N Stock Portfolio Optimization for Nepalese Stocks using Excel and Python

by

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INTRODUCTION

Nepali stock market has a relatively short history. The modern development of stock market began with the establishment of Securities Exchange Centre (SEC) in 1976, which aimed at facilitating and promoting the growth of capital market. The floor opened for secondary trading of government bond in 1981 and corporate shares in 1984. The full-fledged stock trading operation began in Nepal only after the conversion of Securities Exchange Centre into Nepal Stock Exchange (NEPSE) in 1993.

Objective

The important question is what factors do investors need to consider in making investment decisions so that they may achieve the desired return within a stated risk level. We use Markowitz portfolio selection model to make the decision for investing in stocks.

Markowitz portfolio selection model attempts to maximize portfolio expected return for a given amount of portfolio risk or minimize risk for a given level of expected return, by sensibly choosing the assets. The theory models an assets return-as mean, and the risk associated with the asset-as variance. By combining different assets, it seeks to reduce total variance of portfolio returns.

Data Description

I considered of Commercial Banks (3), Insurance Companies (5) and Hydropower sectors (4) for socks portfolio analysis for time duration of one year (2016/07/03 to 2017/07/03).

Hydropower
Api Power Company Ltd. (API)
Arun Valley Hydropower Development Co. Ltd. (AHPC)
Chilime Hydropower Company Limited (CHCL)
Sanima Mai Hydropower Ltd. (SHPC)

Commercial Bank
Citizen Bank International Limited (CZBIL)
Everest Bank Limited (EBL)
Nepal SBI Bank Limited (SBI)

Insurance
Himalayan General Insurance Co. Ltd (HGI)
Lumbini General Insurance Co. Ltd. (LGIL)
National Life Insurance Co. Ltd. (NLICL)
Nepal Life Insurance Co. Ltd. (NLIC)
Prime Life Insurance Company Limited (PLIC)

Data Analysis Using Excel

As the stock activities takes for 226 days in Nepal. (In case of USA it is 252 days)
Annual Expected Return = Daily return * 226
Annual SD= Daily SD * Sqrt(226)
CV= ER/SD
Portfolio Covariance Should be multiplied by 226

	CHCL	API	AHPC	SHPC	CZBIL	EBL	HGI	LGIL	NLICL	NLIC	SBI	PLIC
ER	-0.54	-0.31	-0.38	0.15	-0.50	-0.70	-0.31	-0.33	-0.30	-0.70	-0.60	0.17
SD	0.310677	0.529054	0.441595	0.38732	0.366037	0.56677	0.802785	0.643281	0.475768	0.418068	0.502427	0.490089
CV	-1.74827	-0.58286	-0.85751	0.380068	-1.36968	-1.23182	-0.38719	-0.50527	-0.63901	-1.66973	-1.20278	0.343396

Annual Expected Return for PLIC is highest and lowest for EBL and NLIC. Risk is high for HGI and low for CHCL.

Correlation Matrix

	CHCL	*API*	*AHPC*	*SHPC*	*CZBIL*	*EBL*	*HGI*	*LGIL*	*NLICL*	*NLIC*	*SBI*	*PLIC*
CHCL	1											
API	0.482651	1										
AHPC	0.469331	0.495565	1									
SHPC	0.483676	0.528183	0.423177	1								
CZBIL	0.407527	0.292779	0.319196	0.427455	1							
EBL	0.301812	0.201516	0.201122	0.244661	0.264706	1						
HGI	0.305875	0.312397	0.288575	0.329576	0.367085	0.226046	1					
LGIL	0.377343	0.280489	0.247567	0.295339	0.322128	0.228269	0.394197	1				
NLICL	0.426202	0.375974	0.289819	0.445988	0.37648	0.319235	0.368876	0.3774	1			
NLIC	0.490855	0.399679	0.371466	0.483946	0.432694	0.275437	0.428846	0.422649	0.578096	1		
SBI	0.302766	0.258207	0.349748	0.239504	0.40627	0.236637	0.318036	0.252409	0.339993	0.386428	1	
PLIC	0.544206	0.482532	0.423726	0.512533	0.393198	0.289547	0.483789	0.512407	0.600579	0.650311	0.387443	1

The correlation between NLIC and PLIC is highest and the correlation between AHPC and EBL is lowest.

Covariance Matrix

	CHCL	*API*	*AHPC*	*SHPC*	*CZBIL*	*EBL*	*HGI*	*LGIL*	*NLICL*	*NLIC*	*SBI*	*PLIC*
CHCL	0.000427	0.000351	0.000285	0.000258	0.000205	0.000235	0.000338	0.000334	0.000279	0.000282	0.000209	0.000367
API	0.000351	0.001238	0.000512	0.000479	0.000251	0.000267	0.000587	0.000422	0.000419	0.000391	0.000304	0.000554
AHPC	0.000285	0.000512	0.000863	0.00032	0.000228	0.000223	0.000453	0.000311	0.000269	0.000303	0.000343	0.000406
SHPC	0.000258	0.000479	0.00032	0.000664	0.000268	0.000238	0.000453	0.000326	0.000364	0.000347	0.000206	0.00043
CZBIL	0.000205	0.000251	0.000228	0.000268	0.000593	0.000243	0.000477	0.000336	0.00029	0.000293	0.000331	0.000312
EBL	0.000235	0.000267	0.000223	0.000238	0.000243	0.001421	0.000455	0.000368	0.000381	0.000289	0.000298	0.000356
HGI	0.000338	0.000587	0.000453	0.000453	0.000477	0.000455	0.002852	0.000901	0.000623	0.000637	0.000568	0.000842
LGIL	0.000334	0.000422	0.000311	0.000326	0.000336	0.000368	0.000901	0.001831	0.000511	0.000503	0.000361	0.000715
NLICL	0.000279	0.000419	0.000269	0.000364	0.00029	0.000381	0.000623	0.000511	0.001002	0.000509	0.00036	0.00062
NLIC	0.000282	0.000391	0.000303	0.000347	0.000293	0.000289	0.000637	0.000503	0.000509	0.000773	0.000359	0.00059
SBI	0.000209	0.000304	0.000343	0.000206	0.000331	0.000298	0.000568	0.000361	0.00036	0.000359	0.001117	0.000422
PLIC	0.000367	0.000554	0.000406	0.00043	0.000312	0.000356	0.000842	0.000715	0.00062	0.00059	0.000422	0.001063

Maximum Return

w1	0
w2	0
w3	0
w4	0
w5	0
w6	0
w7	0
w8	0
w9	0
w10	0
w11	0
w12	1
Sum	1
ER Portfolio	0.168295
Var Portfolio	0.240187
Sd Portfolio	0.490089
CV Portfolio	0.343396

Investing 100% on PLIC gives maximum return of 16.8% with risk of 49%

Minimum Risk

w1	0.420058
w2	0
w3	0.065457
w4	0.128986
w5	0.223727
w6	0.06062
w7	0
w8	0
w9	0.007713
w10	0.027637
w11	0.065802
w12	0
Sum	1
ER Portfolio	-0.44984
Var Portfolio	0.071215
Sd Portfolio	0.266861
CV Portfolio	-1.68568

Investing as above weight is of minimum risk of 26.68% and Portfolio return is -44.98%
(I was not able to find the meaning of negative value of return)

Equal Weight

w1	0.08333
w2	0.08333
w3	0.08333
w4	0.08333
w5	0.08333
w6	0.08333
w7	0.08333
w8	0.08333
w9	0.08333
w10	0.08333
w11	0.08333
w12	0.08333
Sum	0.99996
ER Portfolio	-0.36302
Var Portfolio	0.102592
Sd Portfolio	0.320299
CV Portfolio	-1.13338

Equal investment has risk of 32% which is 5% more than the minimum risk value. The return is in negative.

Constrained Portfolio

ER was set 5% and SD was minimized

w1	0.042204
w2	0
w3	0.03385
w4	0.616655
w5	0.084747
w6	0
w7	0
w8	0
w9	0
w10	0
w11	0
w12	0.222543
Sum	1
ER Portfolio	0.05
Var Portfolio	0.115797
Sd Portfolio	0.340289
CV Portfolio	0.146934

For getting 5% return with risk 34% the weight of investment is as above.

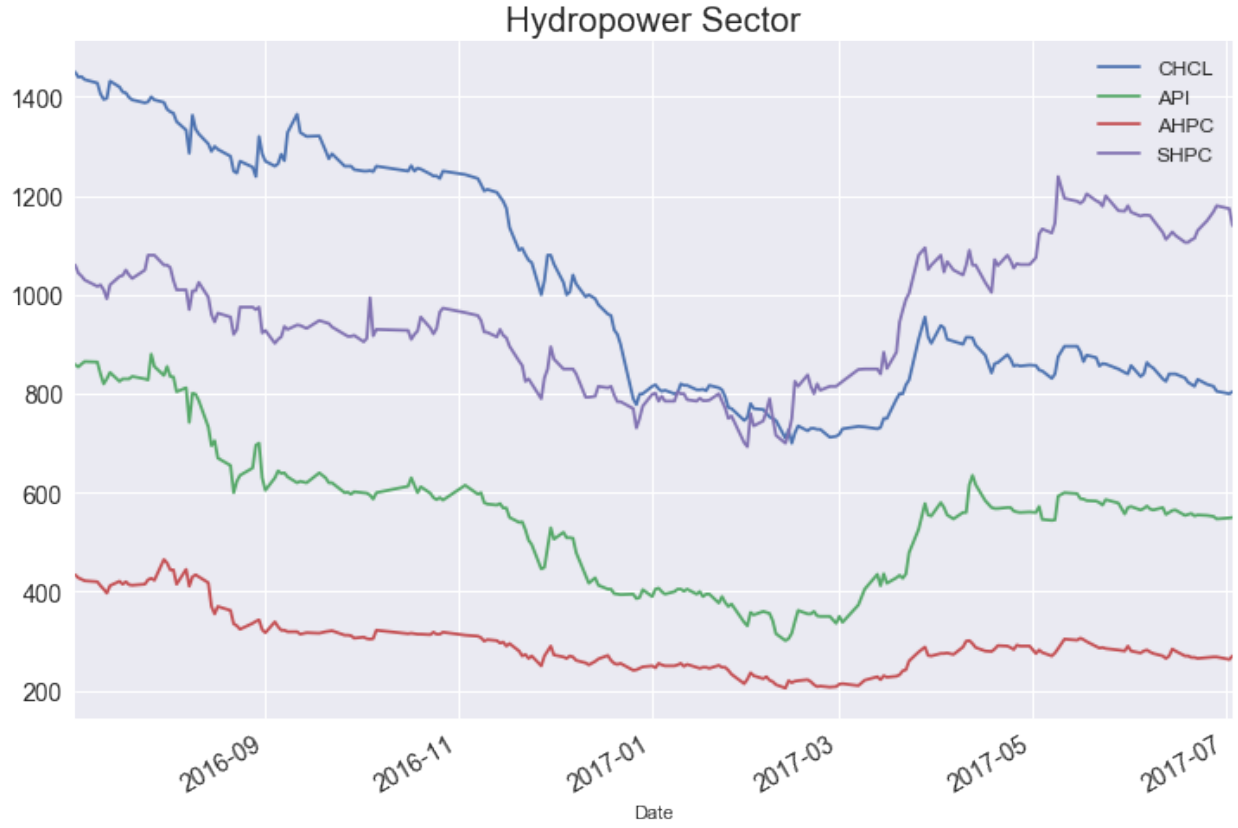
Please Check Combined.xlsx excel sheet for other constrained scenario

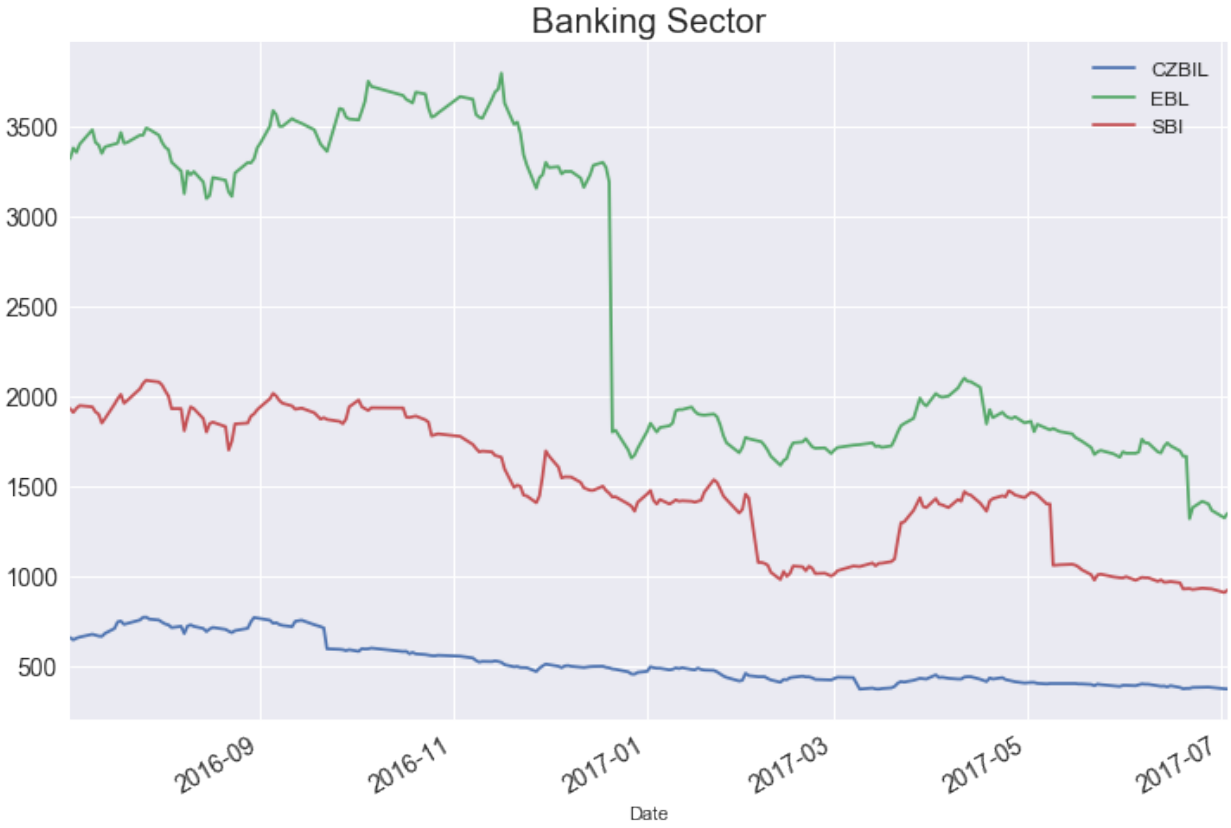
Python Data Analysis

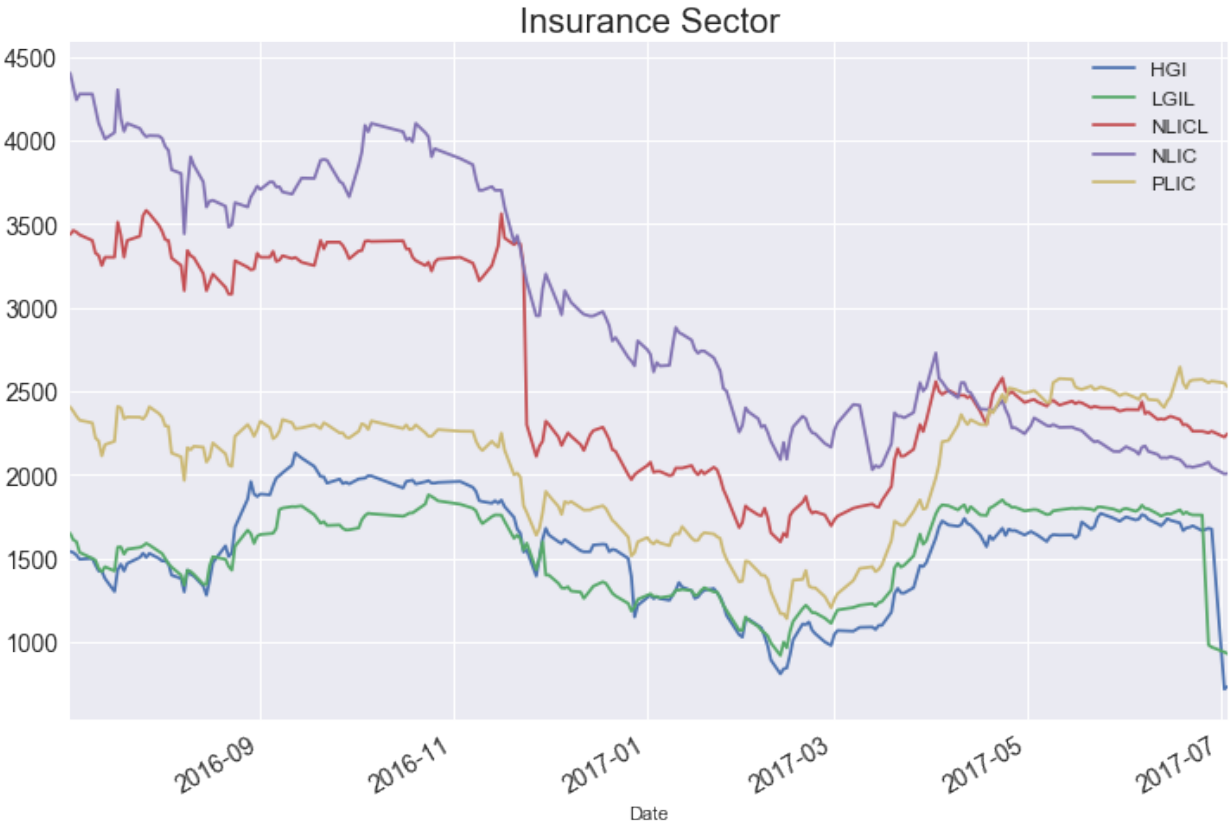
Descriptive Statistics

	CHCL	API	AHPC	SHPC	CZBIL	EBL	HGI	LGIL	NLICL	NLIC	SBI	PLIC
count	226.00	226.00	226.00	226.00	226.00	226.00	226.00	226.00	226.00	226.00	226.00	226.00
mean	1015.26	553.63	294.35	952.63	516.62	2531.74	1542.30	1526.23	2601.48	2979.75	1487.90	2049.65
std	235.07	142.79	60.57	135.11	124.20	837.34	304.06	258.08	604.92	740.77	357.80	398.76
min	700.00	301.00	205.00	693.00	371.00	1318.00	719.00	920.00	1599.00	2005.00	908.00	1140.00
25%	817.00	417.00	253.00	825.00	420.00	1745.25	1312.50	1307.50	2111.25	2291.00	1072.75	1698.50
50%	910.00	565.00	280.00	940.50	481.00	1997.00	1585.50	1577.50	2413.00	2749.00	1452.50	2203.00
75%	1253.75	614.50	315.00	1060.00	593.50	3398.75	1734.75	1769.50	3287.50	3721.00	1858.00	2345.00
max	1450.00	880.00	465.00	1239.00	771.00	3795.00	2130.00	1880.00	3580.00	4400.00	2088.00	2644.00

EDA of Stocks (Historical closing prices from 2016/07/03 to 2017/07/03 of different sectors)




Banking Sector
CZBIL
EBL
SBI
3500
3000
2500
2000
1500
1000
500
2016-09
2016-11
2017-01
2017-03
2017-05
2017-07
Date


Insurance Sector
HGI
LGIL
NLICL
NLIC
PLIC
4500
4000
3500
3000
2500
2000
1500
1000
2016-09
2016-11
2017-01
2017-03
2017-05
2017-07
Date

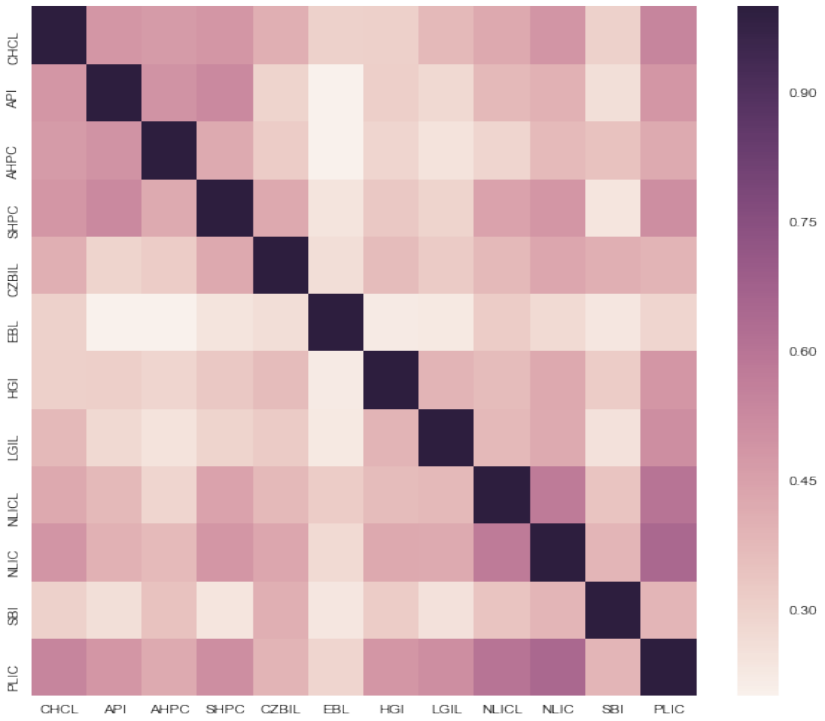
Annual ER

CHCL -0.543148
API -0.308364
AHPC -0.378672
SHPC 0.147208
CZBIL -0.501352
EBL -0.698161
HGI -0.310827
LGIL -0.325029
NLICL -0.304022
NLIC -0.698060
SBI -0.604309
PLIC 0.168295

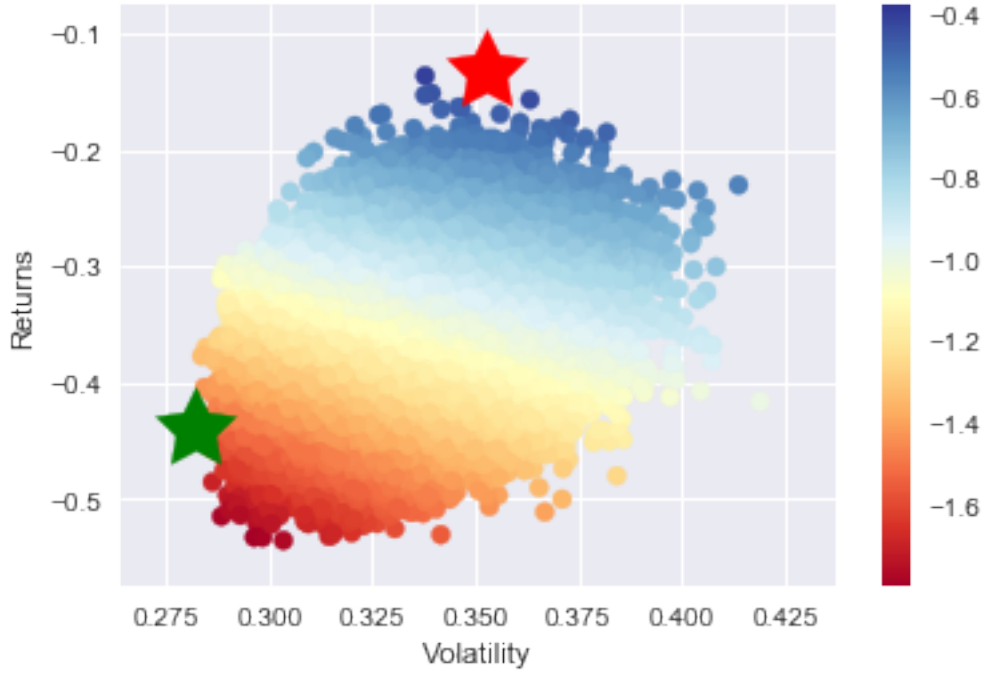
Covariance

	CHCL	API	AHPC	SHPC	CZBIL	EBL	HGI	LGIL	NLICL	NLIC	SBI	PLIC
CHCL	0.000429	0.000353	0.000286	0.000259	0.000206	0.000236	0.000339	0.000335	0.000280	0.000283	0.000210	0.000368
API	0.000353	0.001244	0.000515	0.000481	0.000252	0.000269	0.000590	0.000424	0.000421	0.000393	0.000305	0.000556
AHPC	0.000286	0.000515	0.000867	0.000322	0.000229	0.000224	0.000455	0.000313	0.000271	0.000305	0.000345	0.000408
SHPC	0.000259	0.000481	0.000322	0.000667	0.000269	0.000239	0.000455	0.000327	0.000365	0.000348	0.000207	0.000432
CZBIL	0.000206	0.000252	0.000229	0.000269	0.000595	0.000244	0.000479	0.000337	0.000291	0.000294	0.000332	0.000313
EBL	0.000236	0.000269	0.000224	0.000239	0.000244	0.001428	0.000457	0.000370	0.000383	0.000290	0.000299	0.000357
HGI	0.000339	0.000590	0.000455	0.000455	0.000479	0.000457	0.002864	0.000905	0.000626	0.000640	0.000570	0.000846
LGIL	0.000335	0.000424	0.000313	0.000327	0.000337	0.000370	0.000905	0.001839	0.000513	0.000505	0.000363	0.000718
NLICL	0.000280	0.000421	0.000271	0.000365	0.000291	0.000383	0.000626	0.000513	0.001006	0.000511	0.000361	0.000622
NLIC	0.000283	0.000393	0.000305	0.000348	0.000294	0.000290	0.000640	0.000505	0.000511	0.000777	0.000361	0.000592
SBI	0.000210	0.000305	0.000345	0.000207	0.000332	0.000299	0.000570	0.000363	0.000361	0.000361	0.001122	0.000424
PLIC	0.000368	0.000556	0.000408	0.000432	0.000313	0.000357	0.000846	0.000718	0.000622	0.000592	0.000424	0.001068

Correlation between stocks



Return vs SD/Volatility calculated using Monte Carlo Simulation



Minimum Risk
The return was -43.96% with risk/sd 28.23%

```
ret      -0.439636
stdev     0.282299
sharpe   -1.557338
CHCL      0.260084
API       0.121723
AHPC      0.015524
SHPC      0.090350
CZBIL     0.240568
EBL       0.043523
HGI       0.019599
LGIL      0.007160
NLICL     0.042654
NLIC      0.066562
SBI       0.084049
PLIC      0.008203
```

Note that Excel calculated minimum risk is 26.68% and Portfolio return is -44.98%

Conclusion: Minimum risk and Portfolio Return was calculated using both Excel and Python Monte Carlo simulation. Other scenario of Maximum return, Equal weight and constrained condition was calculated. In case of Nepalese Stocks it seems not that good to get returns.

References:

- **http://www.merolagani.com/**
- **http://www.nepalstock.com/**
- **http://www.pythonforfinance.net/2017/01/21/investment-portfolio-optimisation-with-python/**