FE 630 Final Project

2021 Fall Semester
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Data source

In our project, we use Yahoos Finance to get ETFs' data and download data of factor from Ken French's website.

Time period

We divide the overall analysis period into 3 sub-periods:
1. Before the Crisis: 2007-03-01 to 2008-09-01
2. During the Crisis: 2008-09-01 to 2010-09-01
3. After the Crisis: 2010-09-01 to 2021-10-31

Explanation of the strategy (Long/Short Global Macro Strategy):

Long short strategy pursues absolute return in other words: regardless of market condition the strategy seeks to make profit, for example according to the table below, in 2008 10 out of 12 ETFs plummeted. However, we can make profit by longing the green ETFs and shorting the red ones. Moreover, we can reduce the volatility by allocating the investment in different assets. For instance, according to correlation table below, QQQ is almost 0 correlated to GLD (Gold ETF), so we can invest both assets to reduce the risk.

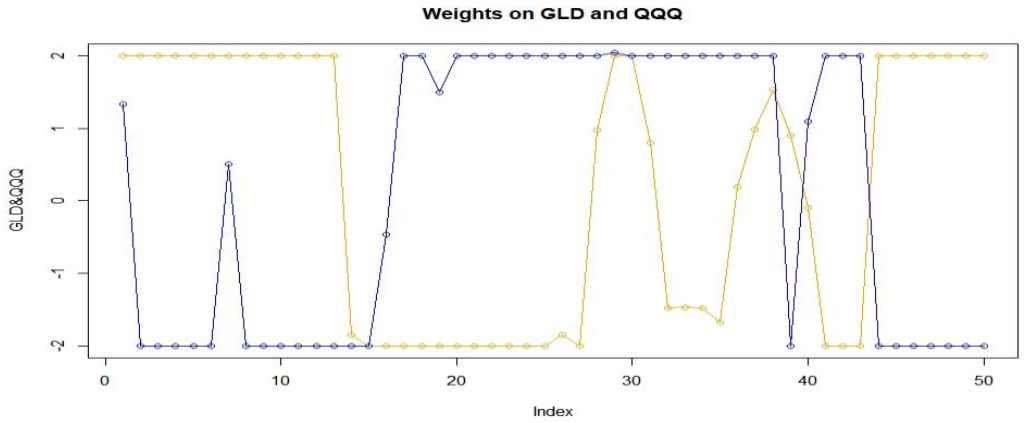
	FXE	EWJ	GLD	QQQ	SPY	SHV	DBA	USO	XBI	ILF	EPP	FEZ
08	-3.46%	-22.83%	10.10%	-46.19%	-39.59%	0.72%	-15.88%	-69.08%	-3.13%	-40.91%	-51.59%	-47.29%

Mean Return during 2008

	FXE	EWJ	GLD	QQQ	SPY	SHV	DBA	USO	XBI	ILF	EPP	FEZ
FXE	1	-0.006704	0.648322	-0.077663	-0.101985	0.158964	0.245582	0.368064	-0.097524	0.182442	0.136043	0.219516
EWJ	-0.006704	1	0.068234	0.625588	0.666613	-0.11913	0.087949	0.014502	0.426709	0.566887	0.690632	0.670789
GLD	0.648322	0.068234	1	-0.032076	-0.018509	0.002632	0.369905	0.514962	-0.037318	0.301498	0.229998	0.232626
QQQ	-0.077663	0.625588	-0.032076	1	0.861157	-0.183333	0.026711	-0.084962	0.68714	0.704773	0.72473	0.739793
SPY	-0.101985	0.666613	-0.018509	0.861157	1	-0.188094	0.037928	-0.042739	0.655256	0.77511	0.798855	0.813455
SHV	0.158964	-0.11913	0.002632	-0.183333	-0.188094	1	-0.048455	0.023715	-0.150694	-0.147769	-0.143452	-0.160043
DBA	0.245582	0.087949	0.369905	0.026711	0.037928	-0.048455	1	0.382732	0.045706	0.20076	0.128141	0.147248
USO	0.368064	0.014502	0.514962	-0.084962	-0.042739	0.023715	0.382732	1	-0.137764	0.204584	0.118256	0.092307
XBI	-0.097524	0.426709	-0.037318	0.68714	0.655256	-0.150694	0.045706	-0.137764	1	0.49607	0.52137	0.549478
ILF	0.182442	0.566887	0.301498	0.704773	0.77511	-0.147769	0.20076	0.204584	0.49607	1	0.814251	0.769937
EPP	0.136043	0.690632	0.229998	0.72473	0.798855	-0.143452	0.128141	0.118256	0.52137	0.814251	1	0.792337
FEZ	0.219516	0.670789	0.232626	0.739793	0.813455	-0.160043	0.147248	0.092307	0.549478	0.769937	0.792337	1

Correlation table

< Example – Weight on assets (Gold and Nasdaq) >



The picture above is the portfolio of GLD and QQQ in 52 weeks in 2008. Since return of GLD and QQQ is bit negative correlated, the position of the two seems somewhat opposite for most period.

The Objective function:

$$\text{Max } \rho^T w - \lambda(w-w_p)^T \Sigma (w-w_p)$$

1 Solving $(w-w_p)^T \Sigma (w-w_p)$

$(w-w_p)^T \Sigma (w-w_p) \rightarrow w^T\Sigma w - 2w_p{}^T\Sigma w + w_p{}^T\Sigma w_p$

$$\Rightarrow \text{Max } \rho^T w - \lambda(w^T\Sigma w - 2w_p{}^T\Sigma w + w_p{}^T\Sigma w_p)$$

$$= (\rho^T w + 2\lambda w_p{}^T\Sigma)\, w - \lambda w^T\Sigma w - \lambda w_p{}^T\Sigma w_p$$

Therefore, Objective function is

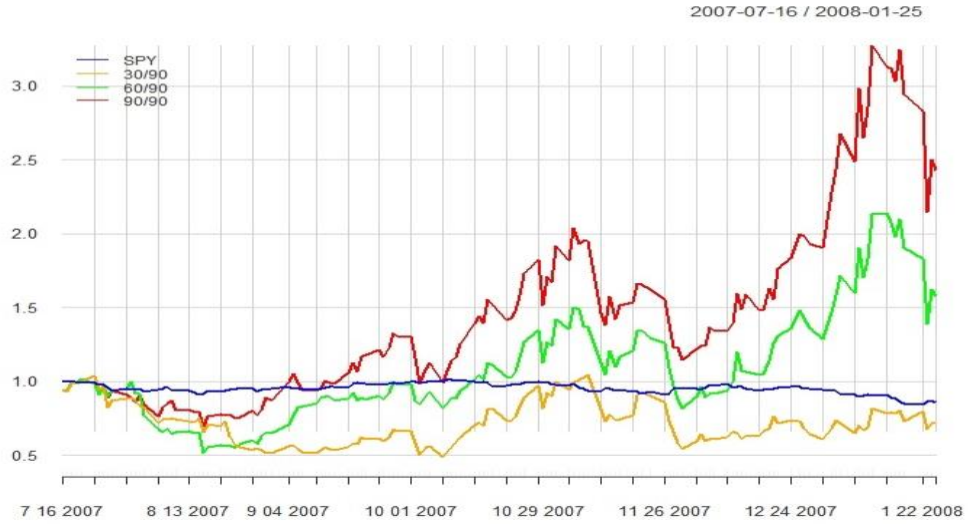
$$\text{Min } \lambda w^T\Sigma w - (\rho^T w + 2\lambda w_p{}^T\Sigma)\, w$$

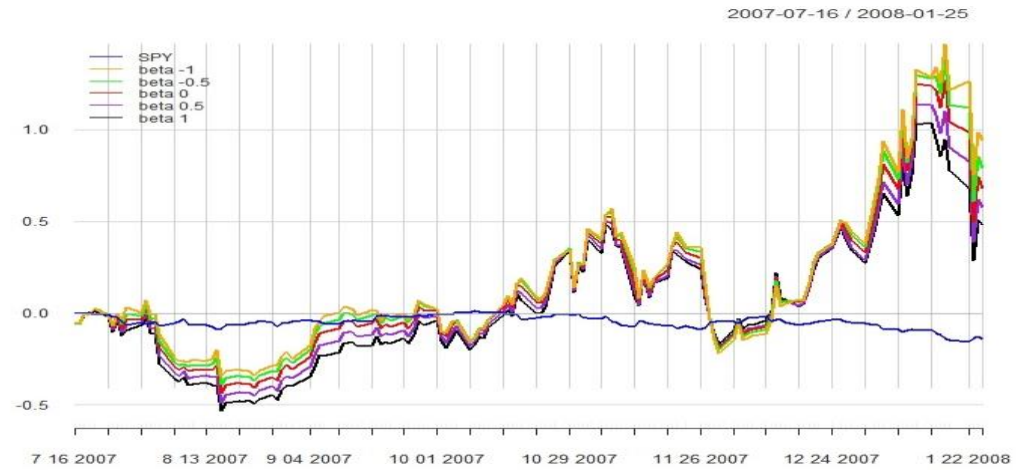
Time period to estimate Covariance and Expected Return

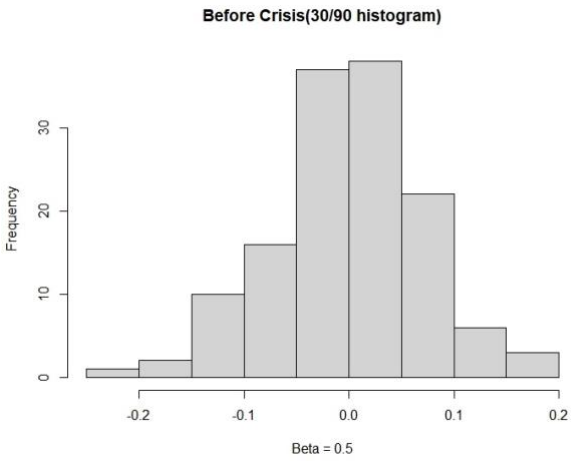
We choose, to estimate Covariance and Expected Return. (a particular strategy being defined by a specific combination, for example (0.5) -> using 30,60,90 days for estimation of covariance, 90 days for estimation of Expected Returns and a target $\beta = 0.5$)

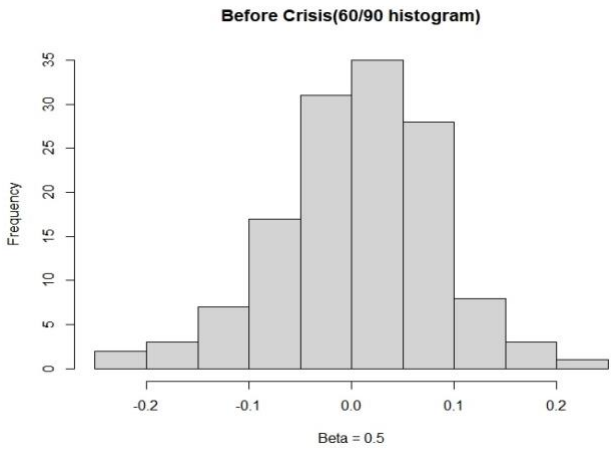
Before The Crisis

	SPY	30/90	60/90	90/90
Mean	-0.26366742	0.05611948	1.6508090	2.4703015
Volatility	0.19825336	1.16167967	1.2599967	1.2642285
Skewness	-0.09798604	-0.22162361	-0.2835175	-0.2930325
Kurtosis	-0.02796805	0.21110030	0.4563014	0.6020131
Sharpe Ratio	-1.24467755	-0.40076258	1.0580530	3.3643282





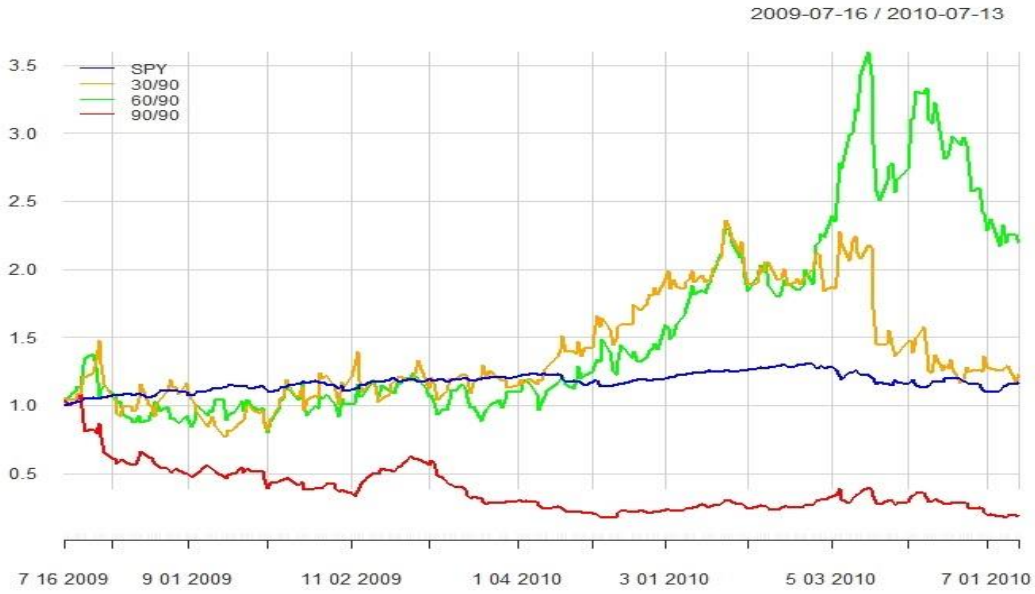


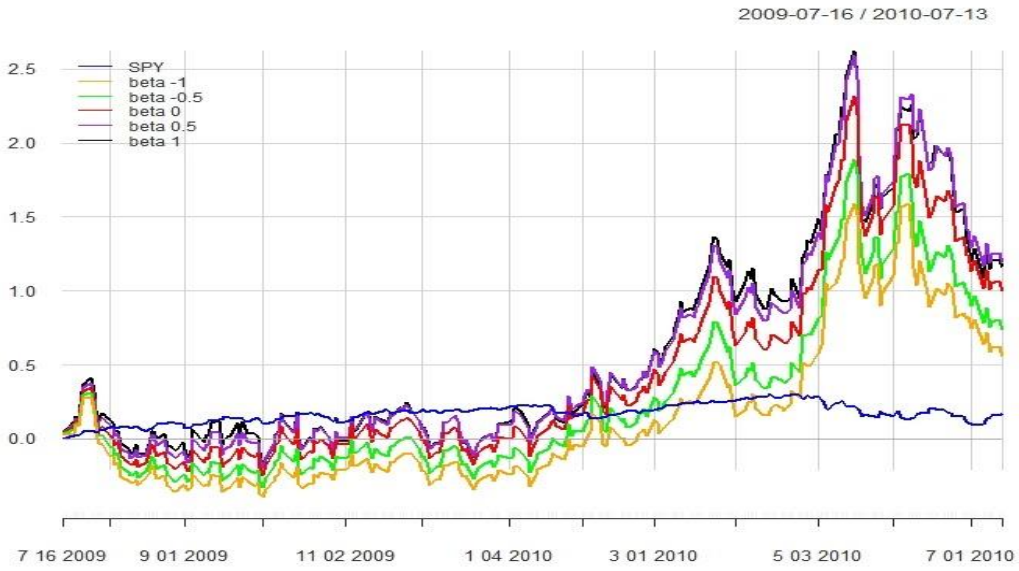


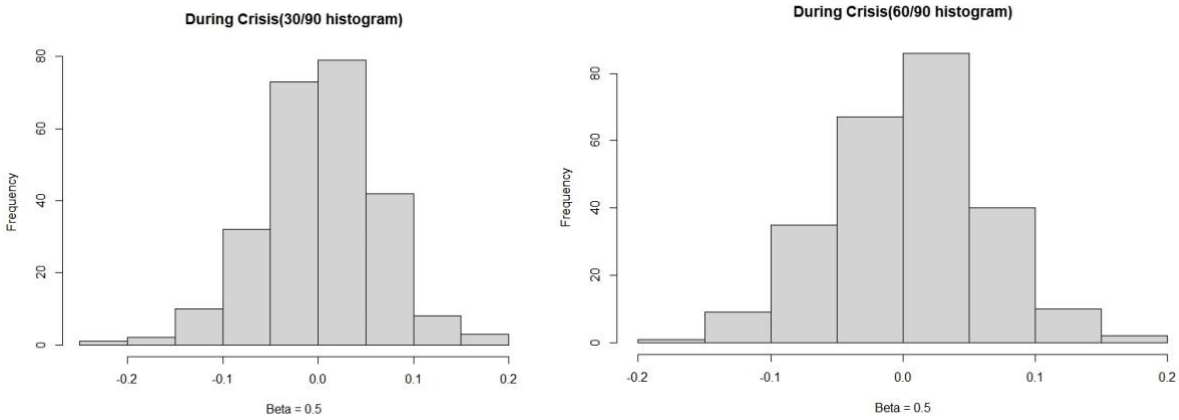
From the graph combined with numerical results, we could notice that during pre-crisis period, (0.5) (long term estimation period) performs the best among the parameters. Besides, the return distribution of over this period is approximately normal. For varying the beta, we observe that beta = -1 generate the highest return over the pre-crisis period.

During The Crisis

	SPY	30/90	60/90	90/90
Mean	0.1801819	0.6861164	1.23709318	-1.2219142
Volatility	0.1837430	0.9749415	0.94274132	0.9782351
Skewness	-0.2616535	-0.1931346	-0.10390367	-0.1625276
Kurtosis	1.5849981	0.3986491	0.06036783	0.2497314
Sharpe Ratio	0.9653556	0.2366232	1.28021376	-0.8378132


2009-07-16 / 2010-07-13
SPY
30/90
60/90
90/90
3.5
3.0
2.5
2.0
1.5
1.0
0.5
7 16 2009
9 01 2009
11 02 2009
1 04 2010
3 01 2010
5 03 2010
7 01 2010

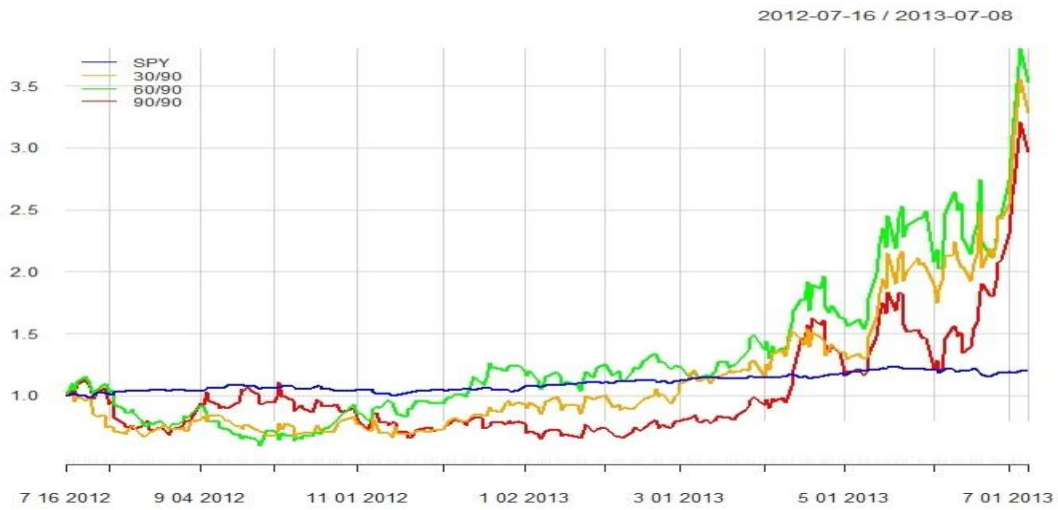

2009-07-16 / 2010-07-13
SPY
beta -1
beta -0.5
beta 0
beta 0.5
beta 1
2.5
2.0
1.5
1.0
0.5
0.0
7 16 2009
9 01 2009
11 02 2009
1 04 2010
3 01 2010
5 03 2010
7 01 2010

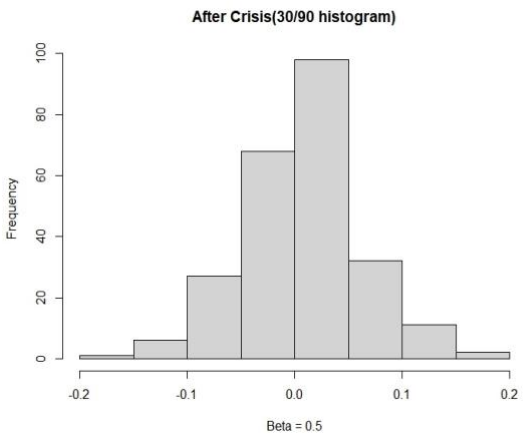


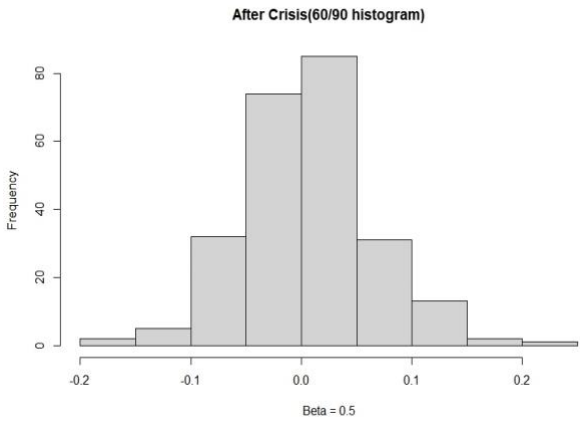
During the crisis, beta 1 is recommended parameter to implement.
When selecting beta, going with the market during the crisis (our crisis period starts with Lehman Brothers bankruptcy) is a good idea, because the price has been already dropped, FED trying to revive the market via providing more liquidity to the markets (QE, Forward guidance)

After the crisis:

	SPY	30/90	60/90	90/90
Mean	0.2016416	1.59140092	1.7045264	1.5487406
Volatility	0.1221079	0.86051604	0.9053199	0.9341331
Skewness	-0.2083261	0.05787071	0.1421014	0.3683234
Kurtosis	1.0201578	0.62934923	0.9987865	1.1290822
Sharpe Ratio	1.7547212	2.77845487	2.9311463	2.2039842







For period after the crisis, S (60/90) is the most promising parameter to go with.
For fixed term-structure, beta = 1 demonstrates the highest absolute and relative return.
Lastly, for general recommendation for the term-structure and beta, we to use short-term such as and high beta such as beta = 1.