

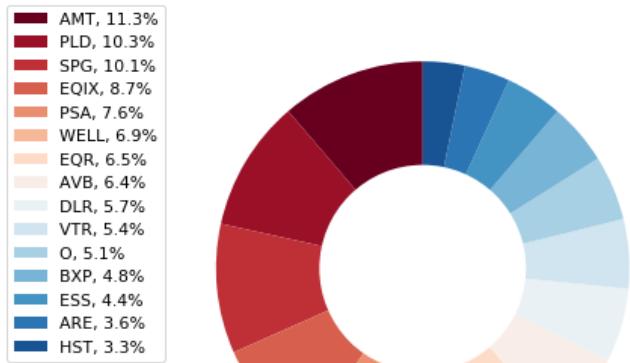
FIN 285A Computer Simulations and Risk Assessment

Research Project

Group 8

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Top 15 Weighted Stocks in ICF



Return Comparison in Recent 6 Month



What is ICF? - iShares Cohen & Steers REIT ETF

Inception Date: 01/29/2001

Segment: U.S. Real Estate

Components: 30 large-cap REITs

- Commercial REITs: 50.95%
- Specialized REITs: 29.42%
- Residential REITs: 19.63%

Why Do We Choose Real Estate?

REIT stocks outperformed S&P 500 in 2019 Q1:

- RMS +16.3% vs SPY +14.0%

Macroeconomic Condition:

- Decreasing mortgage rate
- Unemployment rate at historically low level

Personal Motivation

How Do We Build Our Own ETF?

- Rolling, rebalance every month
- Integer optimization
- Minimize TE under constraints ($N = 11$)

MINLP Solver: gekko

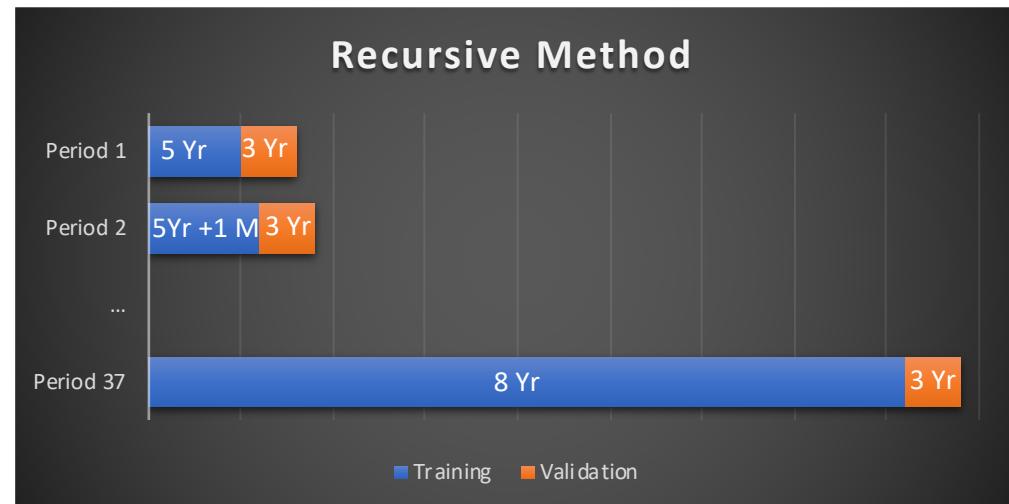
```
def te_opt_gekko(total_num_stock,n_choose,cov,wts_final):
    m=GEKKO()
    y=[m.Var(1,lb=0,ub=1,integer=True)
       for i in range(total_num_stock)]
    w=[m.Var(value=1./total_num_stock,lb=0,ub=1)
       for i in range(total_num_stock)]

    m.Equation(np.sum(y)==n_choose)
    m.Equation(np.sum(w)==1.)
    m.Equations(w[i]<=y[i] for i in range(total_num_stock))

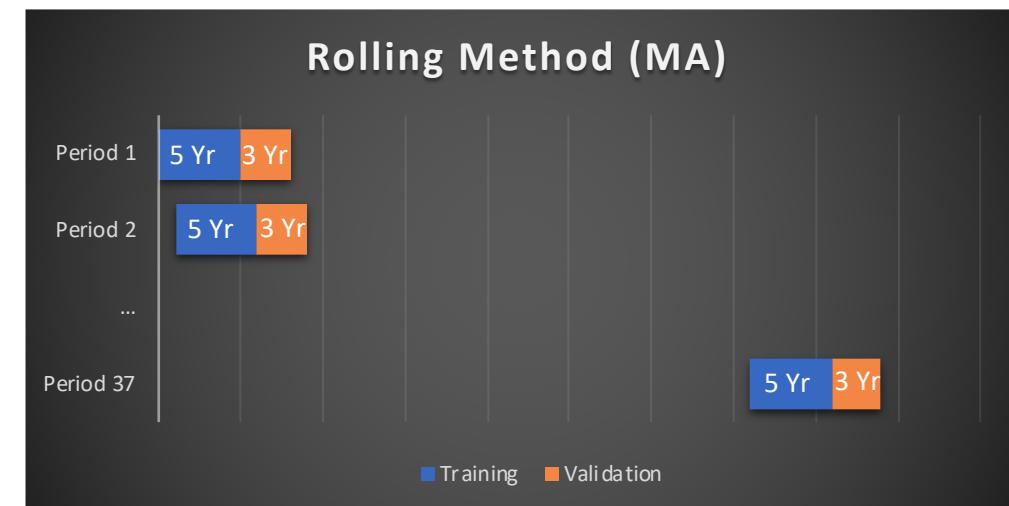
    w_a=[w[i]-wts_final[i] for i in range(total_num_stock)]

    m.Obj(np.dot(np.dot(w_a,cov),w_a))
    m.options.SOLVER=1
    m.solve(disp=False)
    return w,y
```

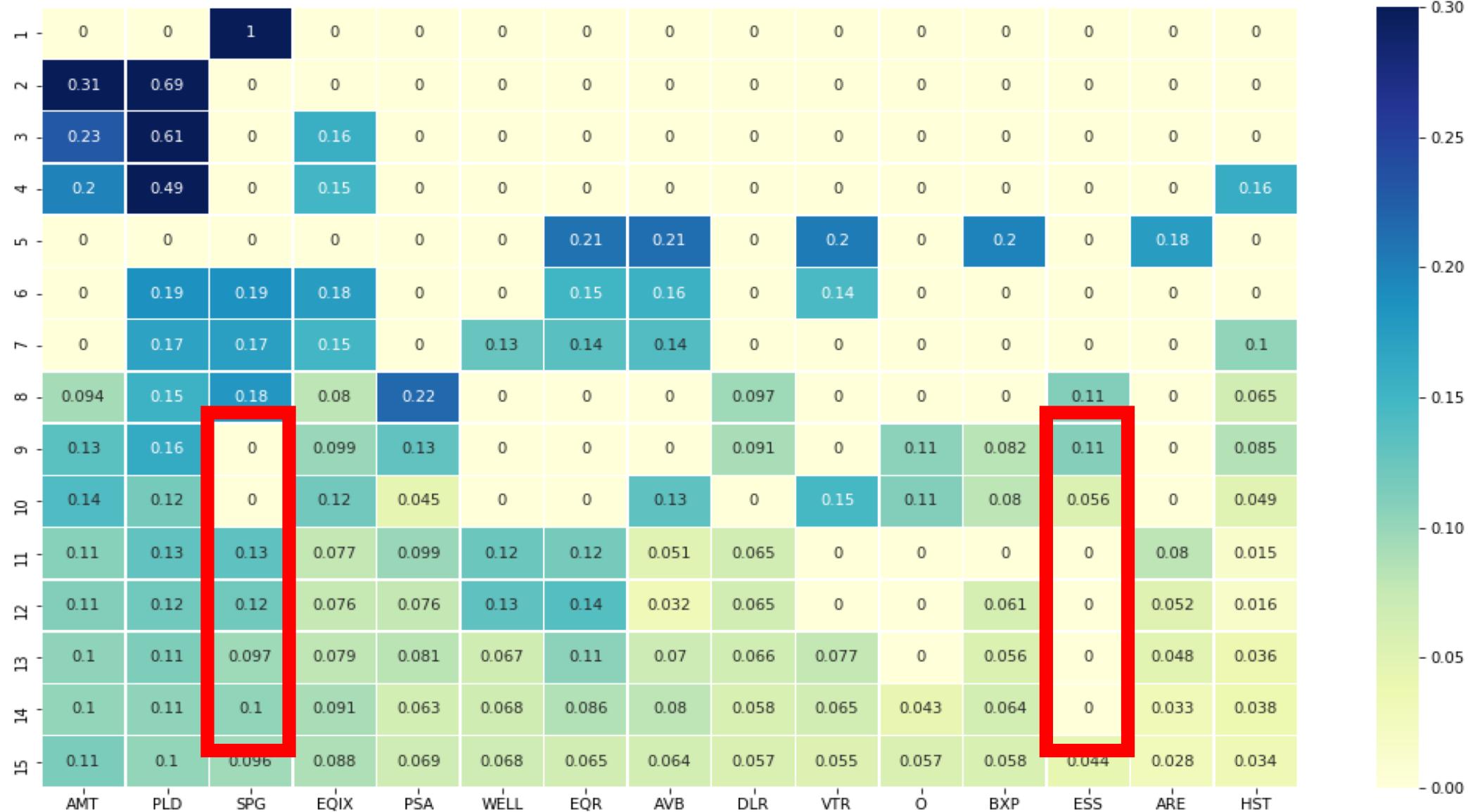
Recursive Method (EWMA)



Rolling Method (MA)



Integer optimization



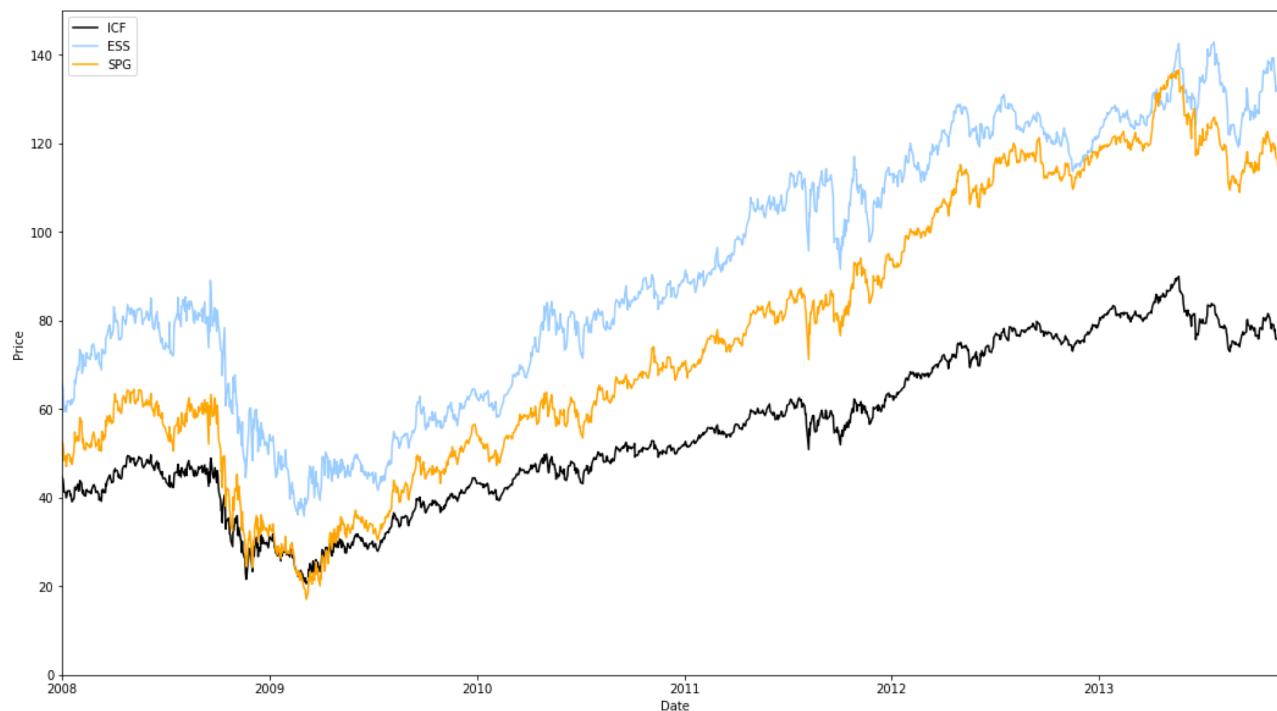
Why not top weighted stocks at low N during int. optimization?

Similarity effect vs Cointegration effect

- Low N: Its ret activity departs from index and replace by stock which is similar to index
- High N: cointegration effect stronger than similarity effect -- 'choose' top weighted stocks
- Algo. gets local minimum

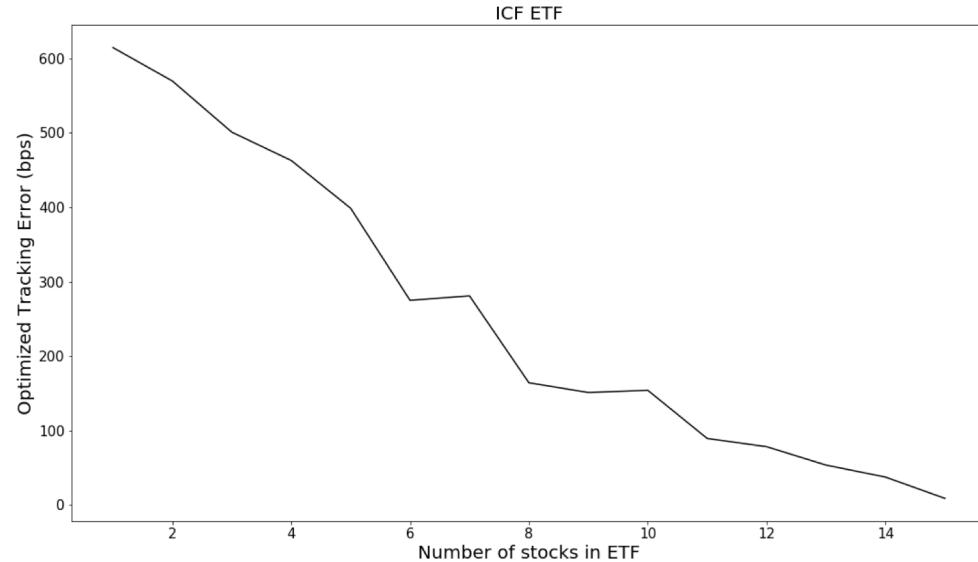
Complementary stock

Which one to add depends on the ret similarity to index in a given period

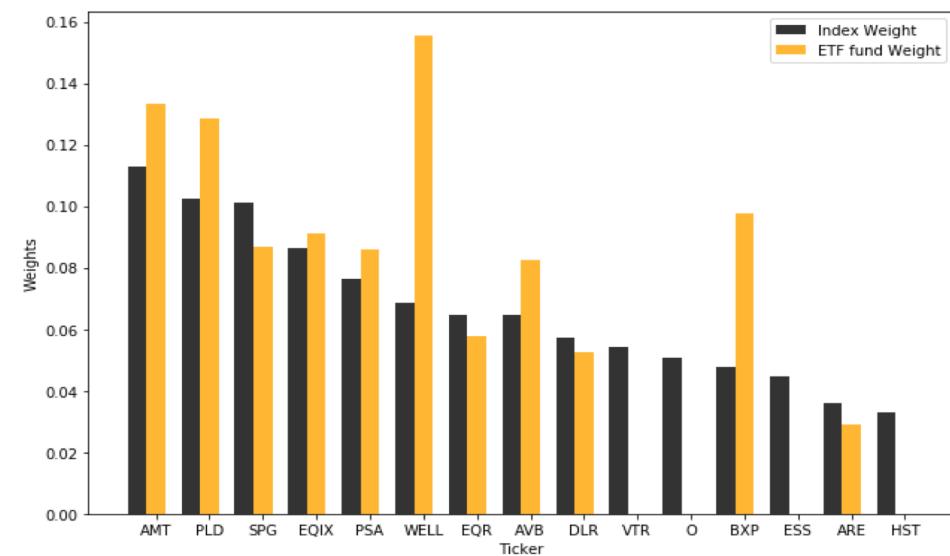
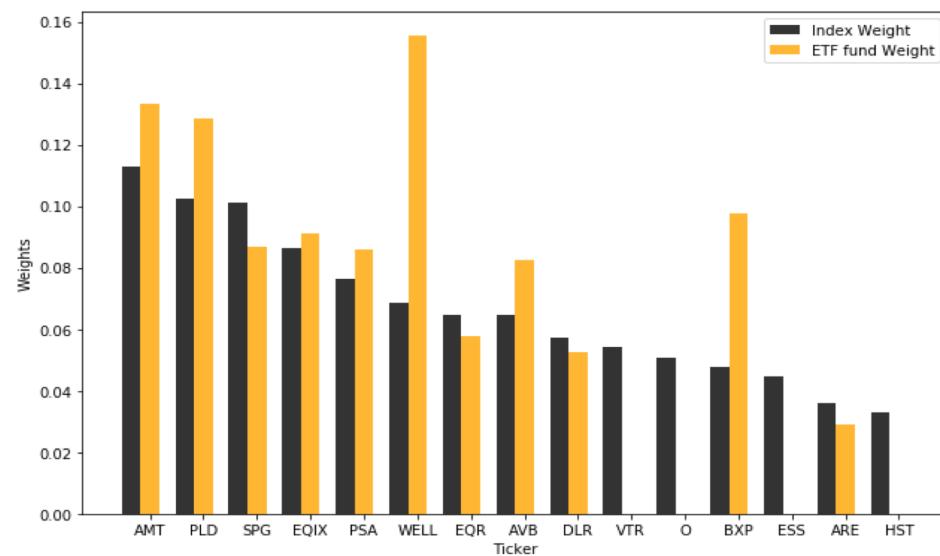
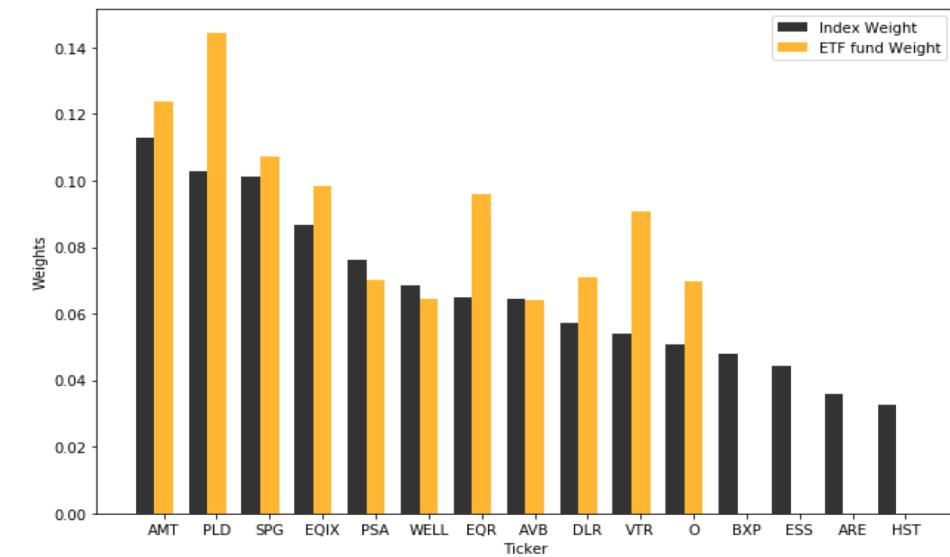


ESS & SPG Price Movements

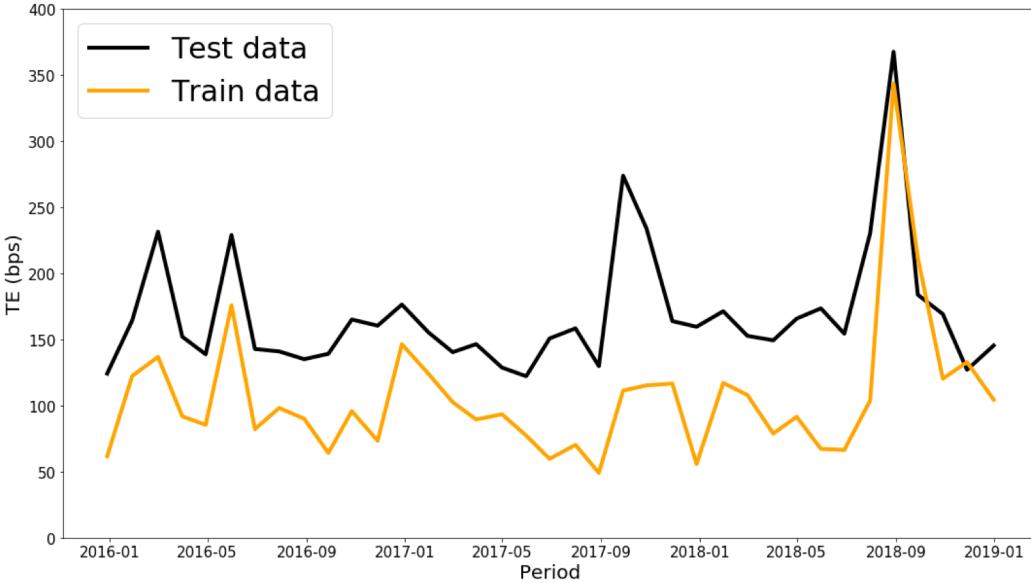
TE vs # of stock to choose



Rebalance ETF every month

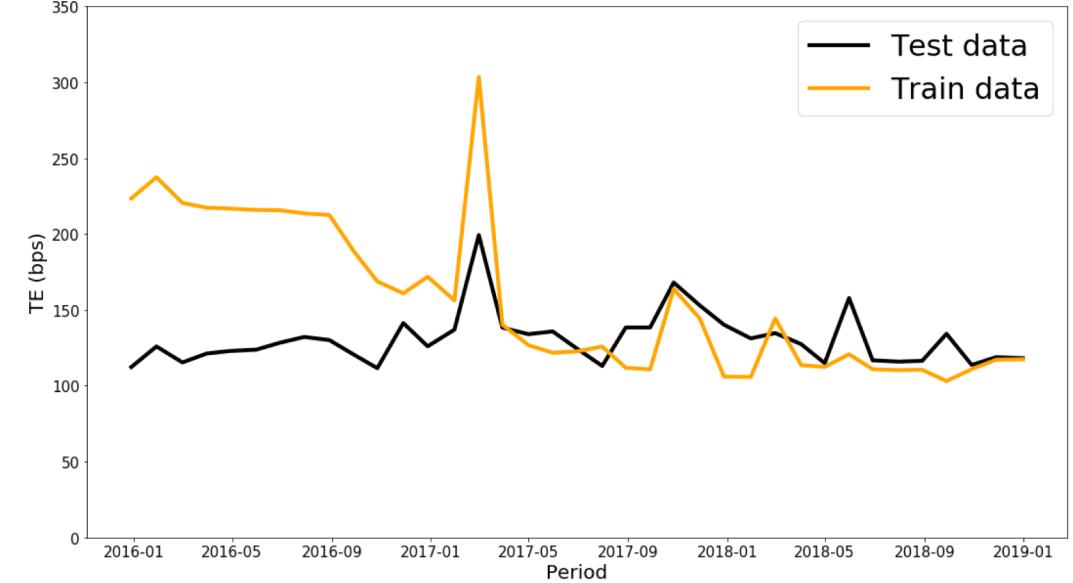


Train vs Test TE Comparison - EWMA

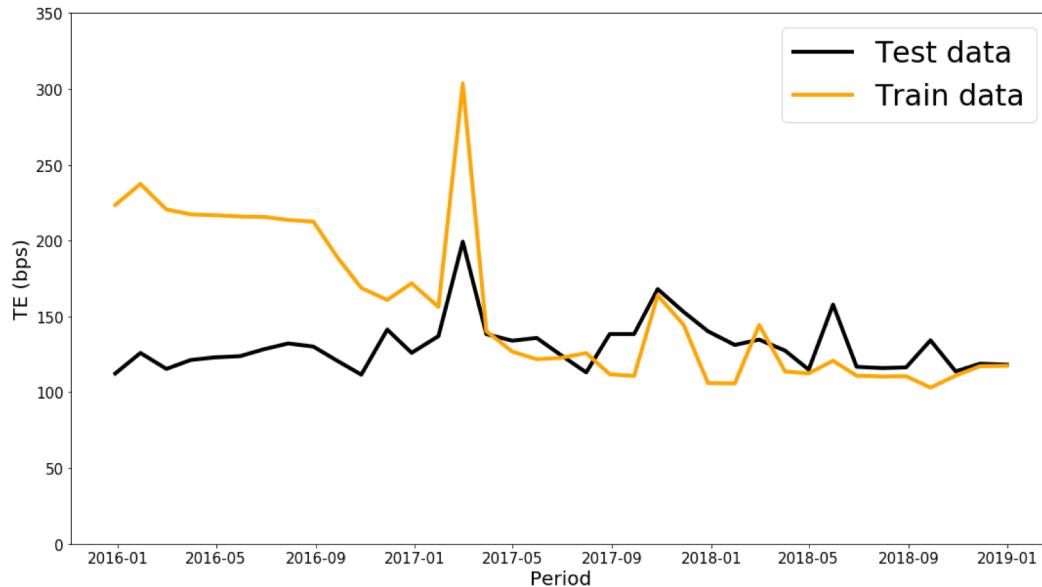
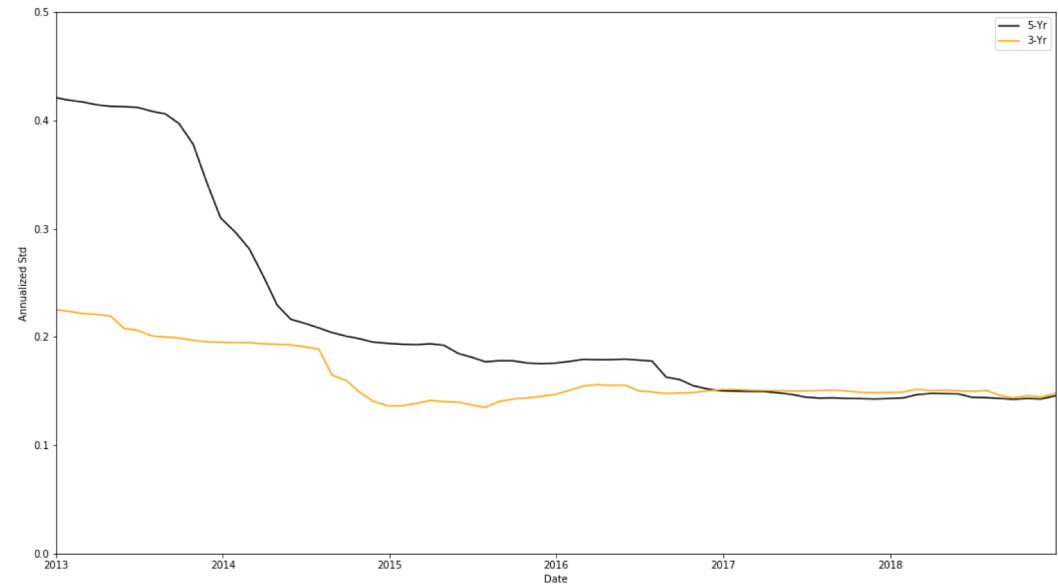


- Relatively close estimation
- 2018 Sep – Nov: Exceptionally high mortgage rate resulting the high volatility of ICF price
- TE(test) 60 bps higher on average

Train vs Test TE Comparison - MA



- Doing no so good before 2017, closer estimation than EWMA in recent years
- TE(test) 25 bps lower on average
- Super helpful if future VOL stay in same regime

Train vs Test TE -- MA**ICF 3-yr and 5-yr Annualized Std**

MA method does well in recent years for volatilities are close in training and test period.

Improvements

- Computational power: more total stocks
- Finding global minimum

FSCSX

- Fidelity Select Software & IT Services Portfolio
- Large-cap, high-growth

HICOX

- Colorado Bond Shares Tax-Exempt A
- High Sharpe ratio: 2.38

AGG

- iShares Barclays Aggregate Bond Fund
- 40% US treasury

Correlation

	AGG	FSCSX	HICOX
AGG	1.00	-0.12	0.17
FSCSX	-0.12	1.00	-0.69
HICOX	0.17	-0.69	1.00

Tax Concern:

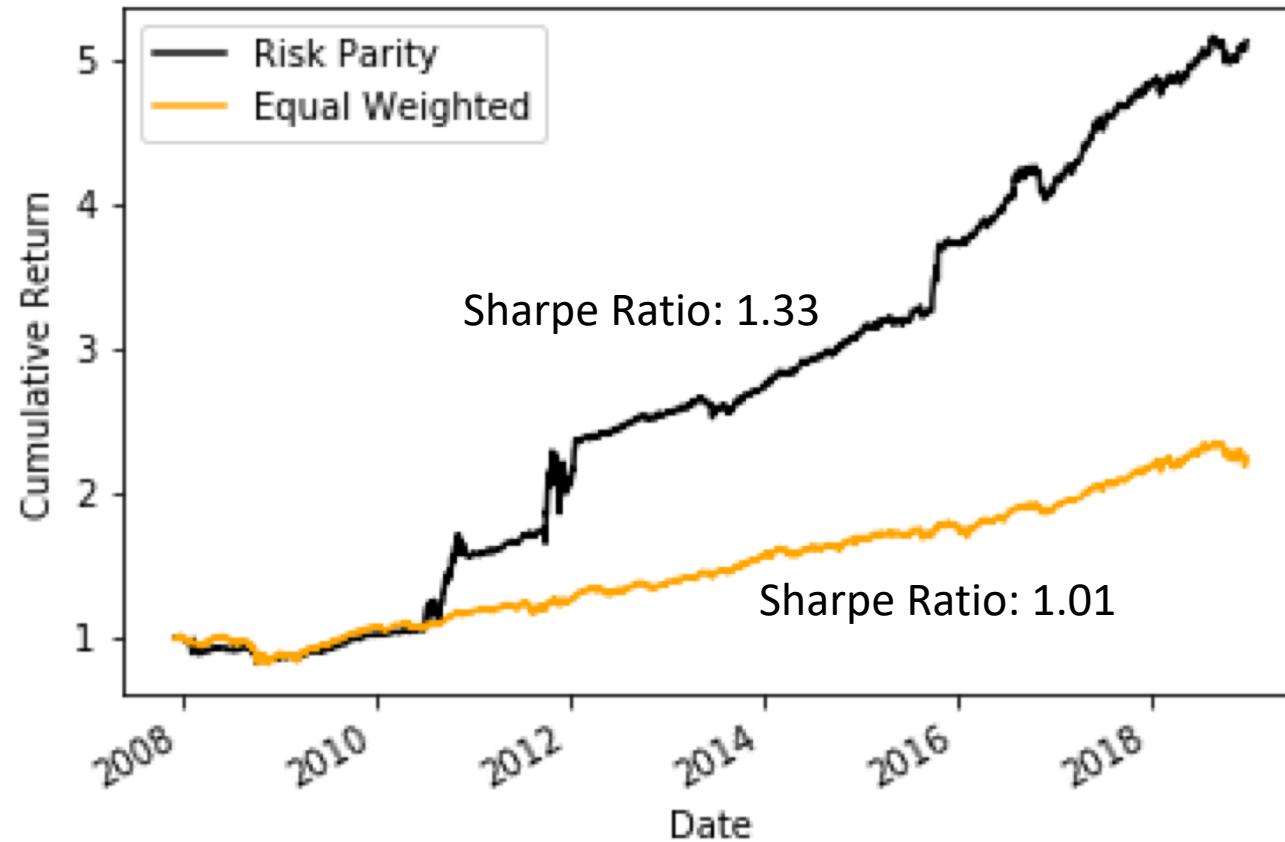
- Tax Reform: advantage over Treasury
- Bond fund: tax exempt

Industry Concern:

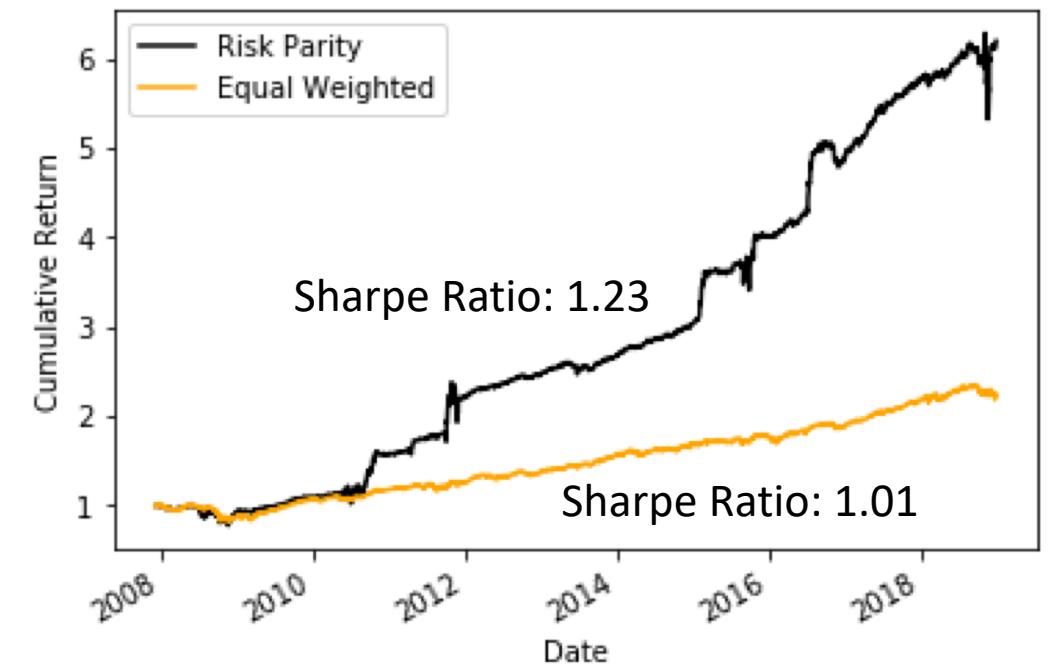
- Flat yield curve
- Trade war ceasing fire

	Sharpe	Return
Equal-weighted	1.01	7.54%
AGG	0.68	3.39%
FSCSX	0.59	13.33%
HICOX	2.38	4.21%

Leverage, Variance Model: MA



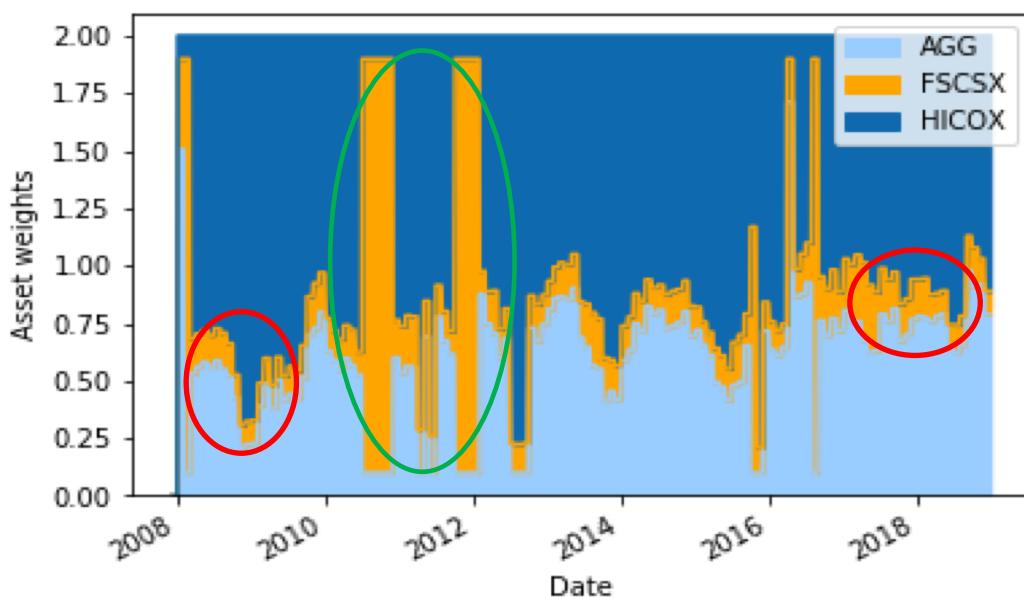
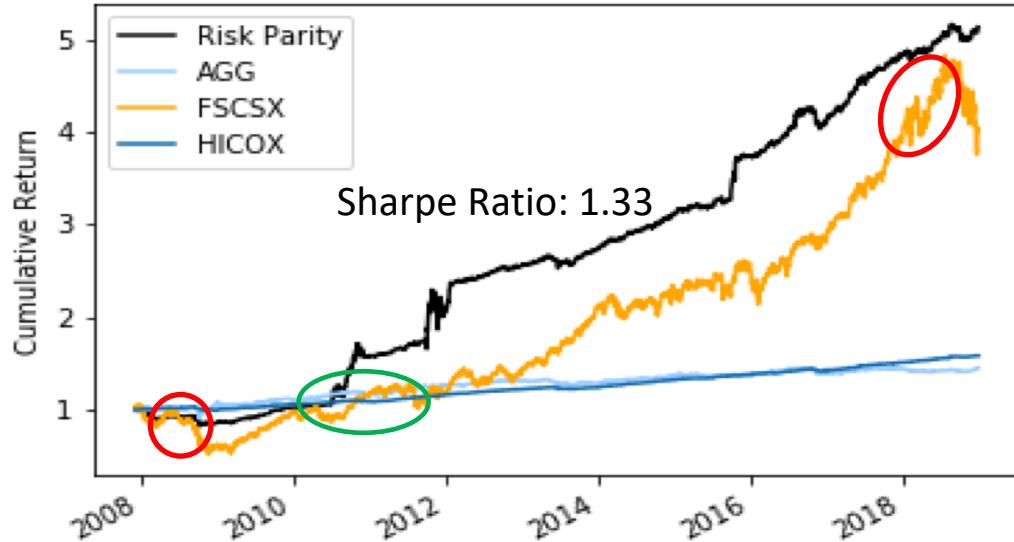
Leverage, Variance Model: EWMA



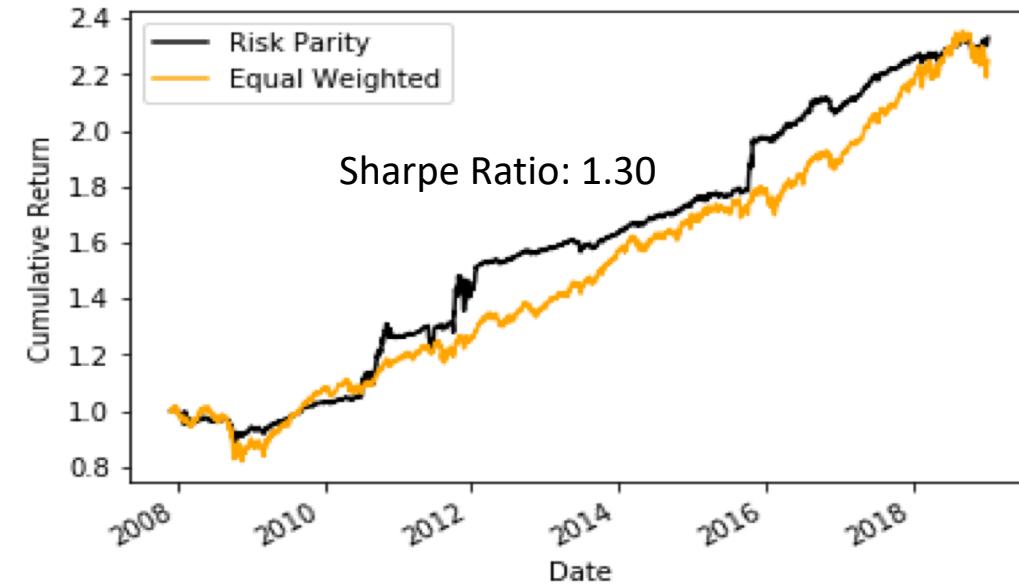
Project 2

Result Analysis

Leverage, Variance Model: MA



Unleverage, Variance Model: MA



- Weight is negatively correlated with volatility
 - protect when market is in downturn
 - compress when market is in upturn
- Leverage helps Sharpe Ratio
- Even though some funds have high Sharpe Ratio, we can not choose them because they might have high return and high volatility(ICF).
- Low correlation can help our Sharpe Ratio.

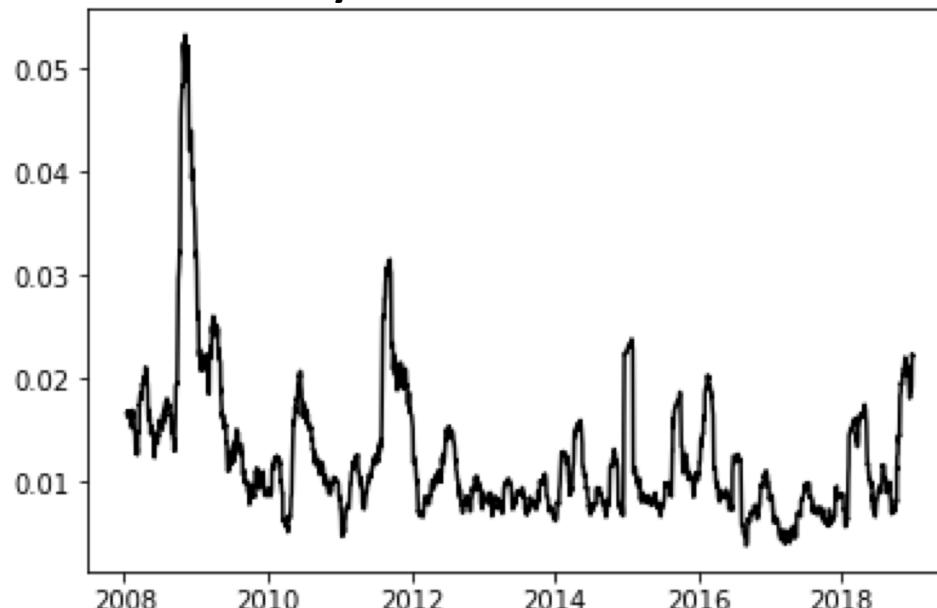
Thank you for listening!

Appendix 1: Tracking Error of Top 15 Stocks (row: periods; column: number of stocks selected)

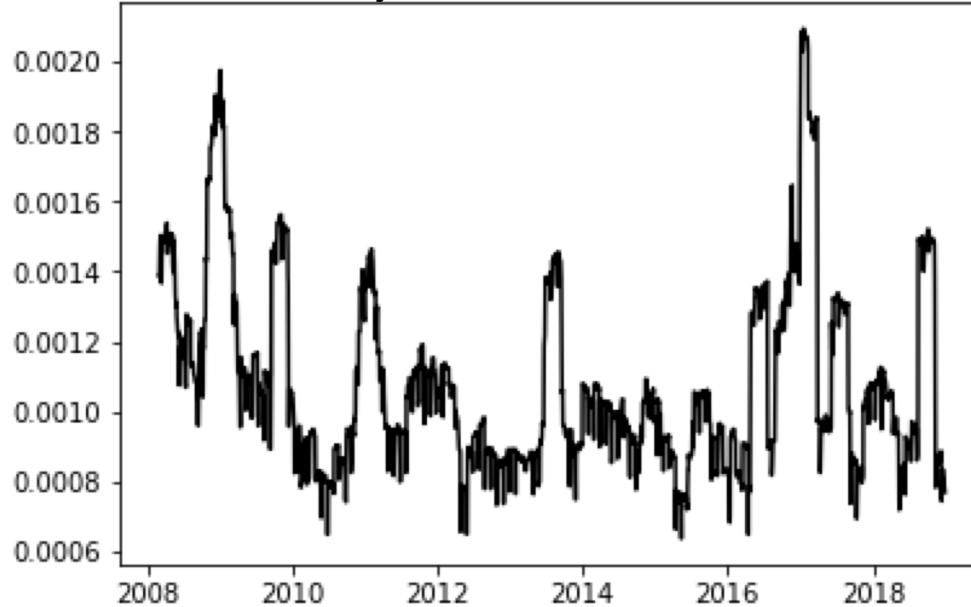
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0.08521	0.06395	0.03399	0.03178	0.03864	0.04291	0.03399	0.01333	0.01452	0.01358	0.00617	0.00457	0.00363	0.00259	0.00033
1	0.10031	0.06563	0.06060	0.02867	0.04764	0.03020	0.02984	0.01513	0.01196	0.01358	0.01224	0.00644	0.00403	0.00219	0.00030
2	0.05571	0.05092	0.04332	0.04013	0.06327	0.05707	0.03257	0.01514	0.02168	0.01543	0.01369	0.00620	0.00440	0.00283	0.00035
3	0.06429	0.06154	0.04237	0.03616	0.05023	0.04650	0.03892	0.02007	0.01574	0.01446	0.00918	0.00862	0.00694	0.00473	0.00017
4	0.07314	0.06287	0.05151	0.04545	0.03888	0.03510	0.02060	0.01598	0.01620	0.01967	0.00854	0.00597	0.00548	0.00399	0.00034
5	0.08987	0.07965	0.05766	0.03131	0.02535	0.02480	0.01716	0.02455	0.01533	0.02265	0.01759	0.00804	0.00690	0.00531	0.00029
6	0.09637	0.08937	0.05948	0.05383	0.05588	0.03910	0.04336	0.02232	0.05285	0.02645	0.00822	0.00756	0.00385	0.00339	0.00011
7	0.09401	0.07294	0.06902	0.05735	0.07119	0.05939	0.03680	0.02461	0.02414	0.02180	0.00982	0.00829	0.00662	0.00331	0.00033
8	0.09507	0.06170	0.05229	0.03737	0.04272	0.04524	0.04552	0.01762	0.01945	0.01894	0.00901	0.00758	0.00574	0.00333	0.00077
9	0.08256	0.06888	0.05088	0.04665	0.06502	0.03059	0.03040	0.02770	0.02156	0.01942	0.00641	0.01283	0.01069	0.00291	0.00059
10	0.06230	0.08483	0.07300	0.04376	0.06017	0.04233	0.05089	0.04688	0.01823	0.02664	0.00958	0.00733	0.00502	0.00273	0.00150
11	0.09068	0.05997	0.05438	0.04308	0.05395	0.04583	0.04914	0.03007	0.02478	0.02444	0.00734	0.01921	0.01730	0.00295	0.00026
12	0.10006	0.06801	0.05920	0.04694	0.03857	0.03835	0.02563	0.02385	0.01988	0.02857	0.01464	0.00878	0.00667	0.00528	0.00015
13	0.07808	0.08469	0.06853	0.04093	0.06262	0.04990	0.02880	0.02154	0.01738	0.01756	0.01240	0.01350	0.00593	0.00426	0.00128
14	0.06522	0.06355	0.04763	0.04015	0.04645	0.04612	0.04169	0.02366	0.02388	0.01922	0.01026	0.00802	0.00493	0.00298	0.00068
15	0.06145	0.05696	0.05009	0.04629	0.03987	0.02750	0.02810	0.01643	0.01512	0.01542	0.00895	0.00784	0.00537	0.00376	0.00090
16	0.05716	0.08991	0.07598	0.05422	0.03843	0.04051	0.02626	0.01565	0.01610	0.01683	0.00934	0.00720	0.00577	0.00366	0.00032
17	0.04551	0.05553	0.02734	0.02569	0.04384	0.02757	0.02983	0.01764	0.01932	0.01185	0.00773	0.00616	0.00441	0.00282	0.00002
18	0.09267	0.05535	0.04629	0.02717	0.03502	0.02911	0.02879	0.01574	0.01662	0.01798	0.00597	0.00467	0.00327	0.00228	0.00031
19	0.03945	0.05029	0.04157	0.03015	0.05538	0.03569	0.03075	0.02920	0.01829	0.01190	0.00703	0.00585	0.00260	0.00153	0.00140
20	0.05884	0.03896	0.03280	0.02543	0.01797	0.04058	0.02132	0.01130	0.01105	0.00927	0.00491	0.00327	0.00400	0.00231	0.00044
21	0.09479	0.04912	0.03041	0.02960	0.04021	0.02131	0.02254	0.01904	0.02013	0.01154	0.01113	0.00500	0.00383	0.00175	0.00106
22	0.08958	0.06430	0.05897	0.04899	0.07284	0.03198	0.02765	0.01799	0.01897	0.01082	0.01153	0.01030	0.00454	0.00236	0.00056
23	0.09605	0.05754	0.05649	0.03367	0.06756	0.04202	0.04387	0.01148	0.02023	0.01310	0.01167	0.00728	0.00442	0.00202	0.00015
24	0.05601	0.04516	0.03618	0.03334	0.05981	0.03831	0.02324	0.02250	0.02128	0.01626	0.00558	0.00567	0.00470	0.00546	0.00040
25	0.08502	0.09015	0.04820	0.03666	0.03819	0.03557	0.03001	0.02124	0.01985	0.01577	0.01171	0.00873	0.00413	0.00299	0.00080
26	0.09912	0.08344	0.05572	0.04198	0.03993	0.04164	0.04378	0.02296	0.02102	0.01382	0.01080	0.00913	0.00651	0.00203	0.00053
27	0.07818	0.06020	0.05425	0.03254	0.03633	0.03862	0.03783	0.01539	0.01514	0.01428	0.00789	0.00671	0.00505	0.00452	0.00034
28	0.07472	0.06254	0.04791	0.03485	0.05283	0.03616	0.02890	0.01969	0.02932	0.01533	0.00915	0.00594	0.00468	0.00233	0.00099
29	0.06143	0.05020	0.03996	0.03018	0.03576	0.03566	0.02533	0.01042	0.01166	0.01831	0.00672	0.00693	0.00425	0.00233	0.00072
30	0.08119	0.06205	0.03215	0.03092	0.04402	0.02651	0.02316	0.02016	0.01945	0.01595	0.00664	0.00603	0.00385	0.00212	0.00017
31	0.06381	0.05769	0.05011	0.03365	0.05209	0.03013	0.02252	0.01846	0.01544	0.01255	0.01039	0.00741	0.00467	0.00228	0.00023
32	0.08226	0.06017	0.05490	0.05562	0.04921	0.05280	0.04243	0.04890	0.04514	0.03463	0.03436	0.00507	0.00421	0.00268	0.00030
33	0.09082	0.09252	0.04465	0.03793	0.06808	0.03282	0.03973	0.02622	0.03795	0.02248	0.02121	0.00924	0.00511	0.00389	0.00013
34	0.09154	0.07386	0.06249	0.03986	0.04822	0.04398	0.05114	0.02652	0.02855	0.02077	0.01203	0.01184	0.00818	0.00663	0.00030
35	0.08502	0.06928	0.05978	0.03929	0.03473	0.03385	0.02891	0.02293	0.02431	0.01972	0.01329	0.01041	0.00825	0.00684	0.00056
36	0.08675	0.05825	0.05225	0.03933	0.04099	0.03808	0.02740	0.03141	0.01787	0.01390	0.01044	0.01139	0.00702	0.00328	0.00036

Appendix 2: Volatility of Selected Assets in Research 2

FSCSX Volatility



HICOX Volatility



AGG Volatility

