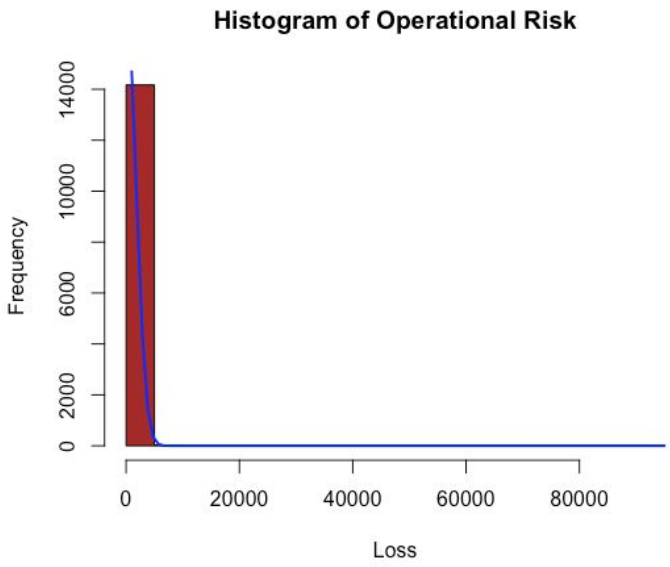
Peng Tian
ADEC 735001
Week 6 Assignment
Mar. 15, 2018

Risk Measurement

I. Operational Risk

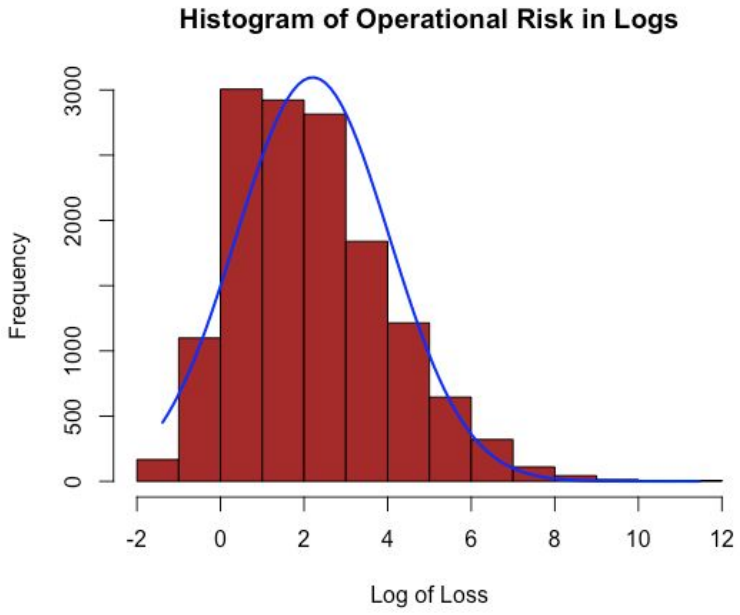
1. Plot a histogram of the losses (of all industries).



Software chosen: RStudio

The total loss distribution is shown above and it looks very skewed to the right and wrong. The normal curve only has the right tail continuing at a large scale. Because the loss variables are of a large scale, so this distribution could not make the variance visible to see on the graph.

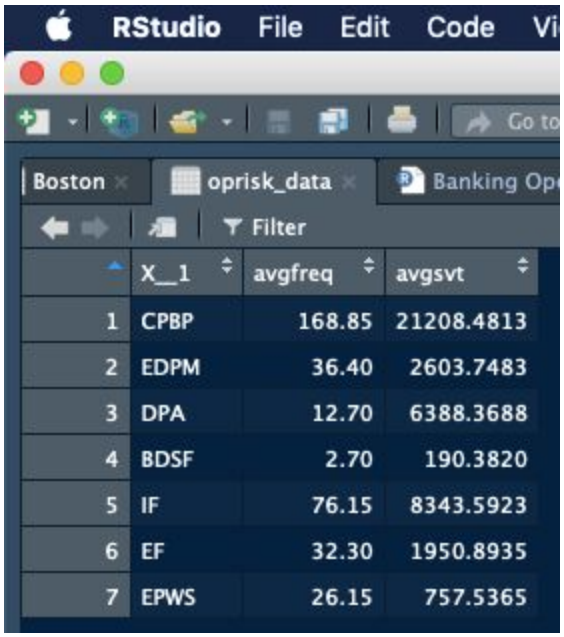
2. Transform the data by taking natural logarithms and plot a histogram.



The log transformation doesn't change the ranking but scale down the numbers of loss, so now the variance is visualized to see from the graph. The natural log calculation maximizes the comparison for visualization, which we could more clearly tell the frequency of event happening from the graph above. Also, the normal curve appears right and centers around 2.206526.

3. Construct a table of average annual frequency and average annual severity.

avgfreq = average annual frequency | avgsvt = average annual severity



	X__1	avgfreq	avgsvt
1	CPBP	168.85	21208.4813
2	EDPM	36.40	2603.7483
3	DPA	12.70	6388.3688
4	BDSF	2.70	190.3820
5	IF	76.15	8343.5923
6	EF	32.30	1950.8935
7	EPWS	26.15	757.5365

4. Curve Fitting

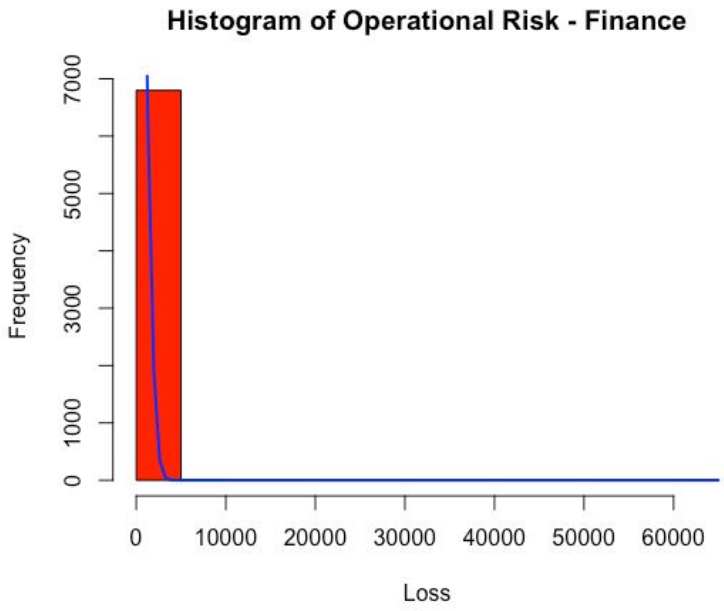
mean(oprisk$log) **μ** = 2.206526, sd(oprisk$log) **σ** = 1.830751

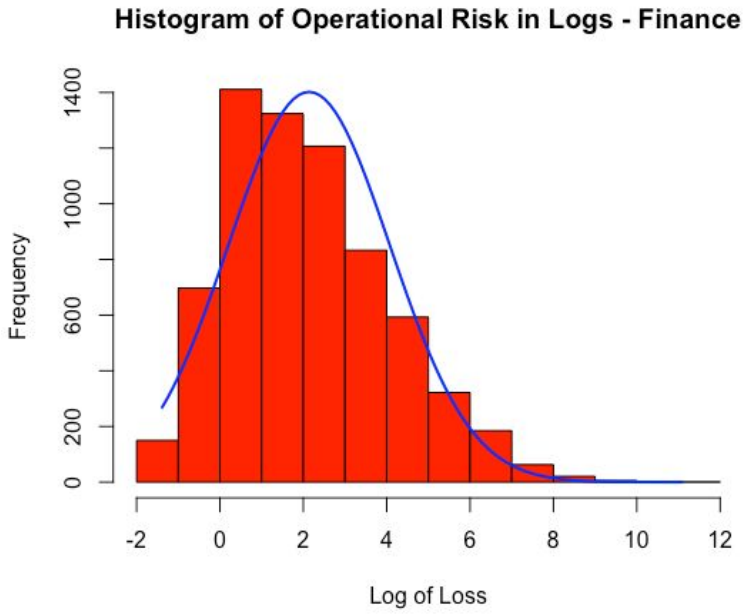
Maximum loss at 0.1%, where confidence level of 99.9% and compute parameters.

Event Type	**Mean μ**	**std σ**	**99.9% percentile**
BDSF	2.817595	1.96024	6.833589
CPBP	2.278546	1.825803	9.216853
DPA	2.808121	2.16189	10.90994
EDPM	2.167699	1.797749	8.509412
EF	1.97233	1.825803	8.856516
EPWS	1.696048	1.464813	7.692019
IF	2.217864	1.894888	8.871878

Looking from the risk chart, obviously, the means of BDSF and DPA are relatively higher, indicating that system failure and the physical damages might result in a higher risk. Also, Damage to physical assets also have the highest 99.9% percentile in accordance. Moreover, external fraud and employment workplace safety processes the least risks.

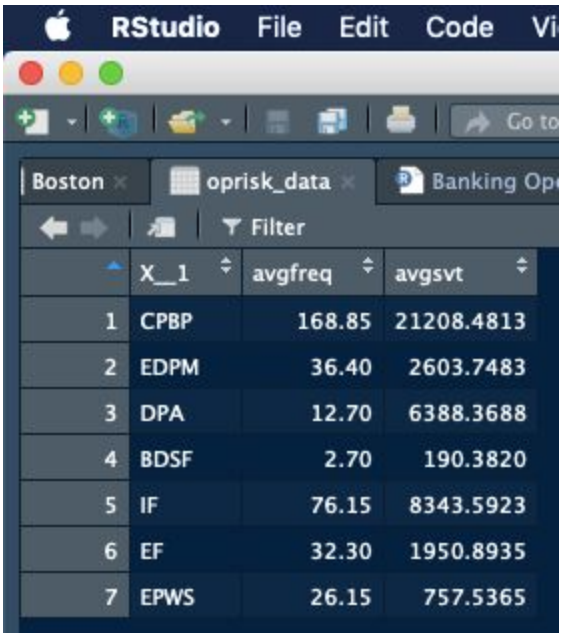
5. “Finance and Insurance” sector (code 52)





I retrieved “52 - Finance and Insurance” from the original database and follow the same analyses. From the two graphs above, it makes more sense to analyze on the log manipulation of losses disregarding all event types, because the data has the same issue of large scale, which could not visualize the variance clearly on a distribution histogram.

NA	avgfreq	avgsvt
CPBP	70.525000000000006	6903.1165000000001
EDPM	13.425000000000001	1154.4292499999999
DPA	6.375	909.64475000000004
BDSF	1.125	52.53275
IF	51.6	6049.9134999999997
EF	24.824999999999999	1259.31475
EPWS	6.375	97.67



	X__1	avgfreq	avgsvt
1	CPBP	168.85	21208.4813
2	EDPM	36.40	2603.7483
3	DPA	12.70	6388.3688
4	BDSF	2.70	190.3820
5	IF	76.15	8343.5923
6	EF	32.30	1950.8935
7	EPWS	26.15	757.5365

The left chart is for the Finance and Insurance sector only, and the right one is for all sectors.

Event Type	**Mean μ**	**std σ**	**99.9% percentile**
BDSF	2.131039	2.050471	5.740213
CPBP	2.196188	2.00029	9.038117
DPA	4.895758	1.928121	8.288425
EDPM	1.84048	1.894573	8.850266
EF	1.916392	2.00029	8.108709
EPWS	1.525854	1.495197	5.557872
IF	2.21252	1.900838	8.869992

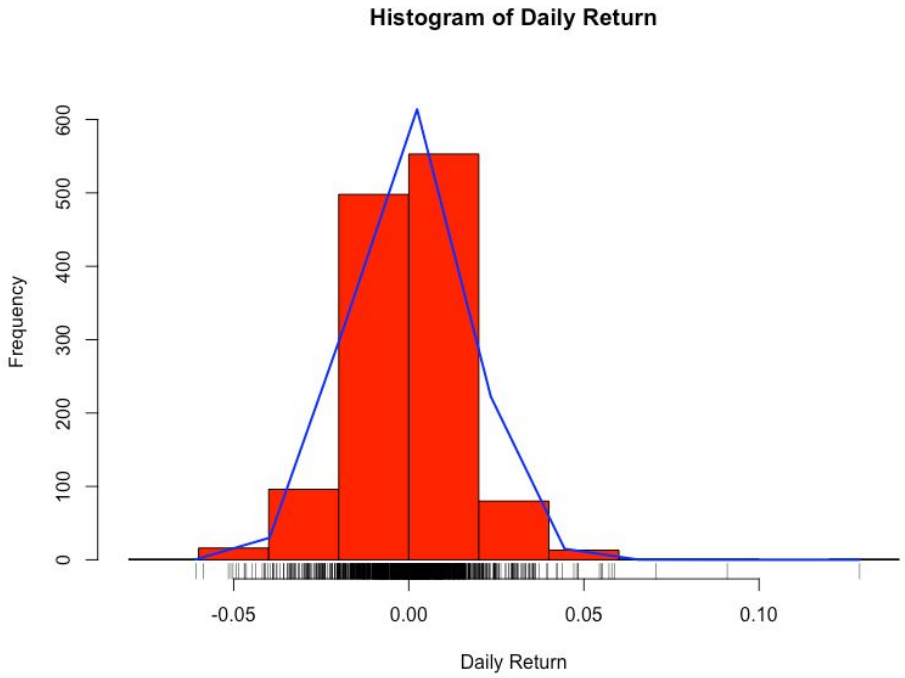
In the financial industry, the highest risk arises from Damage to Physical Assets and its mean has an apparent leading compared to others. Meanwhile, the 999% percentile of CPBP is pretty high, in accordance with all sector cases. However, BDSF - Business Disruption and System Failures doesn't result in a higher risk as in other industry sectors, perhaps because the financial market watches and reflects on the market failure relatively sooner than other industries, so corporations regularly predict operational risks from that perspective in order to avoid.

II. **Credit Risk** (having trouble understanding and calculating the volatility of assets(σV))

	A	A-	A+	AA	AA-	AA+	AAA	B	B-	B+	BB	BB-	BB+	BBB	BBB-	BBB+	CC	CCC	CCC-	CCC+	D	SD
A	0.9594443	0.0239749	0.0100829	0	0.0002241	0	0	0	0	0	0	0	0.0002241	0.0011203	0	0.0049294	0	0	0	0	0	0
A-	0.0153547	0.9510204	0.0001944	0	0.0001944	0	0	0	0	0	0.0003887	0	0.0001944	0.0062196	0.0011662	0.0252672	0	0	0	0	0	0
A+	0.0310881	0.0056131	0.9477547	0.0004318	0.0129534	0	0	0	0	0	0	0	0	0.0004318	0	0.0017271	0	0	0	0	0	0
AA	0.0035088	0	0.0046784	0.9461988	0.0397661	0.0046784	0	0	0	0	0	0	0	0	0	0.0011696	0	0	0	0	0	0
AA-	0.005891	0.0014728	0.033137	0.0147275	0.9440353	0	0	0	0	0	0	0	0	0	0.0007364	0	0	0	0	0	0	0
AA+	0	0	0	0.0462963	0.0092593	0.9351852	0.0092593	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AAA	0	0	0	0.0074074	0.0049383	0.017284	0.9703704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0.9012528	0.0372144	0.0443994	0.0001842	0.0044215	0.0001842	0	0	0	0.0014738	0.002395	0.0011054	0.0062638	0.0003685	0.0007369
B-	0	0	0	0	0	0	0	0.0563951	0.8717287	0.0070033	0	0	0	0.0003686	0	0	0.0066347	0.0180612	0.0003686	0.0342794	0.0033174	0.001843
B+	0	0	0	0	0	0	0	0.0396259	0.0083333	0.9020408	0.0045918	0.0420068	0	0.0001701	0	0	0	0.0001701	0.0001701	0.0027211	0.0001701	0
BB	0	0	0	0	0	0	0	0.0012163	0.0008109	0.0046625	0.9195216	0.0277721	0.0395297	0.0004054	0.0046625	0.0002027	0.0006081	0.0002027	0	0.0004054	0	0
BB-	0	0	0	0	0	0	0	0.0073469	0.0014694	0.0336327	0.0385306	0.9147755	0.0029388	0	0.0004898	0.0001633	0	0.0003265	0	0.0001633	0	0.0001633
BB+	0	0	0	0	0	0	0	0.0015703	0.0002617	0.0023554	0.0251243	0.0094216	0.9199163	0.0031405	0.0374248	0.0002617	0	0.0002617	0	0.0002617	0	0
BBB	0.000218	0.0019619	0	0	0	0	0	0	0	0.000327	0.000545	0.000436	0.0023978	0.9533515	0.0200545	0.0207084	0	0	0	0	0	0
BBB-	0.0001446	0.0001446	0.0001446	0	0	0	0	0.0001446	0.0004339	0.0005785	0.0054961	0.0018802	0.0141741	0.0297946	0.9456176	0.0014463	0	0	0	0	0	0
BBB+	0.000604	0.0188765	0	0	0	0	0	0	0	0	0	0.000604	0.0009061	0.02537	0.0046814	0.948807	0	0.000151	0	0	0	0
CC	0	0	0	0	0	0	0	0.020202	0.0909091	0.010101	0	0	0	0	0	0	0.5050505	0.0808081	0.040404	0.0505051	0.1616162	0.040404
CCC	0	0	0	0	0	0	0	0.0107527	0.0349462	0.0026882	0	0	0	0	0	0	0.0456989	0.7419355	0.0376344	0.0564516	0.0645161	0.0053763
CCC-	0	0	0	0	0	0	0	0	0.0117647	0	0	0	0	0	0	0	0.0470588	0.0117647	0.7764706	0.0588235	0.0941176	0
CCC+	0	0	0	0	0	0	0	0.0142672	0.075227	0.0051881	0	0	0	0	0	0	0.0155642	0.0609598	0.0181582	0.7808042	0.0207523	0.0090791
D	0	0	0	0	0	0	0	0.0588235	0.0180995	0.0271493	0.0045249	0.0090498	0	0	0.0090498	0	0	0.0045249	0.0045249	0.0045249	0.8597285	0
SD	0	0	0	0	0	0	0	0	0.0535714	0.0178571	0	0	0	0	0	0	0	0.0535714	0	0.0892857	0.0178571	0.7678571

III. Value-at-Risk

- Explore the distribution of the daily return



1. I got the open and close prices from Yahoo Finance from 2014-03-03 till 2019-03-04 and calculated the daily returns for 5 years. Here is the histogram of how daily return is distributed with a distribution curve, which is centered at 0 (no gain, no loss).
2. VaR at 99% confidence level: 0.04518121 = 4.518121%

quantile(GMstk$`Daily Return`, probs = 0.99)

VaR at 5% confidence level: -0.02719731 = -2.719731%

quantile(GMstk$`Daily Return`, probs = 0.05)

- Report the 1st percentile, 5th percentile, 10th percentile, and 50th percentile (median) of the distribution of stock returns.

Quantile	1%	5%	10%	50%
Daily Return	-0.0415345510	-0.0271973121	-0.0187108591	0.0008091763

quantile(GMstk$`Daily Return`, probs = c(0.01,0.05,0.10,0.50))

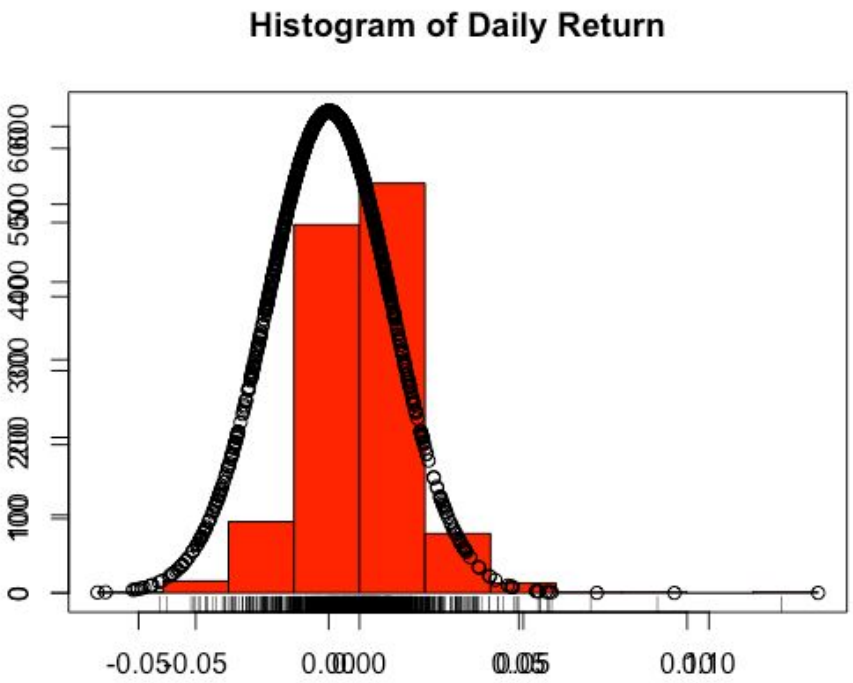
3. How much money, in dollars, can the trader invest in GM and stay within the risk limits of $1 million of daily maximum loss with 99% confidence?

$VaR_{\alpha}@1\% = -4.518121\% \times I \leq -\$1{,}000{,}000$

Therefore, $I \leq \$22{,}133{,}010$, the amount that a trader should invest within the risk limits.

- Suppose the daily return is a normal distribution

1. Plot the histogram with a normal density curve



2. Compute the Value-at-Risk at the 99% confidence level, where VaR is the maximum loss (or minimum returns in this case) = -0.03794967 = -3.794967%

qnorm(0.01, mean = mean(GMstk$`Daily Return`), sd = sd(GMstk$`Daily Return`))

3. How does the investment limit that you would establish for the trader, in dollars, compare to the limit estimated based on the empirical distribution above?

$VaR_{\alpha}@1\% = -3.794967\% \times I \leq -\$1{,}000{,}000$

Therefore, $I \leq \$26{,}350{,}461$, slightly higher than not fitting a normal distribution when compared.