Asset Allocation Report

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0 Road Map

This report is supposed to demonstrate an asset allocation plan across seven assets along with the related features of the portfolio construction. In this report, capital market expectations are built with seven assets, whose proxies are seven indices. A discussion on efficient frontiers incorporating both returns and risk profiles and reasonable shocks would be illustrated in the following section. The portfolio we choose would be selected from the portfolio set on the frontier. A conditional VaR would be computed based on assumptions underlying the descriptive statistics derived from historical performance of the assets universe. At the end, some professional views on the performance expectation will be introduced into the optimization through Black-Litterman model, thus offering a more applicable allocation strategy.

1 Investment Policy Statement

1.1 Investors Profile

Investors defined all through this document are limitedly referring to the clients who bought our asset allocation product/plan to meet their specific investment objectives. Investors' demands vary according to different risk tolerance and required rate of return.

1.2 Investment Objective

Due to various investment demand, we assume all the investors are willing to choose from the efficient frontier set, that is, the optimal (highest return) portfolio given the specific risk tolerance. The construction of the frontier are based on how much information the investors want to be added into consideration.

In this report, our client's (one of investors) target volatility tolerance is 7%, in terms of standard deviation. We will particularly present the optimal portfolio as a customized case under this objective.

1.3 Investment Constraints

The horizon of this long-term investment would be during early 2017 to late 2026. and we assume the investors are allocating, or preparing to allocate their assets at the beginning of 2017.

Due to the conservative policy and risk-aversion profiles, investors will invest all in long position, that is, no short position would be introduced in the report.

1.4 Investment Range (Universe)

After prudent considerations on the selection of applicable assets and their proxies, we finally choose Russell 1000® Index (for convenience shortened to **R1000**, same below), Russell 2000® Index (**R2000**), MSCI EAFE Index (**EAFE**), MSCI Emerging Markets Index (**EM**), BofA Merrill Lynch U.S. Corporate Master Index (**Corporate**), BofA Merrill Lynch U.S. High Yield Index (**HY**), and U.S. 3-Month Treasury Bill (**T3M**).

Given the historical performance and our rigorous estimation involving the industry and macro features, we show at the table as follows the Risk/Return Profiles of each of the asset classes.

Index	$E[R]$	SD	R1000	R2000	Corporate	HY	T3M	EAFE	EM
R1000	8.61%	17.5%	1						
R2000	7.35%	18.2%	.867	1					
Corporate	2.97%	6.2%	.452	.426	1				
HY	4.49%	13.5%	.729	.82	.668	1			
T3M	1.85%	2.6%	.228	.058	.138	-.065	1		
EAFE	13.51%	20.0%	.805	.779	.254	.666	.149	1	
EM	13.86%	31.2%	.594	.692	.393	.699	.158	.764	1

Table 1: Assets Profiles and Correlations

2 Optimal Allocation Advice

This section offers some advice based on different sets of information/assumptions. It is just a guidance for investors to refer to according to the information/assumptions they would like to trust in. All the strategies, if not especially mentioned, are the copyrights of **DDGG Asset Allocation Group, Quasi-Inc.**

2.1 Optimal Portfolio Selection: Efficient Frontier

Considering about all the feasible weights across the seven assets as well as their risk/return profiles, it's always optimal to choose least volatile portfolios at given required return level, or to choose highest-return portfolios at given desired volatility level, which is so-called "efficient portfolios".

Employing the expected returns we forecast using key indices extracted from statements and statistic summaries, we figured out a set of efficient portfolio. This is the incipient takeaway.

However, no analysts can ensure a 100% forecast. Out of the purpose of risk management and our profession, we also give an augmented version of the frontier, which offer a conservative allocation plan even in case the estimation is over-confident.

Both frontiers, original and augmented, are graphed in **Figure 1**, along with individual asset profiles. A simple economic intuition is that the more volatile the portfolio is, the more high-volatility components it may contain. The irregular part in the figure is due to the "no shorting" rule specified in the constraints part in the Investment Policy Statement section. That's also the reason EAFE and EM are lying right on the frontier. This rule also ensure the global maximum/minimum return/risk would not exceed the maximum/minimum return/risk of the seven individual assets.

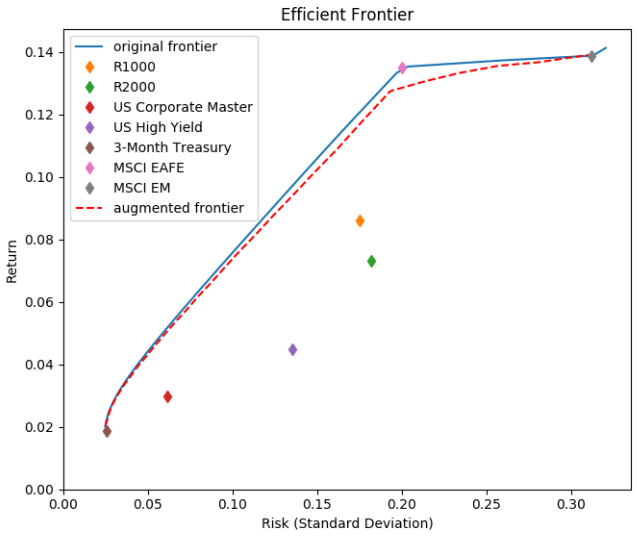

Figure 1: Security Universe, Original, and Augmented Efficient Frontier

Also, to better demonstrate the components of each portfolio on the frontier set, we present two stacked area charts in **Figure 2**.

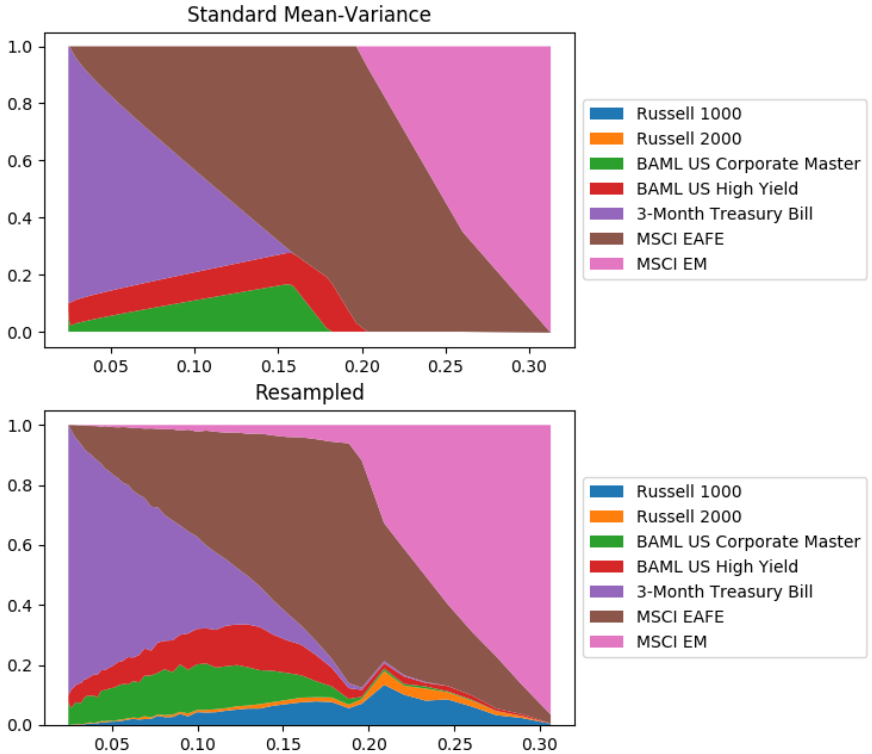

Figure 2: Stacked Area Charts: Original (Standard) and Augmented (Resampled) Versions

2.2 Optimal Portfolio With Specified Volatility

From the augmented frontier set computed in the last subsection, we pick up the desired portfolio with a required volatility level, 7%.

Listed in **Table 2** and **Figure 3** are some key features of the product which we named ***Optimal No. 1***.

Product Name	***Optimal No. 1***
Expected Return	5.62%
Standard Deviation	7.0%
Sharpe Ratio (Risk-free: R_{t3m})	0.54
Product Components	
Russell 1000	2.26%
Russell 2000	1.38%
US Corporate Master	20.46%
US High Yield	0.17%
3-Month Treasury	47.35%
MSCI EAFE	27.34%
MSCI EM	1.04%
Total	100%

Table 2: Product Introduction - ***Optimal No. 1***

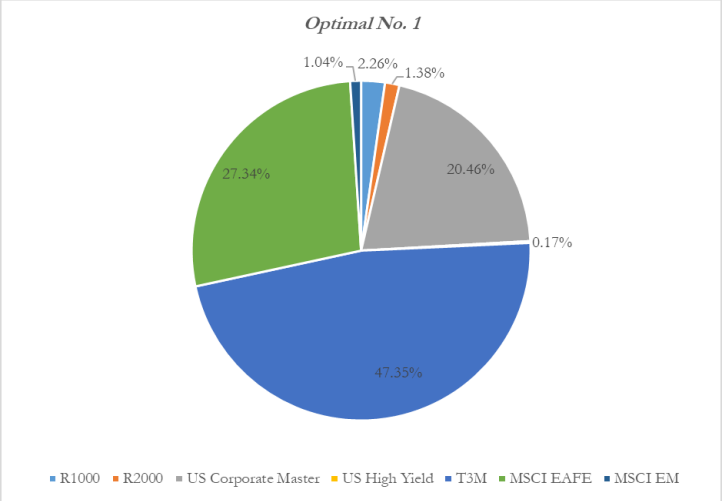

Figure 3: Components of ***Optimal No. 1***

Optimal No. 1 concentrates a lot on the average volatility tolerance of the client. About 50% of the portfolio is the least volatile asset in the universe - 3-Month Treasury Bill. For volatile assets, the plan includes about a quarter of EAFE index, almost the whole world except for United States and Canada. It is a healthy and growth-styled investment item considering the development of the related countries. Another foreign index, Emerging Markets index, is not included much, because although the growth of the emerging markets are witnessed by years, the large volatility it brings would be unfavourable for our client. And we highly recommend low-risk-tolerance clients keep away from high-yield products.

Another key feature of ***Optimal No. 1*** is that it contains little of US equities but about a quarter of US debts. Based on this feature and other components of the portfolio, ***Optimal No. 1*** is a bond-oriented product.

3 Risk Management

3.1 What If Things Go Very Bad - Conditional Value at Risk of *Optimal No. 1*

Standard deviation is not the only measure of risk. Here we introduce Conditional Value at Risk (CVaR). It measures, at the average, how much our client would lose when the market goes very bad. After the scientific computation, we prepare **Table 3**, presenting some characteristics of the historical performance.

Index	$E[R]$	SD	$Skewness$	$Kurtosis$	Weight
R1000	8.61%	17.5%	-1.46	2.94	2.26%
R2000	7.35%	18.2%	-0.88	1.04	1.38%
Corporate	2.97%	6.2%	-0.20	0.28	20.46%
HY	4.49%	13.5%	0.10	2.97	0.17%
T3M	1.85%	2.6%	0.27	-1.17	47.35%
EAFE	13.51%	20.0%	-1.16	1.73	27.34%
EM	13.86%	31.2%	-0.51	0.52	1.04%
Optimal No. 1	5.62%	7.0%	-1.36	2.67	100%

Table 3: Statistics - Member Assets of ***Optimal No. 1***

After prudent estimation and simulation, we present the following conditional value at risk, under significance levels varying from 1% to 5%, in **Table 4**.

Significance	**VaR**	**CVaR**
1%	17.3%	22.8%
2%	13.4%	19.0%
3%	11.1%	16.7%
4%	9.4%	15.1%
5%	8.1%	13.8%

Table 4: VaR and CVaR Under Different Significance Levels

The definition of VaR and Conditional VaR might be annoying, but they are easy to understand if we apply it into our ***Optimal No. 1***. For example, the first line of the table above means that, if our client invests one million dollars in ***Optimal No. 1***, the 1% worst case is that he/she will lose $173,000 (VaR) at the end of the first year (Late 2017), and among all cases he/she loses more than $173,000, she will lose on average $228,000 (CVaR).

Or in a more detailed version, if one can buy $1,000,000 ***Optimal No. 1*** in 100,000 different parallel universes, it is easy to imagine that the product value moves differently in each of the universes. In some it performs well and you win, in some not so good. So here is a rank list of the 100,000 outcomes, from top to low, best case to worst case. The first line of the table above means in the 99,001st row in the list our investor might lose around $173,000. While the average loss of the last 1000 rows (row 99,001 - 100,000, counting 1% of all cases) would be around $228,000. See, in most cases ***Optimal No. 1*** performs so well that you may spend days to scroll down to the end to find these losses at the bottom of the rank list.

3.2 A More Conservative Estimation

To reassure our clients who have doubts towards the historical statistics employed by the construction of ***Optimal No. 1***, our profession and responsibility requires us to make more prudent estimation on expected returns. The control portfolio described in this section is constructed based on the comprehensive consideration on the expected return of each of the assets. This portfolio offers a set with smaller estimation of returns and is highly recommended to advanced investors as a risk management reference. Two 50%-confidence View Matrices are at **Table 5**.

(Matrix P)	View 1	View 2	View 3	View 4	View 5	View 6	**Absolute Expectation** (Matrix Q)
R1000	1	0	0	0	0	0	8.61%
R2000	0	1	0	0	0	0	7.35%
Corporate	0	0	1	0	0	0	2.97%
HY	0	0	0	1	0	0	4.49%
EAFE	0	0	0	0	1	0	13.51%
EM	0	0	0	0	0	1	13.86%

Table 5: View Matrices, with 50%-Confidence

Our (and investors') confidence on the absolute expectation is 50%, leading to an adjustment on the expected returns we estimated in the Investment Policy Statement. We compare new set of adjusted expected returns and the related correspondent new efficient frontier with the previous versions in **Table 6** and **Figure 4**.

Index	Original	Adjusted
R1000	8.61%	8.57%
R2000	7.35%	8.51%
Corporate	2.97%	2.11%
HY	4.49%	6.51%
T3M	1.85%	1.85%
EAFE	13.51%	10.05%
EM	13.86%	13.86%

Table 6: Comparison: Original and Adjusted Expectation

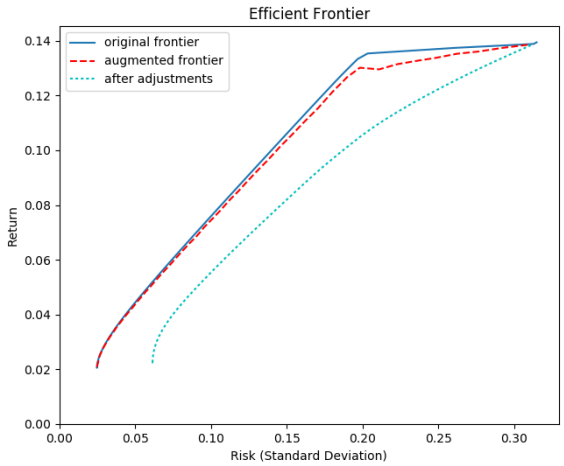

Figure 4: Original, Augmented, and Adjusted Efficient Frontier

The 50% confidence slightly retrenches the estimation of the expected return of each asset, but the less aggressive estimation will be healthier, safer, and more robust. We pick from the new frontier the portfolio with volatility of 7% as an customized case of control portfolio and compare it with ***Optimal No. 1*** at **Table 7**. We also prepare the components pie chart at **Figure 5**.

Product Name	***Optimal No. 1***	***Control Portfolio***
Expected Return	5.62%	3.42%
Standard Deviation	7.0%	7.0%
Sharpe Ratio (Risk-free: R_{t3m})	0.54	0.22
Product Components		
Russell 1000	2.26%	0
Russell 2000	1.38%	0
US Corporate Master	20.46%	80.20%
US High Yield	0.17%	0
3-Month Treasury	47.35%	0
MSCI EAFE	27.34%	19.80%
MSCI EM	1.04%	0
Total	100%	100%

Table 7: Products Contrast - ***Optimal No. 1*** and Control Portfolio

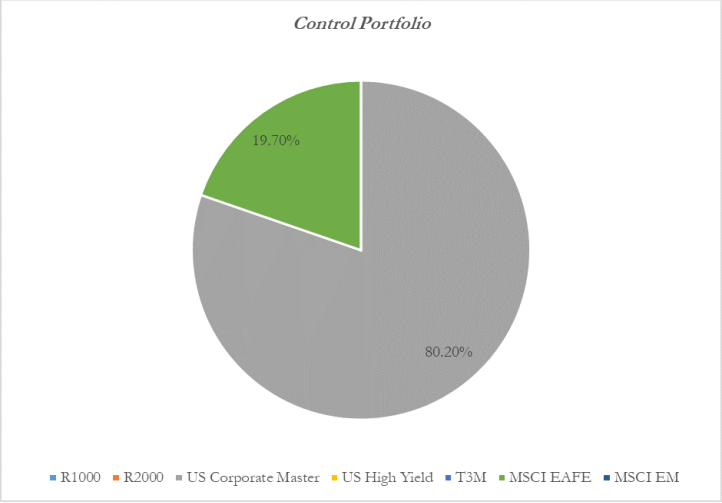

Figure 5: Components of Control Portfolio

Control portfolio here is evidently a bond-oriented product. The introduction of the confidence of views impacts a lot on the estimated performance of domestic equity markets and makes related indices more inferior. It also lowers the whole level of the frontier set.

References

1. Gambera, M. (2017). *MVO_test.m*.
2. Maginn, J. L., Tuttle, D. L., McLeavey, D. W., & Pinto, J. E. (Eds.). (2007). *Managing investment portfolios: a dynamic process* (Vol. 3). John Wiley & Sons.
3. Rockafellar, R. T., & Uryasev, S. (2000). *Optimization of conditional value-at-risk*. Journal of risk, 2, 21-42.
4. CAO, Z. (2013). *Matlab in Finance*. Shanghai University of Finance and Economics Press, Co., Ltd.
5. Idzorek, T. M.(2002). *A step-by-step guide to the Black-Litterman model*[J]. Forecasting expected returns in the financial markets.
6. Pearson, N. D. (2011). *Risk budgeting: portfolio problem solving with value-at-risk* (Vol. 74). John Wiley & Sons.
7. Christoffersen, P. F. (2012). *Elements of financial risk management*. Academic Press.