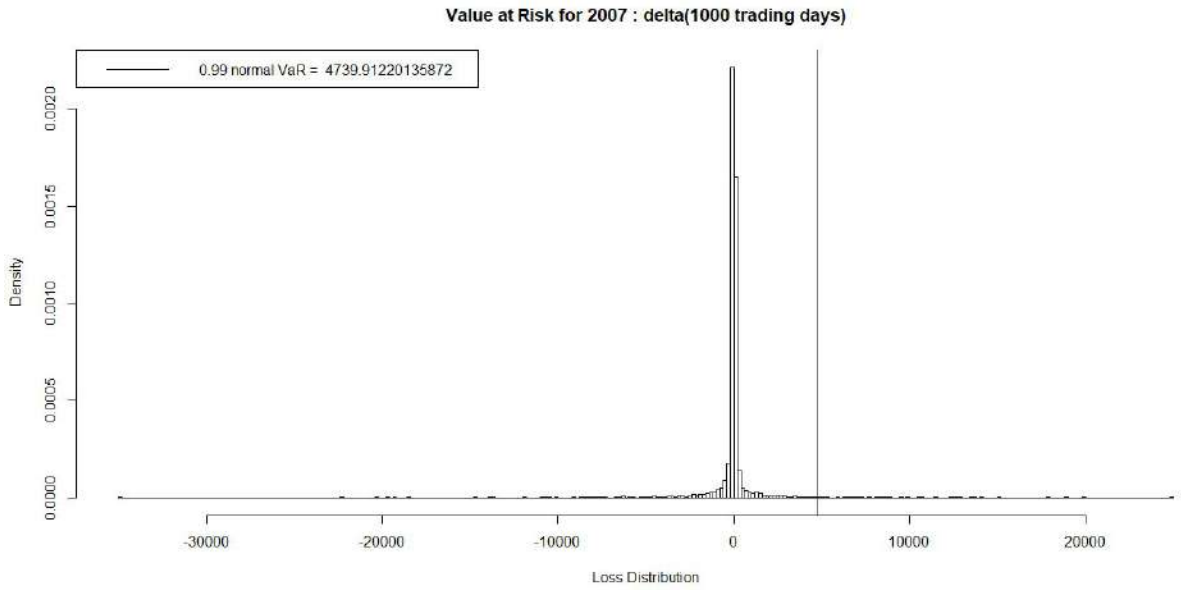
Additional Work

Apart from this, I tried to analyse the Bitcoin Data. Owing to the high volatility and lack of regulation, it produced some really interesting results. On the RIght is daily log returns and on the right is the qqnorm plot.





From the qqnorm test, it is sure that the high values which are experienced by the crypto currency cannot be modelled by normal distribution. In fact the Mardia est and Jarque Bera test gave a p value of 0. Following is the distribution of daily losses:



When estimated to the cauchy Distribution, the cauchy fitness test (cauchy_test()) gave a p-value 0.95. I hope to carry further development into modelling the risk for cryptocurrency space.