Investment side

Assets	Return	Stdev	Return	covariance matrix		
EFA	0.007	0.053	0.007	0.00271685	0.00301339	0.002347
IWM	0.009	0.070	0.009	0.00301339	0.00480253	0.00273944
EEM	0.002	0.055	0.002	0.002347	0.00273944	0.0029205
SPY	0.012	0.054	0.012	0.00249828	0.0032964	0.00211521

3 month t-bill (annual)	5.23
risk free rate (monthly)	0.0043

R(t)

DATE	EFA	IWM	EEM	SPY
4/1/2019	0.02929407	0.03672341	0.02353229	0.04543686
5/1/2019	-0.0503297	-0.078526858	-0.0732985	-0.0637711
6/1/2019	0.0367508	0.066090717	0.05404089	0.06440976
7/1/2019	0.00167907	0.010365939	-0.0191452	0.02005648
8/1/2019	-0.0192397	-0.049310171	-0.0378263	-0.0167433
9/1/2019	0.03164057	0.016796647	0.01691971	0.01477178
10/1/2019	0.03389041	0.030767735	0.04184005	0.02682475
11/1/2019	0.01127267	0.040656017	-0.0009395	0.03619815
12/1/2019	0.01848041	0.024108695	0.05477183	0.02402038
1/1/2020	-0.0172783	-0.027470829	-0.041464	0.00451097
2/1/2020	-0.0776528	-0.088457093	-0.0377584	-0.0791657
3/1/2020	-0.1410669	-0.217795365	-0.1576997	-0.1299871
4/1/2020	0.05817441	0.142878344	0.0735422	0.13361038
5/1/2020	0.05426904	0.065919703	0.02974898	0.04764518
6/1/2020	0.02062372	0.030813711	0.05989943	0.01327576
7/1/2020	0.03385615	0.032674457	0.08880145	0.06355173
8/1/2020	0.04722009	0.054763782	0.0288752	0.06979673
9/1/2020	-0.0204678	-0.036286773	-0.0101035	-0.0412813
10/1/2020	-0.0355068	0.025926765	0.01406225	-0.0210304
11/1/2020	0.14269427	0.182441774	0.08991285	0.10877679
12/1/2020	0.04005702	0.083084449	0.06033232	0.03264658
1/1/2021	0.00181986	0.051726399	0.04240653	-0.0059711
2/1/2021	0.02237871	0.062025716	0.00787845	0.02780545
3/1/2021	0.0251317	0.012047195	-0.0072585	0.04198663
4/1/2021	0.02952428	0.019792269	0.01199857	0.05635885
5/1/2021	0.0348228	0.002712501	0.01648751	0.00656604

6/1/2021	-0.0241247	0.017161715	0.00510309	0.01909351
7/1/2021	0.02151327	-0.034825462	-0.0602732	0.02776387
8/1/2021	0.0144674	0.022031057	0.01569758	0.02975981
9/1/2021	-0.0326142	-0.031736799	-0.038733	-0.04965
10/1/2021	0.03179081	0.045672577	0.01071855	0.07359193
11/1/2021	-0.0453473	-0.043323853	-0.0408483	-0.0080349
12/1/2021	0.02394607	0.019617736	0.00020454	0.042585
1/1/2022	-0.017562	-0.092599188	0.01465528	-0.0494132
2/1/2022	-0.0342917	0.010336013	-0.0432023	-0.0295172
3/1/2022	0.00518988	0.009590726	-0.0338112	0.0343771
4/1/2022	-0.0673913	-0.097220621	-0.061351	-0.0849352
5/1/2022	0.01995923	0.001946538	0.00613487	0.00225739
6/1/2022	-0.1074132	-0.086072047	-0.0595685	-0.0864071
7/1/2022	0.07495494	0.108546706	0.00497708	0.09680502
8/1/2022	-0.0611687	-0.020026768	-0.0132632	-0.0408019
9/1/2022	-0.0922204	-0.101253302	-0.1153943	-0.0961587
10/1/2022	0.05891807	0.117380144	-0.0197821	0.08571718
11/1/2022	0.13168104	0.022036672	0.15589358	0.05559163
12/1/2022	-0.0220502	-0.069434816	-0.0409919	-0.0619358
1/1/2023	0.09440722	0.103254645	0.10792604	0.06776802
2/1/2023	-0.0307479	-0.017234212	-0.0756771	-0.0251426
3/1/2023	0.03129066	-0.051971523	0.03217373	0.03313476
4/1/2023	0.02936244	-0.014313495	-0.0083629	0.01985242
5/1/2023	-0.0400707	-0.00816199	-0.0240225	0.00461622
6/1/2023	0.02589501	0.07768888	0.03587332	0.06085911
7/1/2023	0.04586094	0.064026692	0.06872209	0.0365695
8/1/2023	-0.0393501	-0.050827926	-0.0662694	-0.0162521
9/1/2023	-0.0364882	-0.062934028	-0.0311462	-0.0507826
10/1/2023	-0.0290191	-0.064772198	-0.0329381	-0.0182579
11/1/2023	0.08218767	0.092025232	0.07792912	0.09134385
12/1/2023	0.0404584	0.117165808	0.01643065	0.04143297
1/0/1900	0	0	0	0
1/0/1900	0	0	0	0

	Direct Static Portfolio Calculation:					
		V^-1				
0.00249828		2813.74033	-95.904068	-1028.6554	-1577.5927	
0.0032964		-95.906446	1053.917662	-207.59802	-971.8973	
0.00211521		-1028.6512	-207.59585	1164.72317	274.852137	
0.00287625		-1577.5934	-971.90172	274.859265	2629.69555	
		T-port				
		0.25003108				
		0.24994516				
		0.25026332				
		0.24976044				

		V^-1 x (R-Rfe)	
-5.223		-586.9533	
-5.221		1154.26933	
-5.228		-1066.5029	
-5.218		-1842.7735	

Investment side

Assets	Return	Stdev	Return	covariance matrix		
EFA	0.007	0.053	0.007	0.00271685	0.00301339	0.002347
IWM	0.009	0.070	0.009	0.00301339	0.00480253	0.00273944
EEM	0.002	0.055	0.002	0.002347	0.00273944	0.0029205
SPY	0.012	0.054	0.012	0.00249828	0.0032964	0.00211521

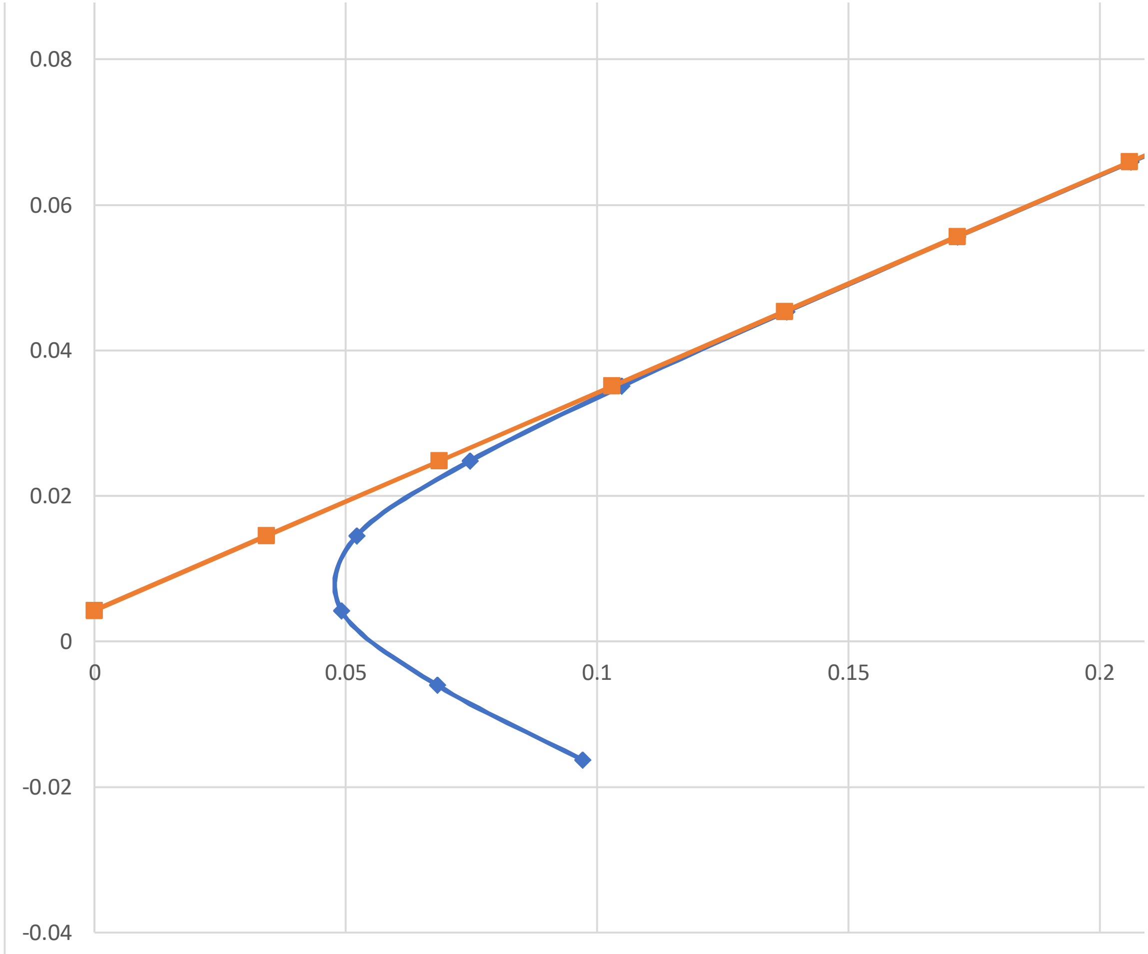
risk free rate 0.0043

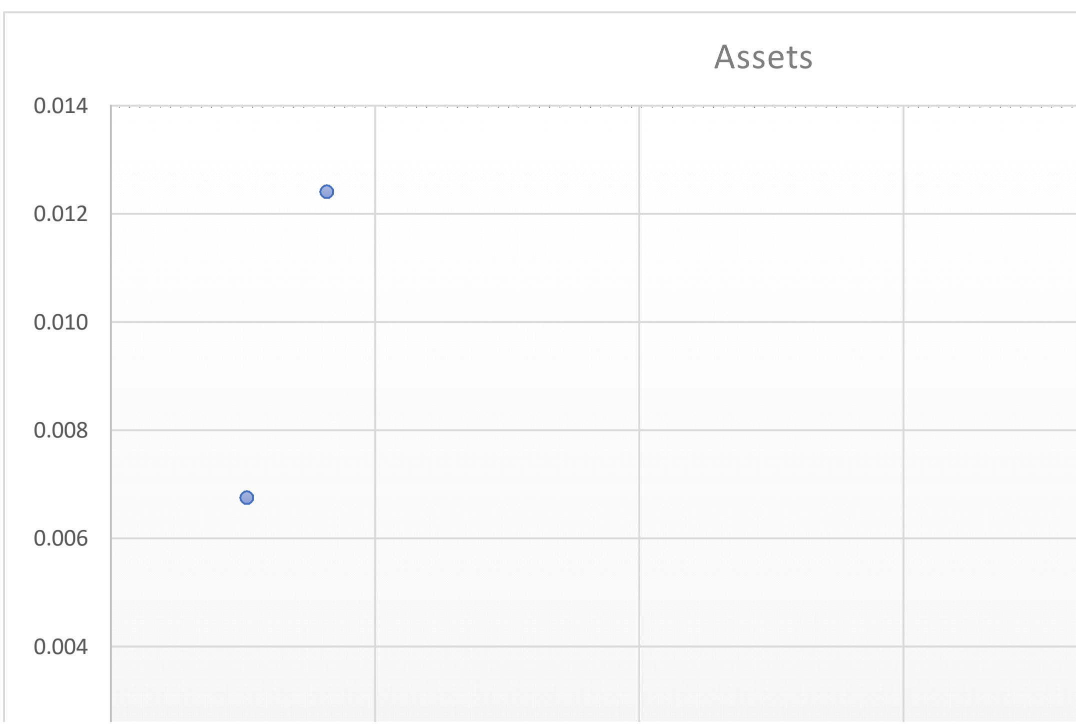
Drawing the Investment Opportunities

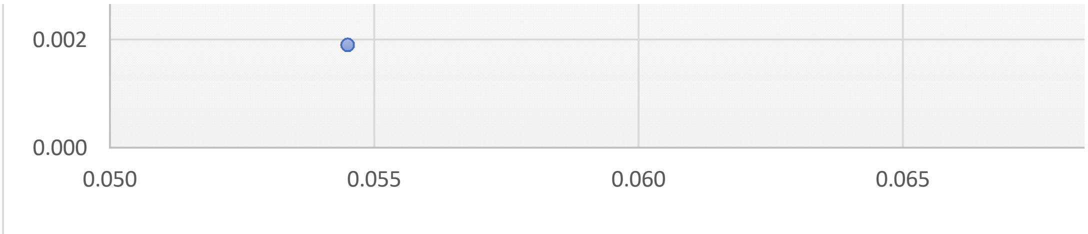
	-40/140	-20/120	**T-port**	20/80	40/60	60/40
Z-weight	-0.4	-0.2	0	0.2	0.4	0.6
T-weight	1.4	1.2	1	0.8	0.6	0.4
EFA	-3.2472631	-2.7192746	-2.1912862	-1.6632977	-1.1353092	-0.6073208
IWM	-2.3736341	-2.0897415	-1.8058488	-1.5219562	-1.2380636	-0.9541709
EEM	-3.45041	-2.8608495	-2.2712889	-1.6817283	-1.0921677	-0.5026071
SPY	10.0713072	8.66986552	7.26842386	5.86698219	4.46554052	3.06409885
std. dev	0.24107166	0.20617966	0.17162126	0.13764795	0.10483012	0.07470639
return	0.07617728	0.06590299	0.05562869	0.0453544	0.0350801	0.02480581
Sharpe	0.29833476	0.29899051	0.29933044	0.29856728	0.29402696	0.27505798

T-portfolio/ Risk Free Combinations

Rf-weight	1	0.8	0.6	0.4	0.2	0
T-weight	0	0.2	0.4	0.6	0.8	1
std. dev	0	0.03432425	0.06864851	0.10297276	0.13729701	0.17162126
return	0.00425722	0.01453152	0.02480581	0.0350801	0.0453544	0.05562869
Sharpe		0.29933044	0.29933044	0.29933044	0.29933044	0.29933044


0.08
0.06
0.04
0.02
0
-0.02
-0.04
0
0.05
0.1
0.15
0.2


Assets
0.014
0.012
0.010
0.008
0.006
0.004


0.002
0.000
0.050
0.055
0.060
0.065

0.00249828
0.0032964
0.00211521
0.00287625

80/20	**Z-port**	120/-20	140/-40
0.8	1	1.2	1.4
0.2	0	-0.2	-0.4
-0.0793323	0.448656145	0.9766446	1.50463306
-0.6702783	-0.386385675	-0.102493	0.18139959
0.08695344	0.676514021	1.2660746	1.85563518
1.66265718	0.261215509	-1.1402262	-2.5416678
0.05217307	0.049115272	0.06820473	0.09716355
0.01453152	0.004257223	-0.0060171	-0.0162914
0.19692713	-1.41278E-16	-0.150639	-0.2114845

-0.2	-0.4	-0.6
1.2	1.4	1.6
0.20594552	0.24026977	0.27459402
0.06590299	0.076177279	0.08645157
0.29933044	0.299330438	0.29933044

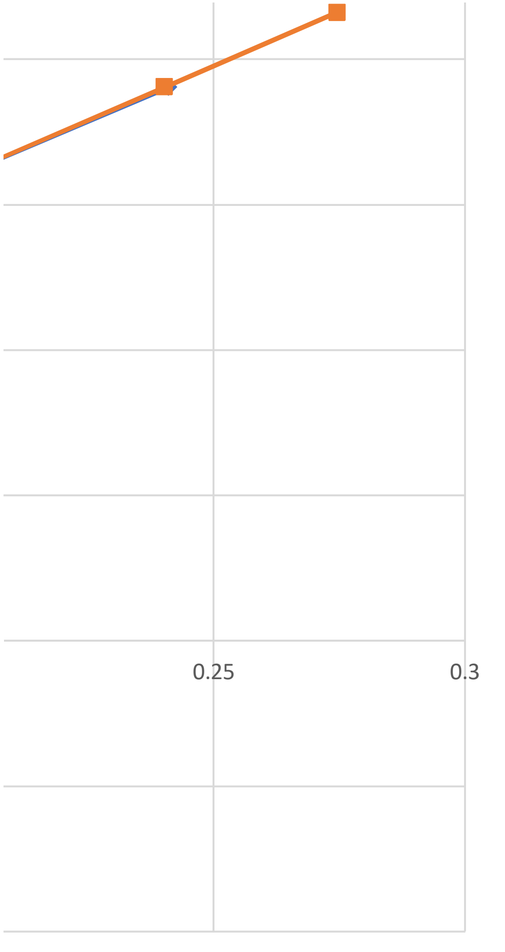
Technical Math Side

Target 1

Target 2

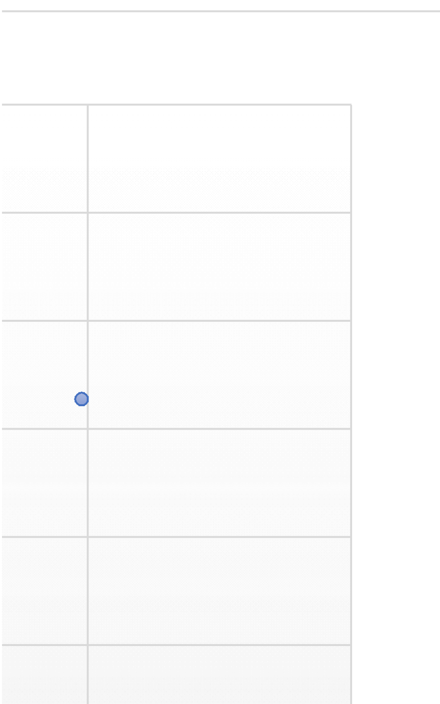
Weight 1	1.393569415
Weight 2	-0.393569415

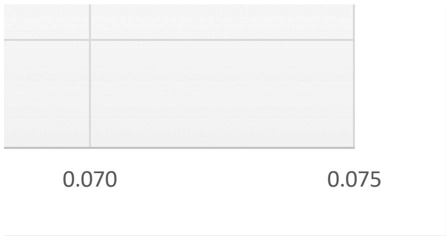
target z



Weight 1
Weight 2

Index Return:




0.070
0.075

Two points on the efficient frontier

0.02

Augmented Matrix

0.00271685	0.003013392	0.002346998	0.00249828
0.00301339	0.004802529	0.002739442	0.0032964
0.002347	0.002739442	0.002920496	0.00211521
0.00249828	0.003296401	0.002115207	0.00287625
-0.007	-0.009	-0.002	-0.012
-1	-1	-1	-1

check return: -0.02

check stdev: 0.062661001

0.06

Augmented Matrix

0.00271685	0.003013392	0.002346998	0.00249828
0.00301339	0.004802529	0.002739442	0.0032964
0.002347	0.002739442	0.002920496	0.00211521
0.00249828	0.003296401	0.002115207	0.00287625
-0.007	-0.009	-0.002	-0.012
-1	-1	-1	-1

check return: -0.06

check stdev: 0.186271781

Finding the return of the Index Porfolio

0.00425722

0.007
0.009
0.002

0.012

check return:	0.004257223	
check variance:	0.00241231	
check stdev.	0.049115272	
Covariance(Target1,TargetZ):		0.00167306
Beta(Target1, TargetZ):		0.69355019
Index Return		0.05562869

Finding the weights of the Index Portfolio

0.10928271

0.89071729

0.05562869

Covariance Check -2.01896E-08

		RHS	solution
-0.007	-1	0	-0.3603537
-0.009	-1	0	-0.8213799
-0.002	-1	0	-0.2268396
-0.012	-1	0	2.40857316
0	0	-0.02	0.14313504
0	0	-1	0.0010637

1.32802E-12

		RHS	solution
-0.007	-1	0	-2.4159245
-0.009	-1	0	-1.926634
-0.002	-1	0	-2.5221237
-0.012	-1	0	7.86468221
0	0	-0.06	0.62613396
0	0	-1	-0.0028709

Solution
0.448656145
-0.38638567
0.676514021

0.261215509

0.004257223

0.306449808

Solution

-2.19128615

-1.80584882

-2.27128888

7.268423855