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MACQUARIE ASSET MANAGEMENT

The wisdom of pairwise analysis

Reducing complexity holds key to broad asset allocation | April 2024

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For broadly diversified investors, reducing complexity offers the potential to render asset allocation both more efficient, and more accurate. In this, we discuss research done by our Vienna-based team and explain how investors can use pairwise analysis in the process of asset allocation. With pairwise analysis, investors make straightforward comparisons of two assets, including analysis of which asset may outperform the other. A series of these directional forecasts become the basis for the asset allocation process. Included in the discussion:

- how pairwise comparisons work, and benefits they can provide in the asset allocation process
- the comparative risks in employing asset class return forecasting within modern portfolio theory (MPT)
- the risk of behavioral bias in most forecasting and ways pairwise analysis may mitigate these biases.

Multi-asset management in practice

Today, we see investors dealing with portfolio construction challenges amid increasing market uncertainty. The search for a truly diversified portfolio is becoming more difficult as investors must assess both return expectations and risk considerations.

As a multi-asset management team that runs a wide range of highly diversified portfolios, we often have discussions with clients about asset allocation and the various processes used for making expected return forecasts, or relative valuations. Our broadly diversified portfolios typically blend equities, bonds, and convertibles alongside currency and commodity investments, and we're generally aiming to maintain flexibility when it comes to adjusting for dynamics like growth, inflation, or interest rate outlooks over time as well. In short, we're active managers faced with a wide range of daily decisions about the underlying assets in our portfolios.

The goal of any portfolio manager should be to deliver consistent performance. The complexity inherent in multifactor models raises the stakes, by increasing the opportunity for professional investors to miscalculate key risks, or worse, not see them at all.

We've found that employing pairwise investment decisions helps bring order and rigor to complex decision making, and is less prone to behavioral biases. These pairwise decisions offer a methodology that we believe helps mitigate complexity, and clarify risk management, in diversified portfolios that are complex by definition.

Complexity is not a friend

We live in an age in which information has become a commodity. For professional asset managers today, this means not just that a higher degree of media and third-party research is available at the fringes, but that massive, open data sets are readily available from multiple providers. This creates a challenge not only to stay on top of the data and information flow, but to apply a mosaic or methodology to regular analysis. In a multi-asset portfolio management context, the risks from this "complexity effect" are only exacerbated, as each asset type comes with its own necessary methodologies and data sets.

Complex systems inherently pose something of a psychological challenge for managers, owing to the potentially paralyzing effects of information overload.

We remain highly cognizant of this "system" risk and sometimes compare it to the effects on the brain of multitasking in day-to-day work.

Today, many of us don't need academic studies to tell us that multitasking often reduces productivity and increases rates of error in humans, thus generating unnecessary frustrations. Still, recent research, like that from the Picower Institute for Learning and Memory at the Massachusetts Institute of Technology, uses an example of a financial services professional who checks email during a quick break from the task of doing actual work. When that worker returns to complete the task, her brain has to expend valuable mental energy refocusing, backtracking, or fixing errors. This, of course, wastes time and limits the ability to perform more creative analysis.

A simpler, more focused thought process is often better and allows for greater clarity. This is the power found in pairwise analyses. In a comparable way, we believe investment managers who employ methods designed to bring rigor, focus, and clarity to portfolio decisions have key advantages. In performance analysis, they may also have more clear insights into the sources of portfolio risk and return within their processes.

The power of focus: Enter pairwise analysis

In our experience, a pairwise analysis results in effective asset allocation decisions that allow investors to consistently implement decisions in an impactful way. Instead of making asset class return estimates, which is ultimately a form of forecasting, the investor takes two assets and simply compares them head-to-head, on even terms.

Comparing two assets directly against each other has the benefits of allowing the analyst to account for interdependencies in his or her viewpoint, something that is much more challenging when considering a multi-asset correlation matrix. Asset types can be compared to each other one at a time successively, in pairs – for example equities versus sovereign bonds, then equities versus cash, then equities versus commodities, in sequence. This provides a methodical way of incorporating dependent data.

Additionally, the approach of making direct comparisons allows an analyst to specialize by focusing on a particular asset-pair comparison. Let's look further at exactly what we mean by pairwise comparison, and how it works.

We refer to these either/or decisions about two assets as "pairwise," which is a term often used in a statistical or medical context. An important distinction is that a pairwise decision is defined by two items, always being compared head-to-head, as a pair. A pairwise comparison decides which is preferred, or has a greater amount of some quantitative property, whether or not the two entities are identical.

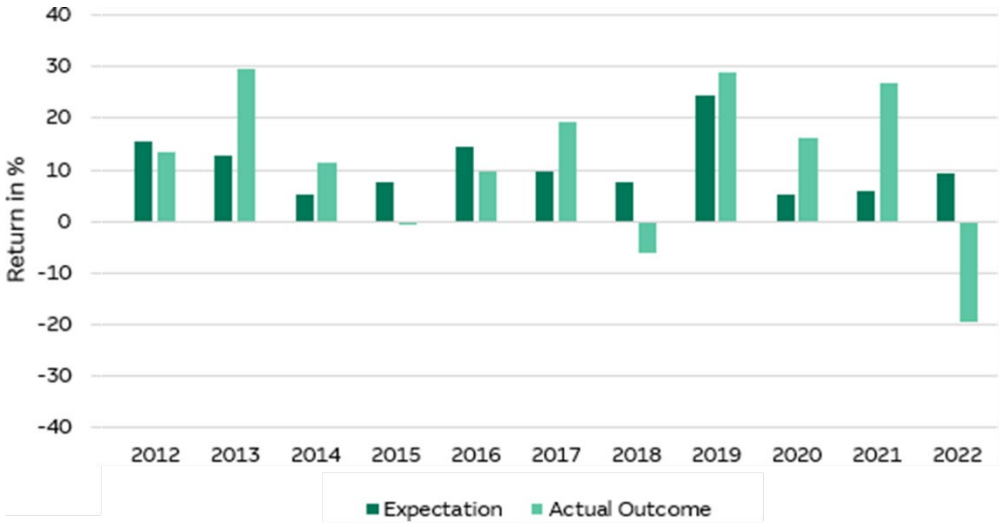
In asset management, pairwise decision making constitutes a form of making a "directional opinion" about the markets, using the asset pair. That is, the investor compares two assets, and makes an either/or call about which asset will outperform, and thus effectively makes a view about market direction. That call, or view, is a form of signal, providing information that's used in the process of portfolio construction.

In this context, we sometimes refer to these pairwise decisions as "binary calls," or sometimes "digital calls," as in computer coding. The resulting signal is either a one or a zero. One asset class will win. Equities will outperform bonds, for example. The investor then goes down the line, comparing assets, and compiling results to be used in asset allocation.

These pairwise analyses are very clean, simple, and importantly, actionable in risk-target frameworks, where direction frequently proves much more important statistically than whether or not one is able to make a precise return forecast. The chart below, which compares forecasted returns for the S&P 500 Index in recent years to actual returns, shows the challenges and inaccuracies inherent in specific return forecasting. The precise return forecast requires more complex and variable methods that are not reliably accurate. Notably, the pairwise analysis is also less prone to behavioral bias.

The folly of "point estimate" return forecasting

Chart 1: S&P 500 Index return expectations* at the start of each year compared with actual performance



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Hit rate
Direction (sign of return)	✓	✓	✓	x	✓	✓	x	✓	✓	✓	x	73%
Exact return**	x	x	x	x	x	x	x	x	x	x	x	0%

*Sources: Bloomberg Consensus Estimates, Macquarie. Data from December 2012 to December 2022 Past performance is not a reliable indicator of future results. **+/- 2% around the actual outcome using data.

The disparity of S&P 500 Index return expectations and actual performance year to year illustrates the difficulty in making specific return estimates for a particular asset type. Not only is it more likely to get a simple directional forecast correct, but point estimates can become "lost information" within the asset allocation process using MPT. When the point estimate is incorrect, MPT and its derivatives are very prone to assigning pronounced weights to the assets with the highest estimation error. In this way, a point forecast, with its very low chance of accuracy to start with, is given an outsized impact. Binary views help bypass this effect.

Why we believe it works

If there are more than two criteria for any decision, determining which criteria are more important is inherently problematic. A portfolio manager faced with asset allocation, for example, naturally strives to rank the criteria in order of importance, and to assign to the criteria some relative ranking that indicates the degree of importance of the criteria with respect to one another.

As a hypothetical example, an investor may inquire: Does this forecast on commodities futures for the balance of the year outweigh the fact that we've deemed the German stock market overvalued by 13%, based on a 10-year trailing earnings model? And by how much? Further, how do we assign value to that decision, and render it into a portfolio weighting?

In stepping away from the investment world, it's easy to find everyday examples where complex decisions are made based on imperfect weightings of data-based analyses. Take the example of a job seeker weighing several potential employment opportunities. Is the most important criterion salary, benefits, opportunity for advancement, location, or perhaps company culture? While it's conceivably simple enough to assign each criterion some value, the weights given to each are inherently subjective. The question then becomes how to increase the chance of making them accurate, so that the result is the best possible decision?

Deliberate portfolio construction

Among the challenges faced by asset managers is how to approach the task of portfolio construction once information has been digested. That is, how to translate analyses into portfolio weights, especially where the methodologies used to analyze various asset classes are not perfectly parallel, or don't lend themselves to easy comparison.

One method, of course, is to assign an arbitrary portfolio weight to a particular asset type, based on a partially subjective view of the analysis, or the relative valuation results. This of course leaves much to be desired and lacks mathematical rigor. For one, what's the true value or impact of a 5% equity weighting, for example, if equity volatility runs somewhere between 10% and 40%?

A better and more popular method, of course, is to use more sophisticated portfolio construction methods that are based in Modern Portfolio Theory ("MPT").[1] While this provides more "methodology," it doesn't always reduce complexity. For example, a manager needs to produce return forecasts for each asset class separately or produce a return forecast that compares the outperformance of one asset versus the other. The manager then must use MPT and its derivatives to implement the asset allocation.

The resulting portfolio in turn still comes with all the well-documented potential shortcomings inherent in MPT. Besides the fact that it is very difficult to determine asset returns in the first place, and that there is potential for behavioral biases when deriving them, these shortcomings include assumptions on efficiency and rationality, potentially overly simplistic risk measures, the lack of transaction cost or tax considerations, and last but not least, the severe impact of estimation error on optimal solutions. Richard Michaud,[2] in his research that built upon MPT, referred to this limitation to MPT as being a method for "error maximization." This is why many enhancements have been developed over time, including the now famous Black-Litterman[3] model, that are usually more robust with regard to estimation errors but still require return forecasts as inputs. In contrast, binary decision making seeks to simplify and reduce risk by relying on individual calls favoring one asset over another. This not only may mitigate some behavioral biases but also allows for a clear view of interdependencies between assets.

To summarize, we believe that binary, directional views thus simplify the portfolio construction process for the asset allocator, allowing for clear views of interdependencies between assets, reducing the potential impacts of behavioral biases, and positioning the allocation well for target-risk optimization.

1. Harry Markowitz, "Portfolio Selection." The Journal of Finance, Vol. 7, No. 1 (March 1952), pp. 77-91.
2. Richard O. Michaud, "The Markowitz Optimization Enigma: Is 'Optimized' Optimal?" Financial Analysts Journal, Vol. 45, No. 1 (1989), pp. 31-42.
3. Fischer Black and Robert Lettermen, "Global Portfolio Optimization." Financial Analysts Journal, September/October 1992, pp. 28-43. The Black-litter man model is an asset allocation model developed in 1990 by Fischer Black and Robert lettermen at Goldman Sachs. It combines ideas of the Capital Asset Pricing Model (CAPM) and Harry Markowitz's mean-variance optimization model to provide a tool for investors to calculate the optimal portfolio weights under specified parameters. The model provides neutral weights and a means for the investor to incorporate their opinions about the market into the neutral weight.

Removal of emotional biases from investment decision-making

Even if risks are properly monitored and managed, investors demonstrate biases in their investment decisions that can be difficult to self diagnose. Even more challenging is recognizing these biases before it's too late, such as after a market crash, when investors tend to make emotional portfolio decisions.

This was evident during the market crash in March 2020. As markets fell, investors rotated out of equities and bonds and piled into cash via money market funds. Money market funds are a parking place for assets when investors do not want to participate in the market's uncertainty or volatility.

That uncertainty resulted in investors' hesitation to rotate back into markets during the rally in April and May of 2020, causing them to miss opportunities to invest in areas of the market at attractive prices. On the contrary, models tend to provide consistency in a portfolio, as the investment objective and approach do not change when markets experience a sudden dislocation.

Reducing behavior bias

Directional calls reduce forecasting to the simplest form of decision-making. In making a pairwise analysis, a decision is made to favor one asset over another. In doing this, the manager brings simplicity and clarity to the decision-making process, which in turn can reduce the effects of an entire class of behavioral biases on forecasts.

Think of it like predicting a football game and having the ability to eliminate the emotions of fan bias, all views about league standings, and comparisons of track records against common opponents. The more straightforward we can make the head-to-head equation at hand, the more analytical and quantitative the directional view can become.

Remember that professional investors are humans and just as subject to bias as anyone. Consider the following well-known "traps" of behavioral finance and how a binary decision may help significantly reduce them out of the equation:

- **Anchoring:** Behavioral finance experiments show that the estimated year-end value for a certain stock index changes dramatically if respondents are anchored to a certain return. This should be much less the case for a binary signal (rise/fall from here).
- **Loss aversion:** For point estimates, it does make a difference in terms of loss how far away the actual result is from the estimate. For binary signals it doesn't.
- **Choice paralysis:** The more choices we have, the better it should be. But people are paralyzed if there are too many choices. With pairwise views, decisions are reduced to the simplest form.
- **Narrative fallacy:** Analysts might write books on why they came up with exactly a 3.72498% return forecast for their asset class. People inherently prefer narratives to data. But when it comes to a binary forecast, those subjective narratives become less relevant.
- **Herding:** If analysts 1-10 all come up with 4-5% return estimates it is very difficult for analyst 11 to say -3% (or +10% for that matter). For a binary signal, it should be less driven by herding.
- **Recency bias:** Recent returns can influence the exact point estimate whereas recent market direction will probably not influence expected returns as much.

Specific versus directional forecasting

Real-world implementation

A choice between two options is the simplest decision that can be made. Of course, most portfolio construction methods are not designed to handle these simple, binary inputs. So despite the benefits of the binary decisions, the challenge remains of how to use these pairwise decisions in portfolio construction.

To see binary decisions work in a target-risk approach to asset management, let's first review results of a simple, two-asset Monte Carlo simulation[4] – for example, fixed income and equities, in which we've made both specific return (point) estimates for the two assets, and also a binary call (directional). The Monte Carlo simulation reveals probabilities for four conceivable outcomes. Those four outcomes are:

i. Return estimates for both assets are correct[5] (0.5% probability).

ii. Return estimates for just one asset is correct (13% probability).

4. Monte Carlo simulation, or probability simulation, is a technique used to understand the impact of risk and uncertainty in financial and other forecasting models. In a Monte Carlo simulation, the model in question is run hundreds or thousands of times, each time using different randomly selected values, with the range of outcomes serving as a representation of randomness.

iii. Both return estimates are wrong, but the binary call or implied direction, is right (41% probability).

iv. Both return estimates and the direction are wrong (45% probability).

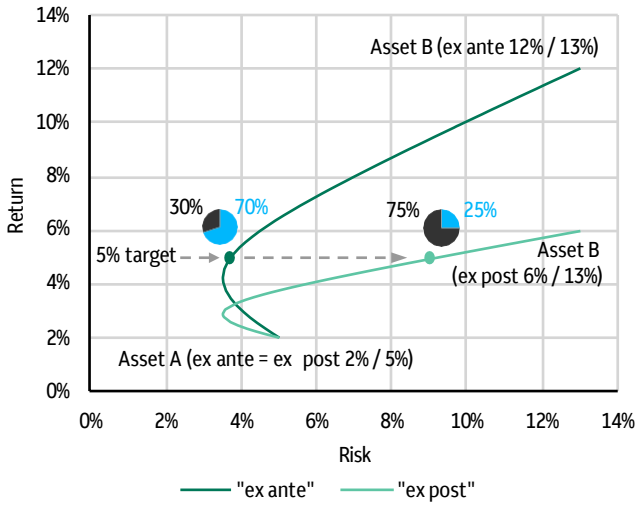
One can see that scenario iii – which includes wrong return estimates but a successful directional decision via the binary call – can be expected to happen fairly often. But in an MPT setting, this scenario includes lost information and can lead to very unfavorable outcomes, since MPT can only handle return estimates as inputs and is very prone to maximizing errors if these estimates are wrong. Therefore, we need a different approach to portfolio construction in order to use the information of the fairly common outcome in scenario iii.

To be able to use this information and thus the simplicity and beauty of pairwise analysis, one needs to resort to different portfolio construction methods. Built on the work of Herold and Maurer[6] and Meucci,[7] we find a target risk optimization being a valuable tool in that regard. The series of charts that follow may help outline why "target risk" is our preferred method of implementing pairwise views.

Chart 2 shows the efficient frontier in the risk-return space for two asset classes. To arrive at this frontier, one has to have return and risk estimates for both assets, as well as a view on correlation. With the help of MPT it is then straightforward to arrive at the optimal weights. In this example, we used 2% and 12% as the return and 5% and 13% as the risk estimates, respectively, with a correlation of -0.5. With a target return of 5%, the resulting weights are 70% and 30%.

Let's assume that the manager has made a valid forecast for one asset, but erred on the other. Then, all else being equal, the optimal weights would be very different. This is one of the well-researched disadvantages of MPT. In our example, we found the return for asset B to be only 6% instead of 12%. The resulting optimal weights would then be 25% and 75% instead of 70% and 30%.

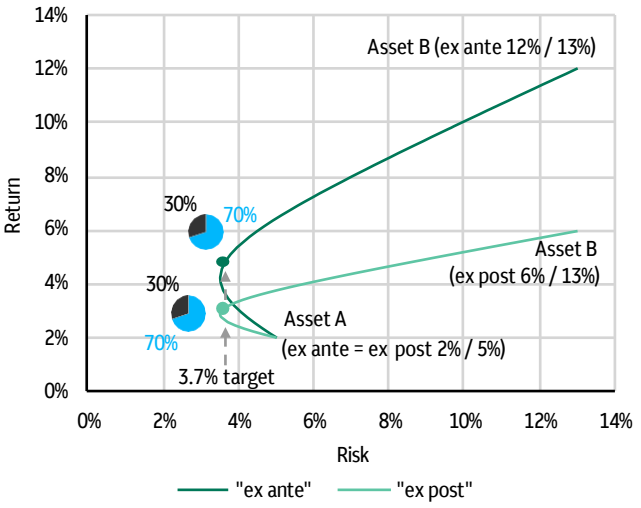
Chart 2: Target return of 5% resulting in 70/30 portfolio weights



Past performance is not a reliable indicator of future results.

However, if one uses the same experimental setup but instead of return optimization uses a predefined target risk (the target of 3.7% was chosen to lead to the same "ex ante" portfolio weights as in the chart above), to arrive at the optimal weights, one can see in Chart 3 that the resulting weights are identical in both cases. This is true for the two-asset case, and the weights are reasonably close to each other in the n-asset case.

Chart 3: Efficient frontier with 3.7% target risk results in same target weights



(For this to be the result, the directional view has to be B > A. The target risk optimization problem is then "maximize usage of Asset B while adhering to the risk limit and making most efficient use of correlation effects.")

5. We assume a return estimate to be correct if it is "reasonably close" to the actual return. We regard ~10% of the total probability distribution as a "reasonably close" interval. This sounds quite high, but the smaller we would set this interval, the lower the probability of a correct estimate gets. The interval translates into a range of valid return forecasts; for example, for equities with return 7% and volatility 20%, we would regard any value between 4% and 10% as correct. Even with our chosen interval, the joint probability for both estimates is only 0.5%.
6. Raimonds Maurer and Ulf Herold, "Tactical Asset Allocation and Estimation Risk." Financial Markets and Portfolio Management, Vol. 18, No. 1 (2004), pp. 39-57. Also: Attilio Merci, "The Black-Litterman Approach: Original Model and Extensions" (August 1, 2008). Shorter version in The Encyclopediaof Quantitative Finance, Wiley, 2010.
7. Attilio Meucci, "Exercises in Advanced Risk and Portfolio Management (ARPM) with Solutions and Code" (August 15, 2010).

It then follows that this method is leading to portfolio weights independent of return estimates, as long as the direction of the asset (that is, Asset B return will be higher than Asset A return) is known, which is exactly scenario iii in the Monte Carlo study described earlier. Thus, it is sufficient to have a ranking of assets, which naturally leads to a pairwise setup. Further, in this way the pairwise decision lets the manager make use of information that would not have been utilized in MPT. This offers yet another proof point about the imperfections of MPT that stem from the potential for "lost information."

Additionally, portfolio risk is stable for both possible solutions, not leading to unwanted spikes in volatility. This makes target risk our preferred choice for implementing pairwise views.

Within a target-risk framework, direction is much more important than precise return forecasting. The process of risk budgeting can become highly efficient because portfolio weights are derived from correlations and tracking error, independent of specific return forecast. In this way, a target-risk portfolio is constructed using weights derived through binary views.

Putting it to use

We have discussed how pairwise analysis could be beneficial to multi-asset portfolio management. To us, it is a straightforward and robust way of decision making – We would even go as far as saying it is the "natural way" in the context of portfolio management: You cannot simply "go long equities" – You always have to consider what to sell instead. There is always a tradeoff, and pairwise analysis compels the manager to examine this comparison.

In our view, one reason why binary views do not yet enjoy more widespread use is because of the challenges in how to translate them into portfolio weights. But investors need not be scared to use pairwise analysis; a careful selection of an appropriate portfolio construction process could help mitigate these challenges. We have shown the simple case of a target-risk framework as one example.

As a result, pairwise views should be seen as a general decision-making framework that can be applied by anyone, and in many different types of portfolios. As such, it is up to the manager/investor to decide how to best use it in a given situation, and also which inputs should ultimately drive the binary assessment at hand. These inputs can cover the full range of macroeconomic drivers, valuation, sentiment and market dynamics, behavioral factors, quantitative models, chart patterns, and so on.

In any case, we believe binary analysis encourages decision making, and thus active management. Continually thinking about "0" or "1" will likely lead to very different allocations over time, and the binary, yet highly active, thinking required in the pairwise decisions encourages an active-minded, holistic approach. In this way, it can be argued that pairwise decisions foment a general awareness and encourage active management in a way that the sometimes narrow process of return forecasting cannot.

In managing multi-asset portfolios for consistent, ongoing performance, pairwise analysis can offer advantages over more traditional methodologies such as return forecasts and MPT or Monte Carlo simulations. Pairwise analysis can help investors implement asset allocation decisions with consistency and clarity.

The case for pairwise analysis

At a time when investors have access to a plethora of investment options and as markets continue to evolve, portfolio management may increasingly become more complex.

The power of focus

The simple mechanics of binary decisions may help asset managers in several ways:

Focus	Each analyst can focus on his or her pair. Each portfolio receives the benefit of all views.
Diversity	Views on multiple pairs provide more insights than just a single return number for each asset. Assets in the pairs can be overlapping, and conflicting views can add information, which is not possible with traditional MPT approaches. * Diversification may not protect against market risk.
Wisdom of the crowd	With multiple analysts providing binary calls, a management team has a structured way to compare and contrast inputs, allowing for resolution of conflicting views, effectively tapping the wisdom of the entire team.
Multiple portfolio views	The binary process can be applied to top-down views such as on sectors, countries, or asset types, and allows for bottom-up and top-down views to be easily combined or compared.
Emphasis on active	The approach allows for a dynamic asset allocation process, in which pairwise views are independent, discernible, and measurable.

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