PM Letter, Northeastern University Student Value Fund

Fall 2023

**Rational Asset Allocation in an Unlevered Portfolio Using a Modified Kelly Criterion**

This letter is intended primarily for new portfolio managers as an informative and persuasive document for the continuation of our asset weighting mechanism but should also be regularly reviewed by the broader fund to (1) reinforce their understanding of how assets can be rationally weighted based on past performance and expectations of future returns, (2) promote transparency around portfolio weighting decisions, (3) ensure that iterative fund improvements are compounding rather than transient, and (4) open the floor for improvements on the weighting mechanism we will soon discuss.

**Context**

SVF’s historical portfolio management has been volatile in ideology, opaque in methodology, and regrettable in performance. The intention of this new portfolio weighting mechanism is to reverse that trend. After many productive discussions with various professors on the rationality of this weighting mechanism and an effort to educate the broader fund on its process, I believe we’ve successfully deviated from the mean. Unfortunately, the mean (past performance) is very magnetic when all that is required is a blasé attitude towards portfolio management. Whether or not we revert back will be dependent on future portfolio managers understanding and proactive enforcement of the philosophy behind this weighting mechanism.

Before proceeding, I encourage you to look at the powerpoint supplemental that was built for the purposes of fund education and is titled “Historical Assessment of Portfolio Management & Performance” (onedrive).

**Objective**

Consider three stocks:

**Stock 1:** A biotech stock that can be traded as an option based on FDA drug approval outcome with an estimated 60% liquidation value and 500% return in the event of approval. The analyst team believes “FDA approval is likely”.

**Stock 2:** A REIT that has historically never traded more than 5% +/- yearly with a stable dividend with an upcoming asset sale that could potentially trigger a bidding war and result in a special dividend or unexpected gain on sale. Recent price action does not reflect market realization of this sale and the analyst team believes this sale could return 30% via dividends/share price appreciation. Downside is limited to historical levels.

**Stock 3:** A blue chip stock that analysts believe has an idiosyncratic edge to peers and will either trade up 30% in a base case or down 15% in a bear case.

What follows is discussion of a mechanism that would formulaically allow us to buy and weight all three stocks. This mechanism was developed with the adoption of the following ideas:

1. Everything in our portfolio should be weighted in accordance with respect to a

risk/return profile and an estimated likelihood of a positive outcome,

1. historical risk and return profiles can be factually quantified using historical data on a

particular asset,

1. historical data is necessary but not sufficient for extrapolating out future expected

risk/return profiles,

1. analyst research (from final pitches) can be used to estimate an asset’s risk/return profile

for the life of that investment, and

1. probabilistic assumptions about the likelihood of outcome of an investment thesis can be made in an unbiased manner by the portfolio manager.

These have been organized in increasing order of offensiveness and difficulty to defend, but I will offer my thought process behind each one briefly below.

1. The original Kelly Criterion shows how wealth can be optimized in an environment with known outcome probabilities and payoff structures. This is not the first time a modification of Kelly has been used to attempt to weight assets in a portfolio. I am not going to discuss this at length here, but [here](https://bsic.it/exploring-the-application-of-kellys-criterion-in-portfolio-optimization/) is a good resource for defense and display of how Kelly can be used to achieve better asset weights in a portfolio to optimize performance.
2. Many portfolio weighting tools that are used in industry exploit historical data on a stock to quantify excess returns and volatility for the sake of isolating the aforementioned risk/return profile. I believe this is helpful because historical data offers a factual account for how a particular asset has traded in the past which will likely be indicative to some extent of how it will trade in the future. However,
3. If historical data were sufficient for estimating the risk/return profile of an asset going into the future, then there should be no future material deviation in investor behavior on an asset from historical behavior. Investor behavior on an asset is (hopefully) primarily driven by perceptions around the fundamentals of the respective business. Therefore, historical data is sufficient for estimating risk/return on an asset **if** we expect the future fundamentals of a business to be unchanged relative to is historical fundamental performance (yes, I know this is flawed but I think you will agree that it is mostly true and I only go at length to argue this because some people actually believe historical data can be used to weight your portfolio). If we don’t expect a change in the fundamentals of a business to drive excess returns, why are we considering buying the company and why did the analyst team waste their time on this stock? Why would it go up?
4. The purpose of a “final pitch” is to aggregate a team’s research on a business into thesis points/risks/catalysts and the purpose of a “model” is to quantify the research into an estimate of drawdown/profit universes. Most models will have a bear, base, and bull case. The analyst team implicitly assumes the base case is the most probable of the three (when thesis variance is not exceptional). We can therefore use the bear case as the expected drawdown (risk profile) of an investment and the base case as the expected return of an investment. Is this perfect? No! However, if you believe that our research can be used to generate alpha, then you are likely implicitly assuming that there is some alpha in our generation of risk/return profiles via final pitches. Why not use them when deciding to weight the asset?
5. It is impossible to defend the accuracy of this statement without historical data (which we of course do not have else you wouldn’t be reading this right now) but I can at least defend its rationality. As portfolio manager, you must make subjective decisions about what should go in our portfolio. A rational manager uses risk/return (both historical and future, as just argued) to inform these decisions. There is, however, another factor that can be incorporated to achieve better weights than assuming an equal likelihood of earning the return or losing the risk. Quantifying the likelihood of the base case successfully playing out is difficult but necessary in making final weighting decisions.

The PM seat will always be dynamic but our investment philosophy must become more static. You (as a PM) may think that you’re God and have more alpha than some mechanism that has been handed down to you, but the PM after you likely doesn’t. This is not about maximizing short-term wealth, it is about maximizing long-term wealth and promoting professional, transparent portfolio management. The first PM to divert from this mechanism may transiently outperform on a weighting basis, but they will unquestionably be responsible for the portfolio management disarray that proceeds them. How do I know? Because I’m writing this.

**Methodology**

The below formula, which evaluates to *K%,* incorporates both historical data and future expected returns and their probabilities. The historical portion is on left side of the numerator and uses historical stock price data and the risk-free rate to calculate the excess returns over a time horizon divided by the stock’s volatility. This is the most complex aspect of the formula and so I’ve included a python tool that runs an optimization function on this formula to calculate the historical implied Kelly weight. The right-side addend is a simplified formula which can be used to calculate the Kelly weight based on known risk, return, and probability of outcome. The sum of the two numerator Kelly’s is divided by four because we want half-Kelly and we are adding two Kelly’s in the numerator. The quick explanation of why half-Kelly is because it allows us to reap the majority of the “optimal wealth pool” while reducing our portfolio volatility dramatically. A more in-depth explanation can be found in the previously mentioned link that discusses Kelly or the powerpoint supplemental.

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**Note:** In equities markets, 100% drawdown is always possible but extremely remote and a more probable but conservative assumption about drawdown must be made to avoid excessively low Kelly weights.

I don’t want to write “this mechanism” or “weighting methodology” anymore so I’m going to refer to the above formula as “KC” from here on.

**Problems**

Aside from the flaws pointed out in the Methodology section, there are a few additional issues KC presents that I’ve offered mitigants for.

1. Cash/Risk-Free Asset

Presently, any idle cash in our portfolio is parked in a money-market fund that returns roughly SOFR less a couple bps. If you plug in a risk-free asset to KC and assume that it is actually risk-free, then you would get (0 + 1) / 4, which evaluates to 25% of the portfolio in cash at all times. Bear with me on this argument, but we should always target a 0% portfolio allocation in cash.

We want our portfolio to be rational and consist of rational investments. If cash is a rational investment, then it must be a better alternative to all other investments we have access to. By “investment that we have access to” I mean a stock we have researched thoroughly enough to trigger an investment, whether it be a stock we already own or a stock that has passed its final pitch and voting phase. I also mean ETFs of your common market indices, like the SPY, QQQ, and IVOO or VIOO (S&P 400 (mid) and S&P 600 (small)). Furthermore, we have the benefit of not being held to any sort of risk mandate or target return profile.

If the risk-free asset is better than all the assets we have access to, then why do we own any stocks? You have to be bearish to make this argument. If you are bearish, then holding the risk-free asset can be rational. If you aren’t, then any position in a risk-free asset is the product of a lazy or irrational portfolio management philosophy.

We should target 0% cash allocation or we should pack up and pivot to an IB or consulting club.

1. Necessity of Normalization

Each individual KC calculation is ignorant of the other candidates in the portfolio. Thus, it is likely that the sum of individual weights will not equal 100%. The simple solution to this is normalizing the basket of KC weights to a portfolio with 100% allocability.

1. Unstandardized Investment Horizons

When it comes time to reallocate the portfolio at the end of a semester, our incoming stocks will likely have different investment time horizons. Whether it be a 1yr, 3yr, or 5yr investment horizon, we need to be conscious of the fact that two equivalent investments (from an *R* & *P(W)* standpoint) will have to be weighted according to how long it takes to realize returns. This presents a few issues. It seems reasonable to annualize the returns, but we still must decide what to do with our drawdown. Annualization of drawdown seems irrational because we should expect a bear case to occur in full in any given year. However, if you annualize returns and not base case, this can result in low-variance, thinner risk/return profiles with high probabilities of success turning into sells from buys. I will leave the decision on whether to annualize the expected drawdown up to the discretion of the acting Portfolio Manager on the basis of the nature of each respective bear case. More unpredictable investments warrant more conservatism (do not annualize) and thus should come along with more asymmetric risk/return profiles.

1. Historical Optimization Function Time Horizon

The left addend in KC represents the historical-implied Kelly weight for an asset. This is calculated using historical price data over a specified time horizon. There is no correct answer for how long we should look back, and depending on your investment thesis (and other things), historical performance may be dramatically disconnected from your expectation of likely future performance. Personally, I default to a two-year lookback period and adjust up depending on my subjective interpretation of how in-sample that two-year historical performance is. Another option is to sensitize based on multiple lookback periods (take the average of two, three, four, five years back) which is perhaps more rational.

**Use**

Employment of KC is very easy. I’ve built an excel sheet that does all the work for you which (if you are a portfolio manager) should have been passed down to you, otherwise you can email me directly for it at [child.m@northeastern.edu](mailto:child.m@northeastern.edu). There’s also a python tool for computing historical implied Kelly weights that is very easy to use and should also be passed down to you. I’ve left these out of the onedrive to make it as hard as I can for analysts teams to try hacking their return assumptions to achieve their desired portfolio weight. While I do not have the skill to create a mechanism that would prevent this issue, I do have faith that analysts will act to uphold the social contract they have with everyone else in the fund that exists to optimize returns and would prevent them from such an unforgivable sin (also, good luck calculating the historical Kelly weight without the tool).

Miles Child –

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