Capacity Discipline

Managing Liquidity & Maximizing Diversification

CTAs like herding but they do not like trading against themselves. Consequently, well run CTAs will try and manage their participation in any market to ensure their trading is not what drives price action. By having positions that are not too big compared to traded volumes, they also try to ensure their positions can be closed in an orderly fashion.

At the same time, we would like to increase internal portfolio diversification, ensuring we take as many diversified bets as possible. As we will see shortly, higher diversification leads to:

- Higher expected portfolio Sharpe ratio
- A more consistent portfolio Sharpe ratio

- Greater robustness to sudden shocks
- Lower correlation to other CTAs

Unfortunately, as AUM increase, managing liquidity and maximizing diversification are often in direct conflict: we want to push risk to diversifying markets but some of them may be too small for our AUM.

How do we measure diversification?

Diversification is usually associated with additional markets. But it is not the market *count* that is important, it is (a) the number of uncorrelated bets the portfolio can make and (b) the allocation to each of these bets. Diversification is driven by the correlation between the markets and the allocation each market receives.

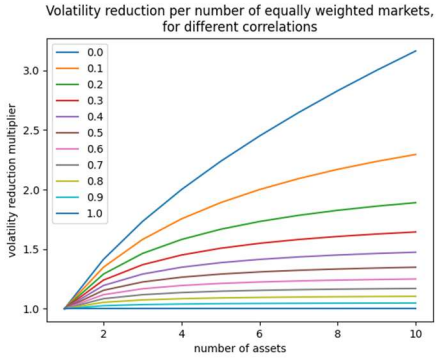

Figure 1: The reduction in volatility, per number of markets, for different correlations. The reduction in volatility can be derived purely from the allocation to individual markets and the correlation between the markets. For example, for equally weighted, uncorrelated bets (top blue line), diversification is precisely $\sqrt{n}$

Diversification and performance improvements are directly related via volatility reduction: diversification improves Sharpe by reducing our portfolio's overall volatility. Indeed, we *define* diversification precisely as the reduction of volatility we observe. For CTAs with a risk target, diversification is also the multiplier we need to leverage our portfolio to achieve our risk target.

For equally weighted, uncorrelated bets, diversification = $\sqrt{}$number of bets, so we usually refer to "number of (uncorrelated) bets" as the square of diversification.

Diversification benefits: A higher expected portfolio Sharpe ratio

Looking at portfolio Sharpe Ratio through the lens of Grinold-Khan's 'Fundamental' law of active portfolio management, which decomposes portfolio into two components – the Sharpe-per-bet, and the number of (uncorrelated) bets – we have the following:

$$\text{Portfolio Sharpe} \cong (\text{Sharpe per bet}) \times \sqrt{\text{Number of bets}}$$

If we assume all the markets to have an average Sharpe over the course of a year of, say, 0.35 (+/-1 standard error for a 1-year measurement), a higher number of bets leads to a higher multiplier on the Sharpe-per-bet. Moving from say, 7 to 14 bets lead to a powerful **1.4x increase** in the expected portfolio Sharpe. This holds both in theory and in practice. Below we plot portfolio Sharpe per year from multiple Monte-Carlo simulations, either making 7 or 14 bets per year. Doubling the number of uncorrelated bets raises the mean portfolio Sharpe from 0.9 to 1.3.

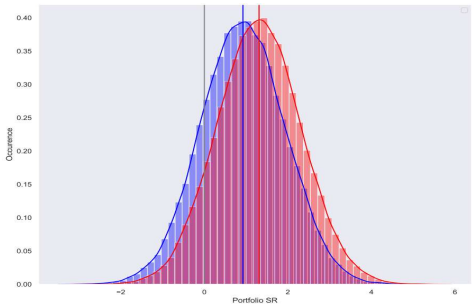

Figure 2. Yearly portfolio sample Sharpe for 7 (blue) or 14 (red) bets

Diversification benefits: A more consistent portfolio Sharpe ratio

If you only make 7 uncorrelated bets in a year, then there is also a higher likelihood that not enough of them come good. Below we sample either 7 or 14 times from a ~N(0.35,1) distribution and ask what the sampled average Sharpe across those bets was for that year. Unsurprisingly, the mean (0.35) is the same in both cases. *But*, with only 7 bets made in a year the experience is more variable and, crucially, in almost 1 in 5 years you end up with a negative average Sharpe-per-bet. With 14 bets that drops to less than 1 in 10 years. Following Grinold-Khan above, it doesn't matter what you multiply a negative Sharpe-per-bet by, the result is still going to be negative. Less diversification means more negative years and less consistency in performance.

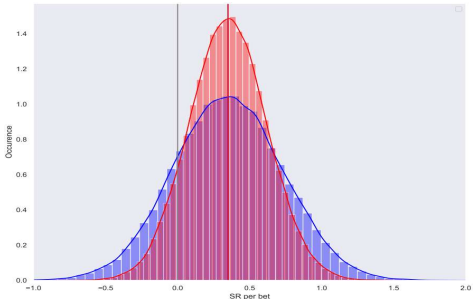

Figure 3. Yearly sample average Sharpe per bet when making 7 (blue) or 14 (red) bets.

Diversification benefits: Better robustness to sudden shocks

So far, we have examined the mean and the standard deviation; but downside risk also matters. Although on a monthly or yearly horizon, trend has positive skew, it is still exposed to short term negative tail events. Just like standard deviation, negative skew is inversely proportional to diversification so the higher your diversification, the less likely you are to experience a sizeable downside shock to your diversified portfolio.

Capacity vs diversification in practice

Not all markets are born equal: some are more idiosyncratic while others are more correlated to each other. That means that even if we disregard capacity, we would still not allocate to all markets equally. As we increase our AUM, smaller markets cannot take the risk we would like to allocate to them as our participation would be too high. We are then forced to allocate more risk to the more liquid markets. This is what it looks like in practice:

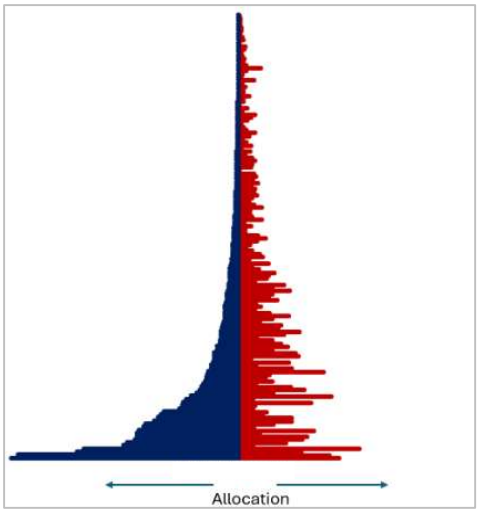

Figure 4: Market allocations when AUM is high (lhs) and when AUM is low and capacity is not an issue (rhs). Markets ordered vertically from high capacity to low.

How do these allocation differences manifest when we simulate the two strategies, both trading the *same* markets, over the *same* period?

Index replicating CTAs

If your underlying markets are highly correlated to start with, the loss of allocation to the smaller markets is less critical: these smaller markets you are "losing" were correlated to the big ones anyway and were not adding much diversity to the overall portfolio diversity in the first place[1].

Given this, you may even want to take this process to its logical conclusion and *start* by restricting your universe to the dozen or so biggest markets. These are the most liquid where trading costs are

[1] A nice way to visualize this is by revisiting Figure 1. For high average correlations, the gradient of diversity as a function of the number of assets is flat, so the impact of reducing the number of markets is less severe.

lowest and your capacity is maximized. The internal diversification of your portfolio is somewhat lower but your original portfolio was not that diversified to begin with.

Your correlation to the rest of the CTA industry increases but this can be thought of as a "feature" rather than as a "bug". Investors may *want* something that looks like everyone else…

Lo and behold! CTA index replication is born!

Alpha chasing CTAs

For a higher ex-ante Sharpe, you may have started by choosing markets with low correlation to each other. For this to have happened, you probably needed markets that are intrinsically decoupled from the broad financial universe dominated by S&P and US treasuries. For example, you are likely to be commodity heavy, as commodities differ from one another by geography, chemistry and even by the time of year.

Now managing your capacity becomes critical.

As you increase your AUM and are forced to push risk into the bigger markets in your portfolio, diversification drops dramatically, in our simulations by as much as 50%. Unfortunately, this also translates to a drop of Sharpe by about 30% and as expected, your worst drawdown's depth and duration increases.

Be prepared…

There is space in the industry for CTAs that focus on high capacity, trading highly correlated, super-liquid markets. There is also space for CTAs that choose diversity and try to maximize their ex-ante Sharpe. Unfortunately, for the alpha-chasing variety, committing to trading diversifying markets also commits you to managing your capacity. You will never be a $10bn CTA and will forever rely on performance fees rather than management fees. Before starting on your alpha-chasing CTA journey, make sure it's a price you are willing to pay.

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