8/15/2016 - 9/30/2016

Length: 34

```
# geo-average return
> cumprod(r_MktLessRF[1:33])[33]^(1/33)
[1] 1.000148
> cumprod(r_SMB[1:33])[33]^(1/33)
[1] 0.9998825
> cumprod(r_HML[1:33])[33]^(1/33)
[1] 0.9999849
Target beta = 0.5 :
```

ETF	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	0.339507	1.129032	-1.7209	0.866613	-1.27345	0.027172	-4.31034	1.579926	4.640889	-5.14208	-5.82509	0.57088	-1.17648	0.3190767
Daily_mean	-0.08902	-0.06156	-0.1507	-0.07082	-0.13614	-0.09917	-0.23172	-0.02687	0.054488	-0.24572	-0.27188	-0.07766	-0.13032	0.01225814
Daily_min	-0.94018	-1.86991	-1.21146	-2.61642	-2.49348	-0.14526	-1.42613	-3.54828	-4.39601	-4.8439	-3.59393	-3.09417	-2.55248	-2.0814565
Max_Drawdown	2.200004	0.5	4.330002	3.639999	5.940002	0.070008	1.01	1.36	3.689999	2.619998	6.020001	2.190003	1.990001	2.145695
volatility	0.382152	0.955719	0.624874	0.78968	0.742655	0.020175	0.59344	2.299148	1.864255	1.698014	1.425209	1.021912	1.065784	0.77037235
sharpe_ratio	0.424147	0.565527	-1.33214	0.530207	-0.83232	0.645347	-3.5519	0.335529	1.185027	-1.51332	-2.0845	0.272749	-0.53313	0.1967678

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	1.3188027	0.6747146	0.3190767	-1.2734461
Daily_mean	0.07992531	0.03085992	0.01225814	-0.03605104
Daily_min	-7.87469	-4.119381	-2.081457	-2.394481
Max_Drawdown	4.736438	3.441067	2.145695	5.940002
volatility	2.9051015	1.5067489	0.7703724	0.7313441
sharpe_ratio	0.2207503	0.214421	0.1967678	-0.832315

1/4/2016 - 9/30/2016

Length: 189

```
# geo-average return
> cumprod(r_MktLessRF[1:188])[188]^(1/188)
[1] 1.000132
> cumprod(r_SMB[1:188])[188]^(1/188)
[1] 1.000063
> cumprod(r_HML[1:188])[188]^(1/188)
[1] 0.9999905
```

Target beta = 0.5 :

ETF	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	3.140918	5.11316	22.11099	8.420092	7.601233	0.190527	-2.10681	-0.45537	-2.27038	35.65554	23.74664	11.97034	-2.78933	7.922367
Daily_mean	0.017773	0.034939	0.111243	0.048674	0.042772	0.001008	-0.00831	0.037304	0.018756	0.183361	0.13016	0.068334	-0.00258	0.045959
Daily_min	-2.69272	-4.55675	-3.03312	-4.11878	-3.59091	-0.05439	-2.1267	-7.87487	-6.93641	-5.59414	-5.78656	-5.16938	-12.2117	-5.86471
Max_Drawdown	5.540001	1.76	8.029999	13.18	18.5	0.110001	2.979999	3.1	22.1	3.5	7.569999	4.25	5.57	6.673003
volatility	0.532138	1.310814	1.053854	1.086073	0.895861	0.016006	0.770355	2.8299	2.486345	2.099056	1.872299	1.303725	1.555304	1.058716
sharpe_ratio	0.481515	0.339693	1.520141	0.670967	0.712791	0.997118	-0.22174	-0.01496	-0.0942	1.225292	0.987663	0.766381	-0.15499	0.618692

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	-19.40493	3.445835	7.922367	7.601233
Daily_mean	33.64784319	0.07685746	0.04595876	0.04198334
Daily_min	-1016.12884	-17.124709	-5.864708	-3.591908
Max_Drawdown	25.363157	15.368308	6.673003	18.5
volatility	384.1961323	3.4161765	1.0587163	0.8958331
sharpe_ratio	-0.12469857	0.09714506	0.61869203	0.71279053

8/13/2007 – 9/30/2007

Length: 34

Target beta = 0.5 :

cum_return	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	-5.73245	-6.65499	4.303583	-18.4277	-9.78456	0.263613	-15.307	-12.5227	-12.2574	-16.6846	-10.5813	-12.3535	-13.768	-9.69115
Daily_mean	-0.16848	-0.17255	0.164959	-0.56961	-0.27334	0.007768	-0.45801	-0.33493	-0.36289	-0.4079	-0.29002	-0.32594	-0.39255	0.067593
Daily_min	-2.57173	-7.74775	-5.024	-7.93574	-7.83616	-0.22626	-7.35745	-10.5788	-5.00796	-13.8408	-6.01504	-11.2218	-9.89686	-14.6899
Max_Drawdown	9.770004	1.18	9.220001	10.43	18.81001	0.279999	7.43	23.22	10.18001	13	10.35	7.45	8.329998	31.99128
volatility	1.01508	2.466323	2.94672	2.36174	2.423246	0.071503	2.454967	3.42102	2.068142	5.099711	2.797504	3.505235	2.927981	8.956525
sharpe_ratio	-2.75753	-1.33616	0.701647	-4.1677	-2.01155	1.735375	-3.12868	-1.8911	-3.06108	-1.79883	-1.8963	-1.81836	-2.44267	-0.60023

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	-48.154868	-20.369297	-9.691149	-9.78456
Daily_mean	-2.86319205	0.3728249	0.06759273	-0.2733428
Daily_min	-446.550595	-30.521207	-14.689928	-7.836161
Max_Drawdown	36.56189	34.27658	31.99128	18.81
volatility	133.354952	15.091382	8.956525	2.423246
sharpe_ratio	-1.0547011	-0.8580181	-0.6002295	-2.0115486

1/2/2008 - 9/30/2007

Length: 189

ETF	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	-4.31152	-19.4255	0.247465	-22.8129	-19.9683	0.537785	-9.63207	4.511279	1.331306	-84.2742	-22.5679	-76.6154	-31.9105	484.3649
Daily_mean	-0.02081	-0.09892	0.017824	-0.1211	-0.10571	0.002853	-0.03027	0.053731	0.021584	-0.49169	-0.11409	-0.51049	-0.18557	-1.09541
Daily_min	-2.57173	-7.74775	-5.024	-7.93574	-7.83616	-0.24464	-7.35745	-10.5788	-5.00796	-80.7807	-6.01504	-67.2551	-9.89686	-909.396
Max_Drawdown	20.37001	3.59	26.09	12.8	33.55	0.599998	12.77	42.49001	13.23001	270.22	19.61	121.76	21.7	18.33646
volatility	0.710008	1.746771	1.832785	1.776493	1.552331	0.056014	2.161499	2.467043	1.713056	6.542373	2.058356	5.333954	1.871168	94.09091
sharpe_ratio	-0.49728	-1.03065	0.011225	-1.21702	-1.219	0.801449	-0.33748	0.129692	0.065838	-1.12203	-1.02403	-1.40438	-1.746	0.793286

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	-207.46345	-89.61973	484.36489	-19.96826
Daily_mean	3.73772	-2.0523264	-1.0954059	-0.1057099
Daily_min	-317.698211	-314.669475	-909.395986	-7.836161
Max_Drawdown	83.28178	31.43132	18.33646	33.55
volatility	66.604639	39.522047	94.090913	1.552331
sharpe_ratio	-1.3303899	-0.7166041	0.7932858	-1.2190047

8/15/2007 - 10/2/2007

Length: 34

```
# geo-average return
> cumprod(r_MktLessRF[1:33])[33]^(1/33)
[1] 0.9997604
> cumprod(r_SMB[1:33])[33]^(1/33)
[1] 0.9995689
> cumprod(r_HML[1:33])[33]^(1/33)
[1] 0.9995961
```

Target beta = 0.5 :

ETF	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	4.909389	5.779078	9.405718	13.31154	9.252697	-0.07303	7.921937	11.79031	11.20607	34.98037	17.23333	27.96733	13.1379	16.91426
Daily_mean	0.141874	0.169754	0.268985	0.37429	0.265414	-0.0021	0.233685	0.337164	0.317183	0.914051	0.48035	0.745868	0.372955	0.467853
Daily_min	-0.82847	-1.92995	-2.19265	-2.38095	-2.19802	-0.3823	-3.91822	-2.81153	-1.42936	-5.22137	-1.83542	-3.5221	-2.74185	-2.51135
Max_Drawdown	1.779999	0.56	1.550004	1.479999	4.610001	0.46	1.75	2.780003	1.400001	10.99001	1.849998	6.159989	2.129997	2.696247
volatility	0.4096	0.950818	0.934592	1.118331	0.996552	0.101254	1.375969	1.349171	0.944431	2.408097	1.555827	1.924875	1.386292	1.21947

sharpe_ratio	5.494323	2.837121	4.531219	5.380789	4.207444	-0.33955	2.535845	3.937849	5.297105	6.172255	4.981845	6.332571	4.288841	6.21495

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	38.029403	30.322249	16.914256	9.252697
Daily_mean	0.9872716	0.804666	0.4678526	0.2487376
Daily_min	-5.578144	-4.507478	-2.511347	-2.216024
Max_Drawdown	10.615529	6.655888	2.696247	4.610001
volatility	2.6912807	2.1704221	1.2194704	0.9964174
sharpe_ratio	5.948503	6.011215	6.21495	4.207444

1/3/2007 – 10/2/2007

Length: 189

```
# geo-average return
> cumprod(r_MktLessRF[1:188])[188]^(1/188)
[1] 0.9999659
> cumprod(r_SMB[1:188])[188]^(1/188)
[1] 0.999975
> cumprod(r_HML[1:188])[188]^(1/188)
[1] 1.000019
```

Target beta = 0.5 :

ETF	fxe	ewj	gld	qqq	spy	shv	dba	uso	xbi	ilf	gaf	epp	fez	portfolio
cum_return	7.235043	1.830986	16.16891	20.28214	8.997667	0.708375	12.70984	24.75708	28.09013	47.54629	14.00323	35.02555	14.40073	26.91476
Daily_mean	0.037613	0.013353	0.084207	0.102609	0.049677	0.00389	0.073475	0.130594	0.137166	0.226093	0.108123	0.170706	0.078231	0.188201
Daily_min	-0.84733	-2.5784	-3.95006	-4.10746	-3.90576	-0.42868	-4.05904	-4.10148	-3.99201	-7.94739	-4.07106	-5.85042	-4.73984	-3.72537
Max_Drawdown	4.179993	1.69	5.169998	4.869999	14.03001	0.489997	2.780001	6.180001	4.469994	51.84	9.75	27.45001	7.5	15.10331
volatility	0.360754	0.868533	0.988927	0.986244	0.903875	0.081135	1.383759	1.647413	1.106845	2.004126	1.438632	1.529225	1.186986	1.430923
sharpe_ratio	1.638322	0.175332	1.291244	1.604795	0.802726	0.750802	0.738036	1.222824	1.889222	1.700409	1.100832	1.713076	0.964235	1.998412

ETF	pf beta = 1.5	pf beta = 1	pf beta = 0.5	spy
cum_return	42.609254	36.984064	26.914759	8.997667
Daily_mean	0.28930667	0.25366853	0.18820128	0.03055007
Daily_min	-5.799573	-5.081564	-3.725365	-3.925764
Max_Drawdown	46.15675	30.63003	15.10331	14.03001
volatility	2.1998544	1.9311542	1.4309234	0.9038867
sharpe_ratio	1.9462515	1.9619731	1.9984117	0.8027257

Conclusion:

Before recession, the market grew more quickly with larger volatility than it after recession.

By building a right portfolio, we can always over-perform the S&P 500 at any time. In the short run during recession, not matter what kind of positions we made, we always get negative returns.

Usually, it is best to set target beta as 0.5, for we can get the highest Sharpe Ratio. But in recent, it is best to set target beta as 1.5, which means the portfolio is more risky.