Automated Risk-managed Investment™

An introduction to the investment approach of Syfe, a digital wealth manager based in Singapore

by

Akiko Matsumoto, PhD

Richard Yeh

et al.

Syfe Pte. Ltd.

Singapore

June, 2019

Table of Content

Executive Summary

Most retail wealth managers often sell products by promising or showing returns from previous years - even though they know that the past performance is not an indicator of future performance. Investors should not be looking for something that cannot be accurately predicted, i.e. returns, but rather on what can be managed, i.e. risk. By using award winning academic research, further accentuated by the use of technology, it is possible to now offer solutions typically reserved for the ultra high net worth individuals to everyone in an easy, cost-effective and transparent way.

1. Introduction

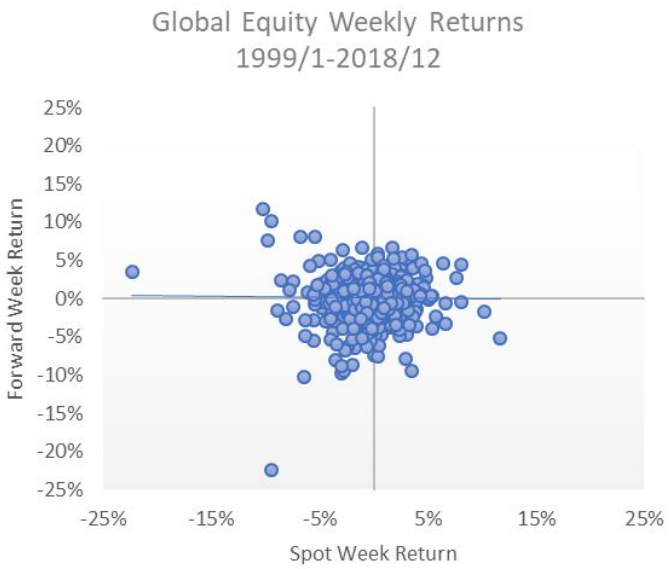
With the advent of the digital age and the resulting technological advances, the ability to provide superior investment service to retail consumers at lower costs provided the impetus for the growth of so-called digital wealth managers over the last decade. The earlier ones have acted as market disruptors, and their continued success provides testimony on how inefficient and costly investment advisory services provided by banks and other financial institutions had become; essentially using dated infrastructure and legacy systems.

At Syfe, we developed a proprietary **Automated Risk-managed Investment** ("ARI") technology to provide investors with customised investment portfolios based on their individual risk profiles based on an optimal blend of the Global Market Portfolio and Risk Parity, by **focusing on risk management**. The Global Market Portfolio is a result of Modern Portfolio Theory that won the Nobel-Prize and Risk Parity is a risk diversification paradigm conceptualized by Ray Dalio at Bridgewater[1], one of the world's largest institutional funds.

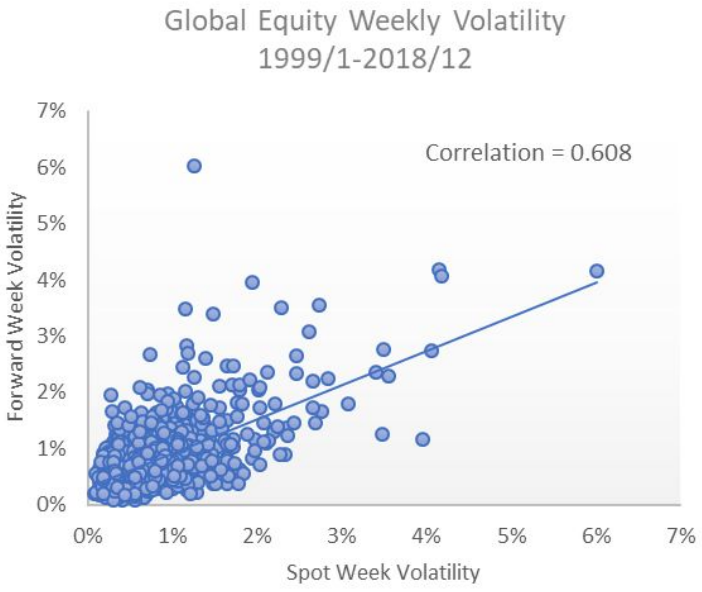
Why Risk Management Focus

From the chart below, it is quite evident that past returns have almost no correlation with future returns. Accordingly, we do not believe that expected returns can be accurately forecasted by past returns (*as the Risk Disclosure statement in every selling document is obliged to proclaim*).

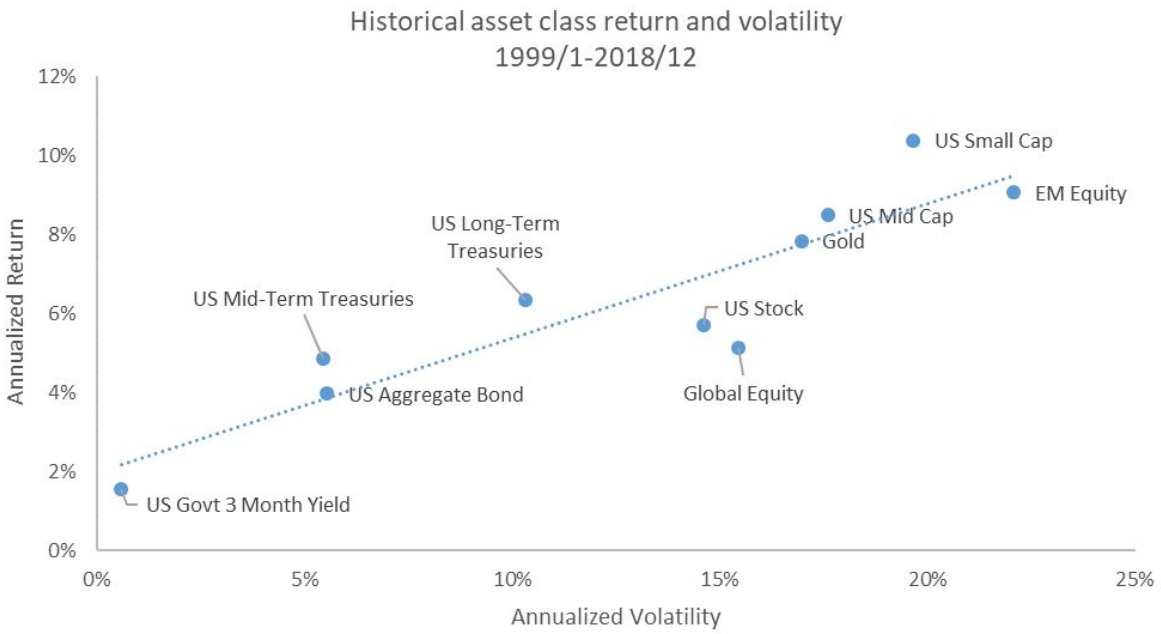
[1] https://www.bridgewater.com/leadership/ray-dalio/



However, risk, as measured by volatility of returns, can be relatively reliably estimated using past data as can be seen from the chart below.



Over the long-term, say an investment horizon of 20 years which includes two significant periods of market volatility, the tech bubble and the global financial crisis (GFC) systematic risk is highly correlated with returns.

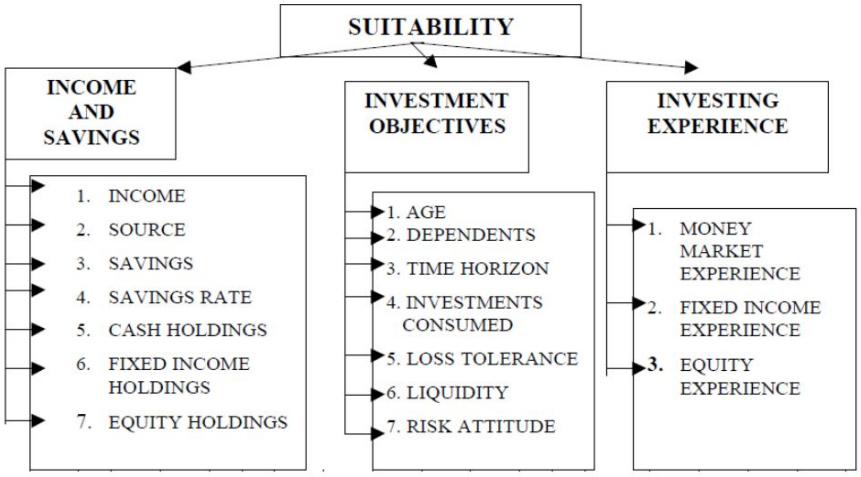


2. Investor Risk Profiling

The investment process starts with the investor. We would determine the prospective investor's risk profile and investment suitability through a Risk Questionnaire.

The first few questions are information gathering tools, helpful to gain an insight into each investor's financial world while setting the stage for the subsequent risk/reward questions. We endeavour to understand each prospective client's feelings and biases regarding financial risk in the context of their personal financial position.

An illustration below extracts from a series of factors drawn from the "know your customer" rule generically required in established market jurisdictions.



Essentially, we seek to help the investor understand the three facets of his or her risk profile to identify the right level of risk for him or her.

Risk needed

Risk Needed is the amount of risk necessary to achieve an investor's financial goals. For instance, if two investors in similar situations both need to reach one million dollars in savings and are starting with account balances of $500,000 and $900,000, the Risk Needed for the first investor will be higher.

Risk capacity

Risk Capacity is the investor's ability to take risk or the amount of risk they should take based on their financial situation and lifestyle. Investors with similar characteristics will have a similar Risk Capacity and it can be seen as a measure of a segment or group. Generally Risk Capacity is higher if there is more time to achieve a goal, higher income, higher monthly savings and lower age of an investor. This is the most prevalent method used in the financial industry to assess risk. Risk Capacity ignores the possibility of emotional responses or actions of a particular individual. It assumes that the investor is a perfectly rational investor.

Risk tolerance

Risk Tolerance is an individual investor’s willingness to take risk and be comfortable with it. It is a measure of personal behavioural traits and gauges the emotional response to risk.

Along with self-assessment, factors such as high (or low) risk free quota indicate a lower (or higher) Risk Tolerance.

From these data points, we would be able to calculate each investor's monetary utility. Upon completion of a Risk Questionnaire, we convert the solution into an understandable and actionable Risk Number that we call Downside Risk. Downside Risk ("DR") is our customer-friendly name for Value-at-Risk ("VaR"). The three risk facets are each expressed as an X% Downside Risk. Syfe's portfolios are also defined by DR. Syfe offers 11 portfolios beginning with 5% DR and incremented by 2% to end at 25% DR. Hence the transition from risk profiling to portfolio selection is seamless.

Each investor's recommended Downside Risk and how this is translated into an investment portfolio is described in subsequent sections of this White Paper.

3. Investment Universe

Extracting from seminal research by Brinson, Hood and Beebower[2], which intuited that the best way to maximize returns across every level of risk is to combine asset classes rather than individual securities, we start by identifying a broad set of diversified asset classes to serve as the building blocks for our portfolios.

Asset classes generally fall under 3 broad categories that reflect investment opportunities under different economic regimes manifested by the intersection of economic growth and inflation:

(a) Stocks offer investors exposure to economic growth and long-term capital gains despite higher short-term volatility;

(b) Bonds offer investors income-producing assets, has relatively lower volatility than stocks, and provide some diversification benefits to stock-heavy portfolios in times of economic turbulence; and

(c) Inflation Assets such as Real Estate, Commodities, Natural Resources, and Inflation-Linked Securities, that provide investment relief during high inflation regimes.

[2] Determinants of Portfolio Performance FAJ 1986

3.1 Exchange Traded Funds ("ETFs")

Our investments would predominantly be in ETFs; however, where bond-like ETFs are not available or inappropriate due to high cost or illiquidity, we would consider investing in liquid government securities, e.g. SGS.

Since their introduction more than 25 years ago, exchange-traded funds (ETFs) have seen their popularity grow with investors looking for alternatives to mutual funds. Market participants saw the benefits associated with using these investment vehicles—a basket of assets designed to track an index—that offered low management fees and higher intraday price visibility. However, as no investment vehicle is perfect, identifying the advantages and disadvantages of ETFs can help investors navigate the risks and rewards of using ETFs for their portfolios.

There are numerous advantages to ETFs when compared to their mutual fund counterparts:

(a) Diversification: an ETF can give exposure to a broad range of stocks, bonds, or commodities and can even endeavour to mimic the returns of a country or a group of countries.

(b) Trades Like a Stock: an ETF trades like a stock in that although the ETF might give the holder the benefits of diversification, it has the trading liquidity of equity. In particular:

(i) ETFs can be purchased on margin and sold short*

(*might be worth noting that currently at Syfe we do not use either of these options)

(ii) ETFs trade at a price that is updated throughout the day. An open-ended mutual fund, on the other hand, is priced at the end of the day at the net asset value.

(iii) ETFs also allow you to manage risk by trading futures and options just like a stock.

(iv) Because ETFs trade like a stock, you can quickly look up the approximate daily price change using its ticker symbol and compare it to its indexed sector or commodity.

(c) Lower Management Fees: ETFs, which generally tend to be passively managed, have much lower expense ratios when compared to mutual funds that tend to be actively managed funds.

(d) Zero Entry/Exit costs: Unlike most funds which have charges on one or both sides of trading

(e) Higher liquidity: Given they can be traded by all, ETFs generally have higher liquidity further decreasing the cost of trading them.

Our ETFs would be selected to reflect a diverse set of asset classes covering the 3 broad categories in a geographically diversified manner; and would comprise primarily of low cost and passive, i.e. index tracking, ETFs. Besides considering fees, our ETF selection criteria would also take into account

(i) withholding tax considerations,

(ii) index tracking error, i.e. performance risk,

(iii) trading liquidity, and

(iv) use of derivatives and securities lending, i.e. credit risk.

4. Our Portfolio Construction

4.1 Modern Portfolio Theory – Global Market Portfolio

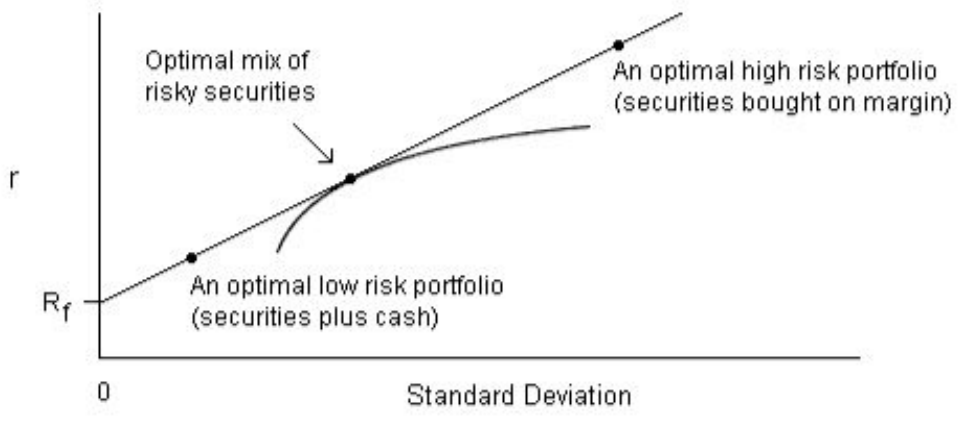
Modern Portfolio Theory (MPT) which provides the key tenets for "efficient" risk-adjusted portfolio investing was first established when Nobel laureate Harry Markowitz wrote his seminal paper based on which the goal was for an investment portfolio to deliver the greatest return for the least amount of risk.[3]

Another Nobel laureate James Tobin, who has worked closely with Markowitz provided another aspect of MPT when he concluded that although many "efficient" portfolios existed, depending on the investor's risk tolerance, there was only one super-efficient portfolio that

[3] Harry Markowitz (1952) Journal of Finance. 7:1, pp. 77–99

cannot be improved upon[4]. The super-efficient portfolio (a.k.a. the "tangency" portfolio) was located on a pivotal edge of utility where any change made to it was a change for the worse, delivering poorer returns for greater risk.

Given this super-efficient portfolio, Tobin's Separation Theorem says you can separate the problem into first finding that optimal combination of risky securities and then deciding whether to lend or borrow, depending on your attitude toward risk.



Subsequently, a clearer perspective to MPT was added when William Sharpe, also a Nobel Laureate, proved that Tobin's super-efficient portfolio was none other than the global market portfolio[5]: the portfolio of all risky assets proportionally weighted by their respective market capitalization - which was then approximately 60% equities and 40% fixed income securities.

4.2 Post MPT – Risk Parity

Notwithstanding the modern investing world gravitating towards the use of the global market portfolio as the accepted "benchmark" to be measured against, one of the key tenets of efficient investing, viz. portfolio diversification, appeared to be deficient in MPT's golden child. While diversification in asset allocation in a global market portfolio comprising 60% equities and 40% fixed income securities appeared to pass muster, from a risk diversification perspective it does not.

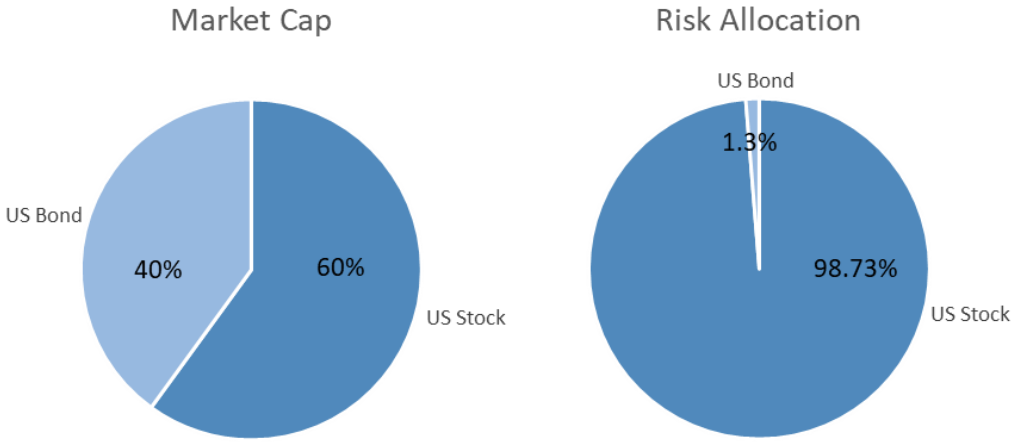
[4] James Tobin (1958) Review of Economic Studies, XXV(2):65–86

[5] William F. Sharpe (1964) Journal of Finance. 19:3, pp. 425– 42.

One well-understood axiom on investing is: Don't put all your eggs in one basket. Apparently, many investors who invest in a balanced portfolio of 60% equities and 40% fixed income securities do not realize a 60/40 portfolio does not offer true risk diversification. From a risk contribution perspective over 90% of your eggs are in one basket providing little or no diversification.

Assuming returns from equities and fixed income securities have annual volatilities (measured in standard deviations) of 15% and 5%, respectively, from a risk contribution perspective (measured in terms of their respective variances) the stock "eggs" are about nine times as big as the bond "eggs".

While our egg analogy might appear simplistic, it is not far from reality. For example, from 1999 to 2018, the respective returns of the Vanguard Total Stock Market Index had an annualized volatility of 15.0% and the Vanguard Total Bond Market Index had an annualized volatility of 3.4%, while the correlation between the two was close to 0. Based on these inputs, equities contributed 98.7% of risk and fixed income securities contributed the remaining 1.3% for a 60/40 portfolio. While a 60/40 portfolio might appear balanced in terms of capital allocation, it is highly concentrated from the perspective of risk allocation.



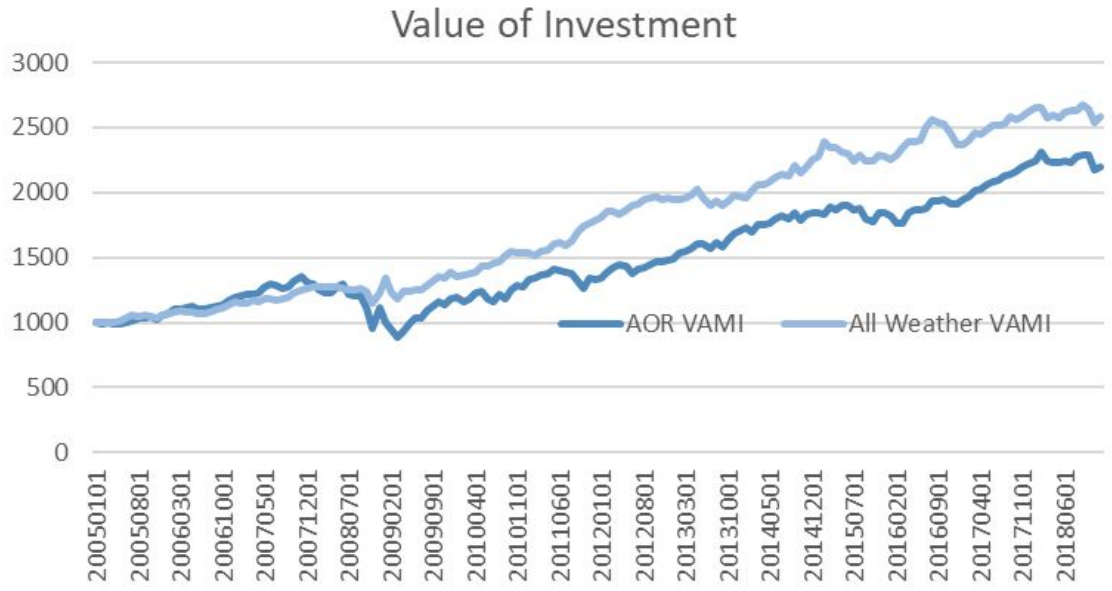
Why should investors care about risk contribution? Our research shows the risk contribution is a very accurate indicator of loss contribution. For instance, in the 20 years through 2018, there were 12 months where losses from an investment portfolio comprising 60% of US Stocks and 40% of US Bonds exceeded 5%. More than 99% of the losses during these high

loss months came from US Stocks, which means <1% loss came through Bonds, which were in fact 40% of the portfolio.

Risk Parity portfolios allocate market risk equally across asset classes, including stocks, bonds, and commodities. Hence it is radically different than traditional asset allocation and it delivers true diversification that limits the impact of losses of individual components to the overall portfolios. As a result, Risk Parity portfolios are expected to generate a superior return for a given level of targeted risk.

4.3 Global Market Portfolio Vs. Risk Parity

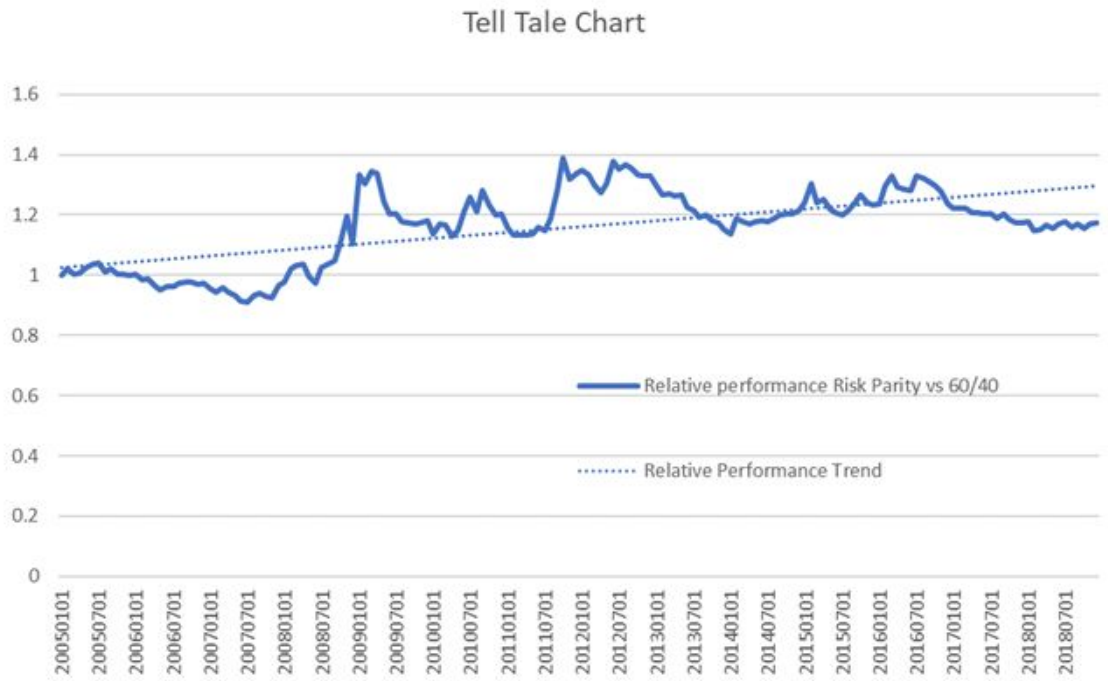
The chart below shows a comparison between the relative performance between a Global Market 60/40 Portfolio ETF proxy ("AOR") [6] vis-à-vis a Risk Parity Portfolio ETF proxy ("All Weather") over the past decade-plus; in the form of Value of $1,000 Invested ("VAMI") since 2005 (when the respective ETFs started trading). The Risk Parity VAMI appears to dominate its Global Market Portfolio counterpart for most of this history.



However, it has not been a one-way street over the years. The "Tell-Tale Chart" below (adapted from the writings of the late John Bogle, founder of Vanguard Funds) that charts the

[6] https://www.ishares.com/us/products/239756/ishares-growth-allocation-etf

relative performance of Risk Parity Vs. Global Market Portfolio over time shows that there is a cyclical aspect, albeit irregular, to Risk Parity's out-performance.



Based on empirical research, Syfe's "super-efficient" Model Risk-Managed Portfolio is constructed by applying a Bayesian weighting technique to derive a judicious blending of the Global Market Portfolio and Risk Parity.

4.4 Portfolio Optimization

To determine the optimal mix of our chosen investments, we utilize Markowitz's Mean-Variance Optimization ("MVO") algorithms to build the Efficient Frontier of optimal portfolio combinations whereby for every level of risk, we find the portfolio combination that would provide the highest expected return.

However, while the MVO portfolio construction process is elegantly intuitive and conceptually sound its implementation is far from simple. As inputs, MVO requires estimates of each asset class's expected return, risk (as measured by standard deviation), as well as the pairwise correlations between asset classes. MVO is highly sensitive to such input parameters and tend to produce unintuitive portfolios if such parameters are not properly specified.

To overcome this difficulty in applying MVO in practice, we apply the Black-Litterman model, which was intuited by Fisher Black and Robert Litterman[7], to derive expected return parameters from equilibrium asset allocations that are consistent with their respective risk and correlation parameter estimates.

Once the MVO Efficient Frontier is generated, we then apply Tobin's Separation Theorem by determining the Capital Market Line using a Risk-free asset and Syfe's Model Risk-Managed Portfolio to produce a super-set of efficient client portfolio aligned with their respective risk appetites.

5. Portfolio Monitoring

We would have an inhouse Portfolio and Fund Management System monitoring all investor positions that are marked to market daily. Investor portfolios would be continually monitored for **Median Tail Loss (MTL)** to ensure that they are individually in line with their respective designated risk level.

5.1 Downside Risk Measure

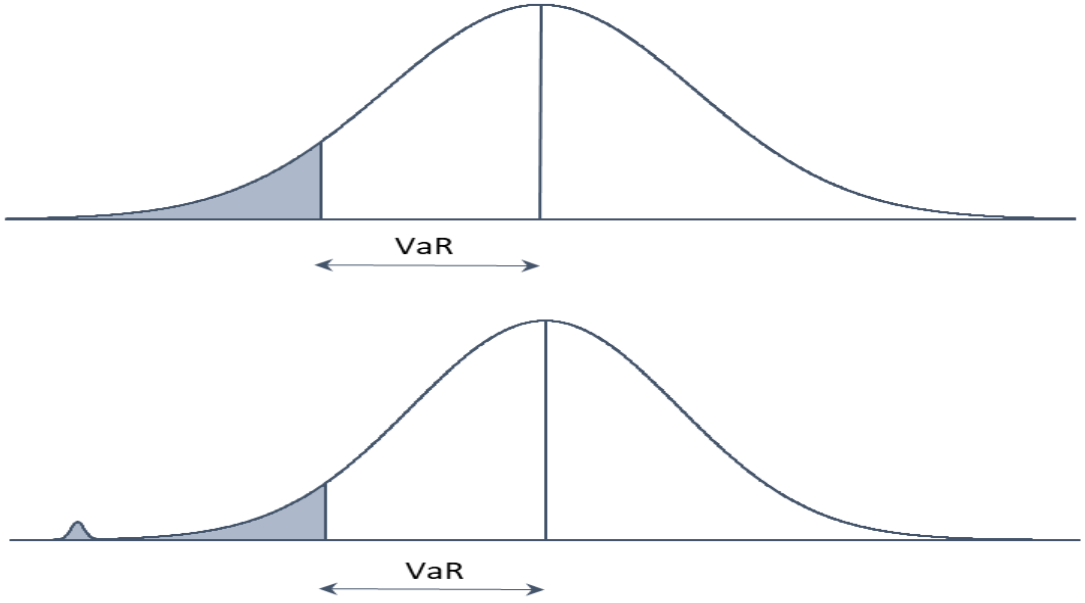
In a recent consultative document by the Basel Committee on Banking Supervision (2013) [8]it was proposed that one of the major changes to the trading book capital rule is to move from value-at-risk (VaR) to expected shortfall (ES) [a.k.a. expected tail loss ("ETL")] mainly because of "the inability of the measure [VaR] to capture the tail risk of the loss distribution."

For example, '1-year 95% VaR is $1 million' means that we can be 95% certain that will not lose more than $1 million over the next 1 year. But if we fall in the 5%, VaR does not tell us how much we could lose.

The figures show two different probability distributions which have the same VaR but the potential loss in the bottom figure is much higher and ES tells us the potential loss.

[7] Fisher Black and Robert Litterman (1991) The Journal of Fixed Income Fall 1991, 1 (2) 7-18

[8] Basel Committee on Banking Supervision (2013), Consultative Document, Fundamental Review of the Trading Book: A revised Market Risk framework, BIS, Basel, Switzerland, https://www.bis.org/publ/bcbs265.pdf



Elementary statistics teaches us that both mean and median measure the average size of a random quantity, but they have different properties. In particular, if we want to obtain a robust measurement, then median is a better choice than mean.

At Syfe, we encapsulate the customer's risk propensity in a Downside Risk number that we define to be the 95% Median Tail Loss ("MTL"). As argued by Kou and Peng in a 2014 paper published in the Journal of Financial Engineering[9], MTL has several advantages over ETL:

(1) Elicitability - MTL satisfies a basic statistical property called elicitability (i.e., there exists an objective function such that minimizing the expected objective function yields the risk measure), but ETL does not. If a risk measure is not elicitable, then it is hard to justify the use of a forecasting procedure for the risk measure.

(2) Robustness - MTL has a desirable property of distributional robustness with respect to model misspecification, which means that a small deviation of the model only results in a small change in the risk measurement; but ETL does not. This means that MTL leads to "more stable model output and often less sensitivity to extreme outlier

[9] Kou and Peng (2014) Journal of Financial Engineering Vol. 1, No. 1

observations", a desirable property mentioned on p. 18 of the consultative document of Basel Committee on Banking Supervision (2013).

(3) Easy Implementation - Kou and Peng (2014) show that, for any loss distribution, MTL at a given confidence level is simply equal to VaR at a higher confidence level. For example, MTL at 95% level is simply equal to VaR at 97.5% level.

Furthermore, the backtesting for MTL can be easily done using the existing methods for backtesting VaR while it is difficult to do backtesting for ETL. In fact, the consultative document of Basel Committee on Banking Supervision (2013) suggests doing backtesting by "comparing 1-day static value-at-risk measure at both the 97.5th percentile and the 99th percentile to actual P&L outcomes," although it has suggested replacing VaR by ETL in measuring risk.

For a 60% Equities / 40% Fixed Income portfolio, the 95% MTL would approximately average 15% p.a. over time. Essentially this means that if the MTL were judiciously managed to be constant at 15% p.a. through some portfolio rebalancing process then: (a) in 1 out of every 20 years that the portfolio might likely experience a median loss of 15%.; or (b) viewed from a 97.5% VaR equivalent perspective (see point (3) above), in 39 out of every 40 years, the portfolio should not lose more than 15% p.a.

5.2 Monte Carlo Simulation

For every investment portfolio, we calculate the 95% MTL on a "look-forward" basis regularly. This is done using an advanced form of non-parametric Monte Carlo simulation known as Filtered Historical Simulation ("FHS").

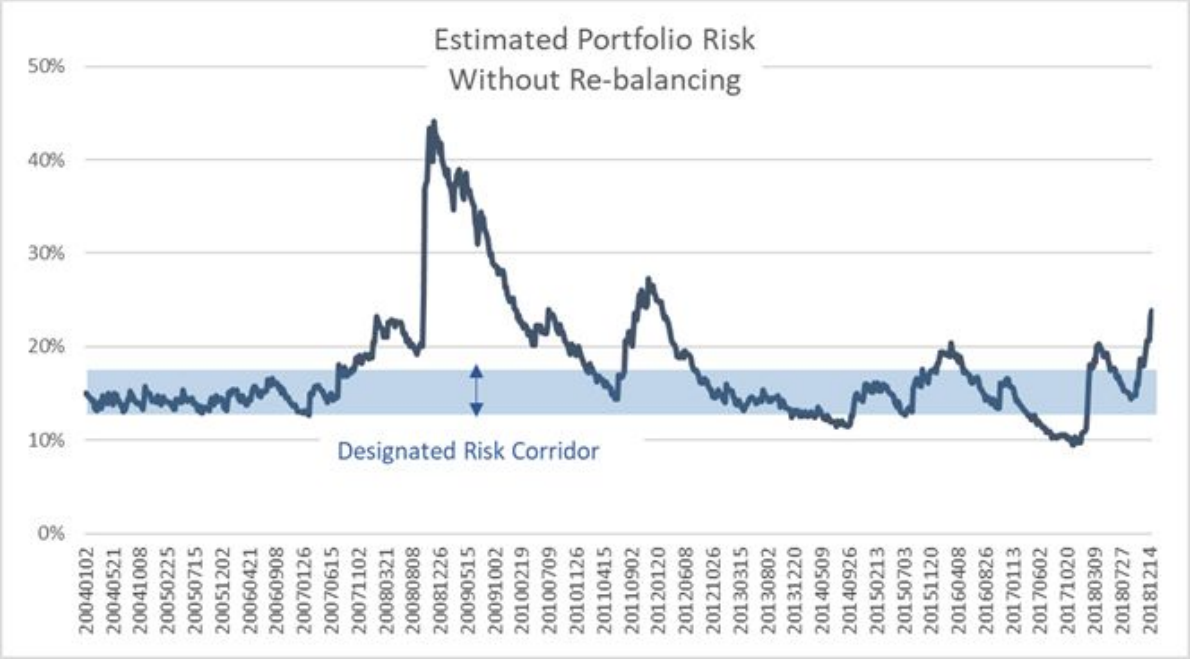
In contrast to some other techniques where the scenarios are generated on an ad hoc basis, FHS is a systematic scenario generating technique for assets prices where it uses a combination of nonlinear econometric models and past returns to build the probability distribution of possible values that the asset prices could take in the days ahead. Risk estimates are then directly derived from the tails of the distribution.

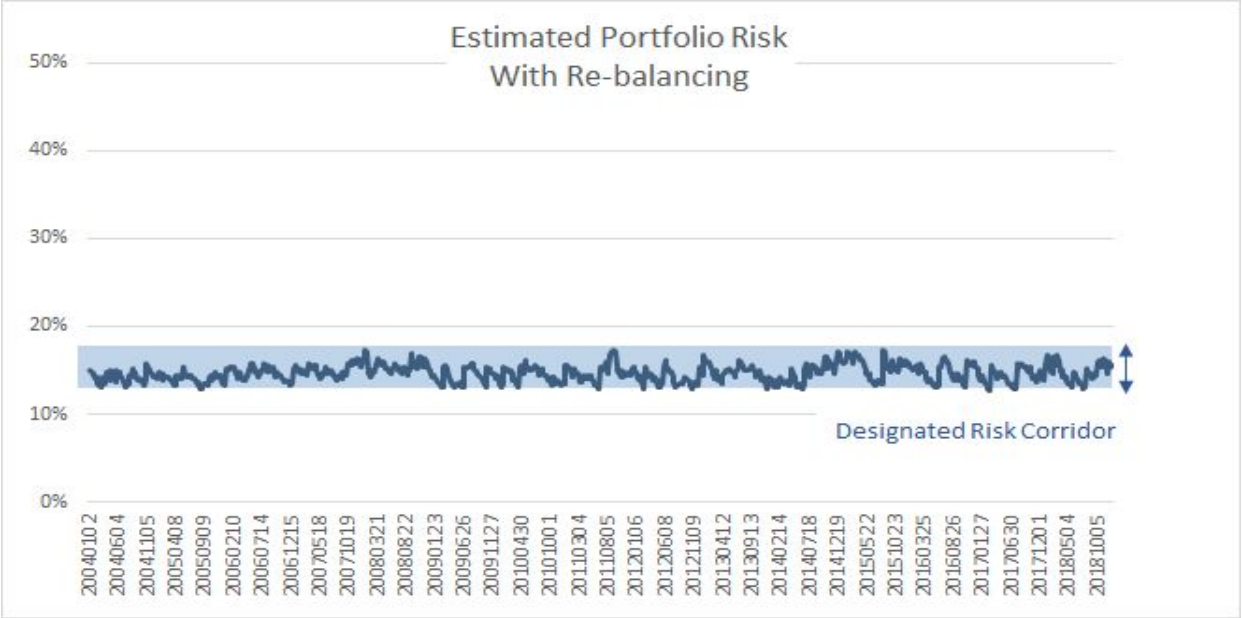
The price series is not forced to conform to any kind of probability distribution, but rather the data is allowed to speak for itself; unlike parametric simulation models that draw innovations from theoretical distributions. As the estimation of "tail" risk is highly dependent on the good

prediction of uncommon or catastrophic events, parametric Monte Carlo simulation models tend to smooth the empirical distribution of the data and consequently might likely underestimate "catastrophic" risk.

7. Portfolio Rebalancing

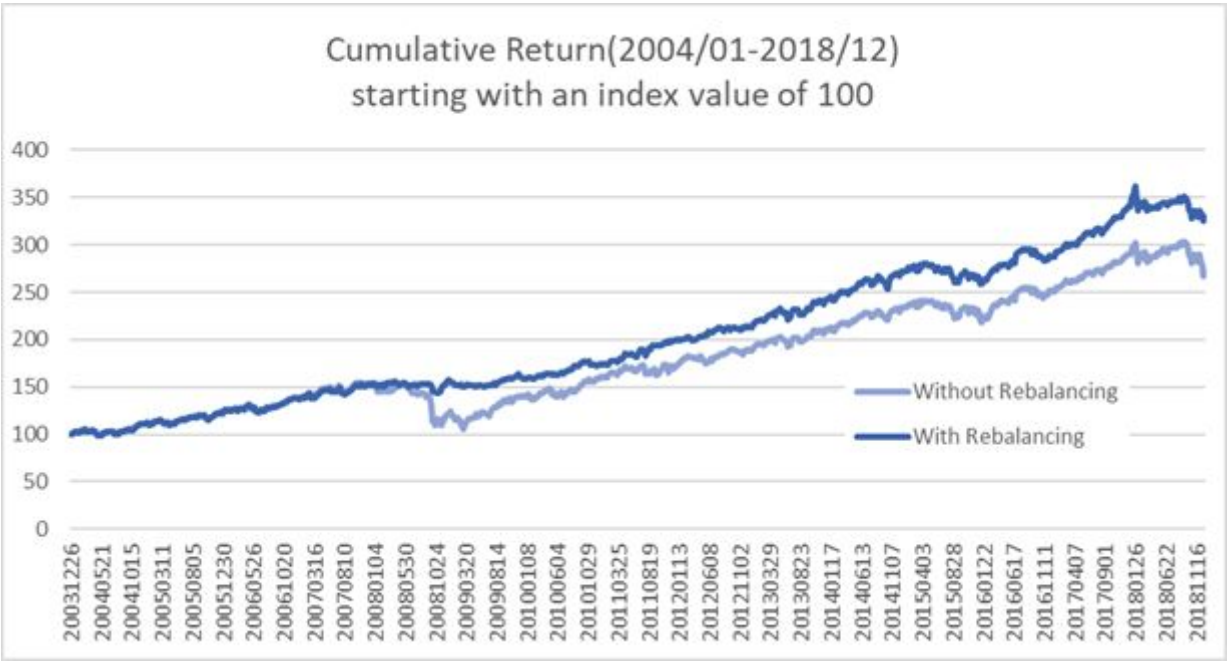
If the risk projection for any investor's portfolio signals a violation of the portfolio's designated risk level (chart below), the portfolio would be re-optimized, and rebalanced to ensure that it stays within the designated risk corridor (following chart). This rebalancing would be risk-based and event driven and would be done irregardless of when the last rebalancing took place.



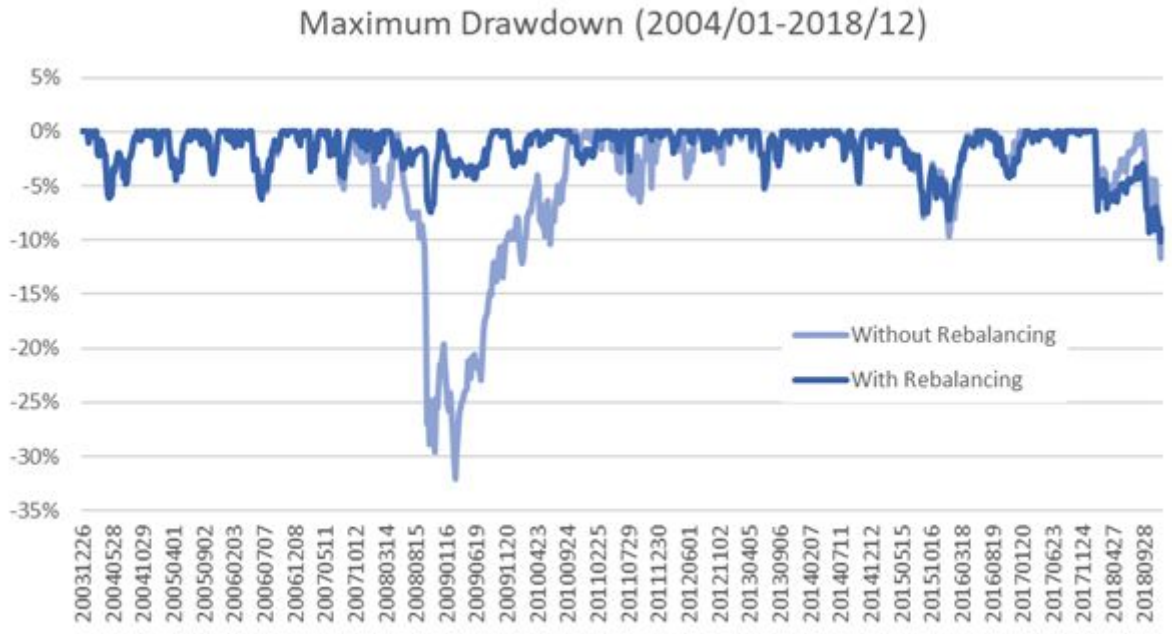


The charts below illustrate the efficacy of Syfe's portfolio rebalancing process in that:

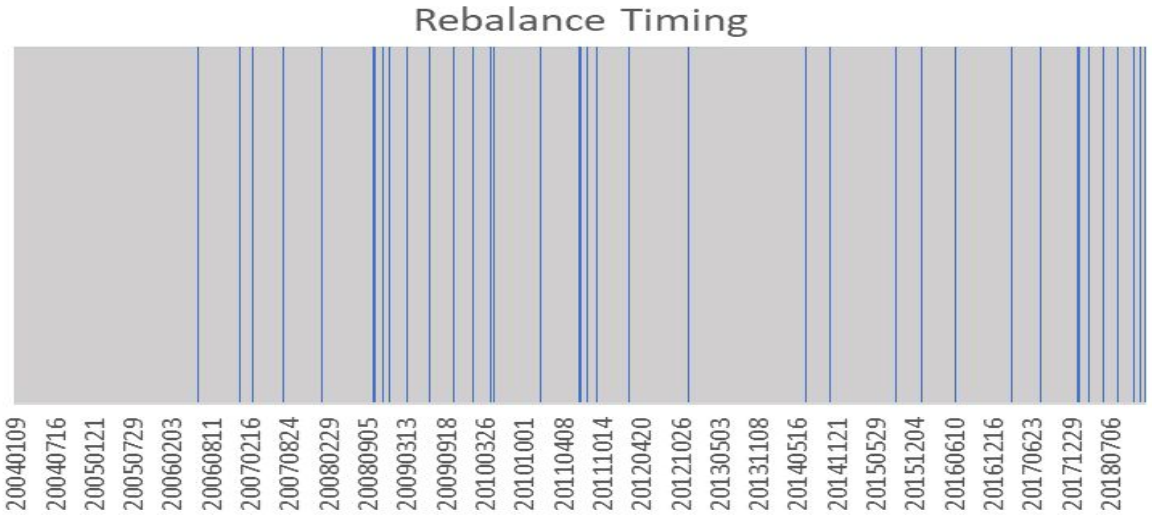
(a) ***With Re-balancing*** outperforms ***Without Re-balancing*** in the long run as can be seen below; and



(b) The absolute maximum draw-downs over time were well contained within reasonably defined ranges (i.e. akin to the chosen risk profile of the customer).



Each line in the chart below shows the day when we re-balanced our portfolio. During GFC in 2008, we frequently re-balanced to keep portfolio's risk within the designated risk corridor.



Conclusion

Returns cannot be predicted, but risk can be managed. The risk associated with a portfolio is not of only function of the weights of different asset classes it holds, but also and more importantly the risk associated that each asset class represents. By finding a matching portfolio on the 'Super-efficient frontier', it is possible to offer the optimum returns for a

desired risk level. Furthermore, by using Monte-Carlo simulations, a portfolio's expected risk level can be assessed, and hence portfolio component weights can be changed to keep the risk associated with a portfolio in check.