Scientific Portfolio Case Study

February 2025

Scientific Portfolio
An EDHEC Venture

Risk-Aware Performance Analysis of Equity Portfolios

Introduction

Analyzing the performance of an equity portfolio or index may bear some resemblance to the work of a medical diagnostician. The symptoms are clear to see for everyone: a given strategy has either outperformed or underperformed the market over a given historical sample period. What caused the out- or underperformance is a slightly more difficult question to answer, but the investigation generally does not stop there.

To decide whether some capital should be allocated (or remain allocated) to a strategy, an investor will want to address a series of more complex questions which include but are not limited to:

- Is recent outperformance likely to persist in the future?
- Does recent underperformance point to areas of the strategy that require adjustment?
- Are there signs of unintended risks compared to a stated/assumed investment objective?
- In the absence of a long track record, is there a way to put recent performance into a broader perspective?

Additionally, the passive or active nature of the strategy will bring a set of differentiated questions.

For a passively managed strategy , investors want to verify whether performance is mainly driven by systematic sources of risk and which of those risks (if any) have been rewarded lately. The persistence of returns can in turn be assessed by examining the stability of exposures through time and the possible presence of concentrations.

For an actively managed strategy[1], the questions aim to separate skill from luck; the focus is therefore more on specific risks and whether their outperformance (if any) displays signs of stability consistent with the presence of "alpha".

The present Case Study aims to answer the above questions by leveraging the analytics and insights available on the Scientific Portfolio platform. The next section offers a brief recap on performance attribution methods. In the two following sections, we present a detailed analysis of one passively managed equity strategy and one actively managed equity strategy.

Recap on Performance Attribution Methods

Performance attribution methods generally fall into two broad categories: asset-based or factor-based (also called risk-based), as shown in Exhibit 1 below.

Asset-based methods such as the Brinson attribution[2] were initially designed to evaluate the performance of active managers. The approach is based on the portfolio's active weights relative to a benchmark and aims to identify and quantify the drivers of performance from the active manager's point of view. Returns are therefore broken down into allocation effects and stock selection effects. Although Brinson-like methods offer a granular assessment of a manager's decisions and their impact on historical returns,

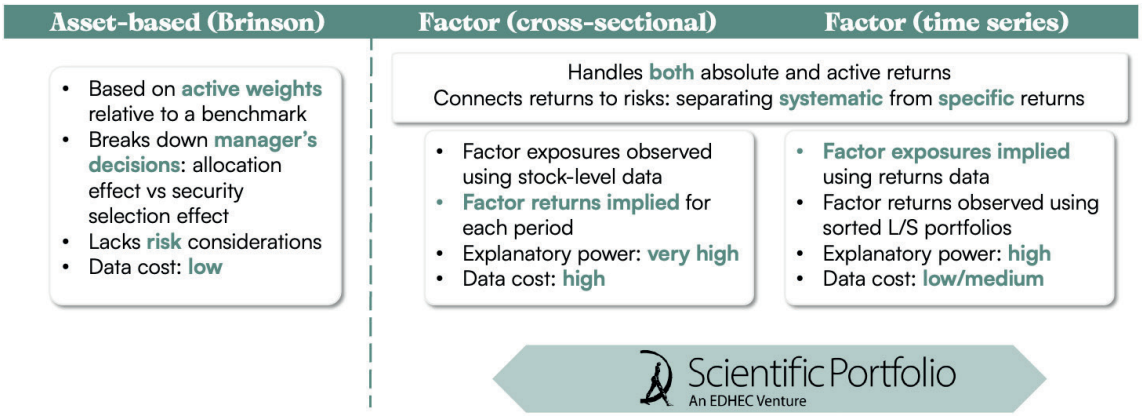
1 - By "passively managed" strategies, we mean non-discretionary, rules-based investment strategies that deviate (via systematic bets) from a simple market capitalization-weighted benchmark.
2 - See Brinson, Hood & Beebower (1986)

they lack risk considerations. More generally, they do not provide a link between risks and returns and will fail to provide an answer to most of the questions we raised in the introduction section.

Factor-based (risk-based) methods rely on a risk model designed to quantify systematic sources of risk in the portfolio and to separate them from specific risks. By identifying what drives the risks, a factor-based approach sheds light on the true drivers of observed returns and their persistence, while also warning investors of the presence of possibly unintended risks.

Factor-based performance attribution can either be constructed using a time-series approach (more commonly found in academia) or a cross-sectional approach (more commonly found among commercial providers of risk models). The latter approach offers a higher explanatory power of risks but is often more complex to implement and requires a larger amount of stock-level fundamental data.[3] The methodology implemented by Scientific Portfolio combines the two approaches[4] to obtain explanatory powers on par with cross-sectional models while using no more data than required by time series models.

Exhibit 1: overview of common performance attribution methods



Performance Analysis of a Passively Managed Strategy

In this section, we conduct a comprehensive performance analysis of the Russell 1000 Value Index (the Index), comparing it to a reference benchmark representing a market capitalization-weighted (CW) portfolio of the top 500 US companies (often considered a proxy for the overall US equity market).

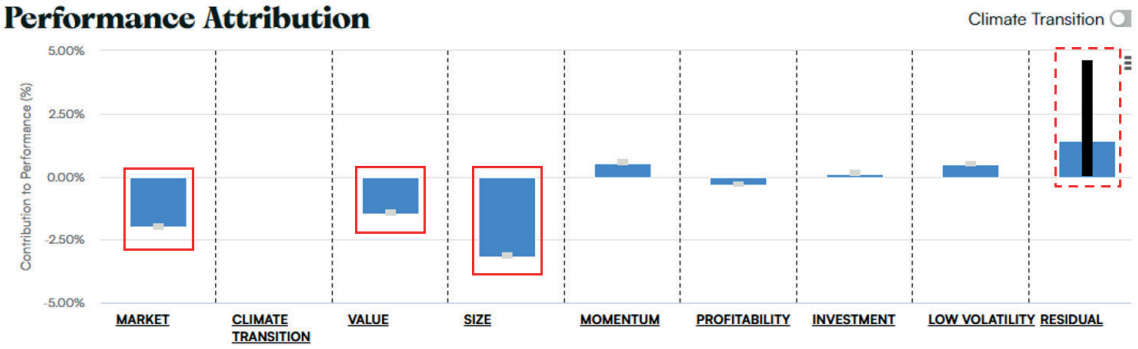
The Index is "*based on transparent rules*"[5] and "*measures the performance of the large-cap value segment of the US equity universe*". It therefore fits the definition of a passively managed strategy. In practice, the Index deviates from the reference benchmark because it overweights stocks with lower price-to-book ratios, lower EPS growth and lower sales growth, leading to systematic bets that drive the Index's risk and return relative to the reference benchmark. Over the past three years (Jan2022 – Jan2025), the Index underperformed the reference benchmark by 4.3% per annum.

Performance Attribution

We begin with a factor-based time series performance attribution, decomposing the total relative underperformance into contributions from 7 fundamental equity factors – Market, Value, Size,

3 - See Scientific Portfolio's Investment Philosophy for a brief review of common risk modelling approaches
4 - See the documentation of the Scientific Portfolio Risk Model for more detail.
5 - https://www.lseg.com/content/dam/ftse-russell/en_us/documents/ground-rules/russell-us-indexes-construction-and-methodology.pdf

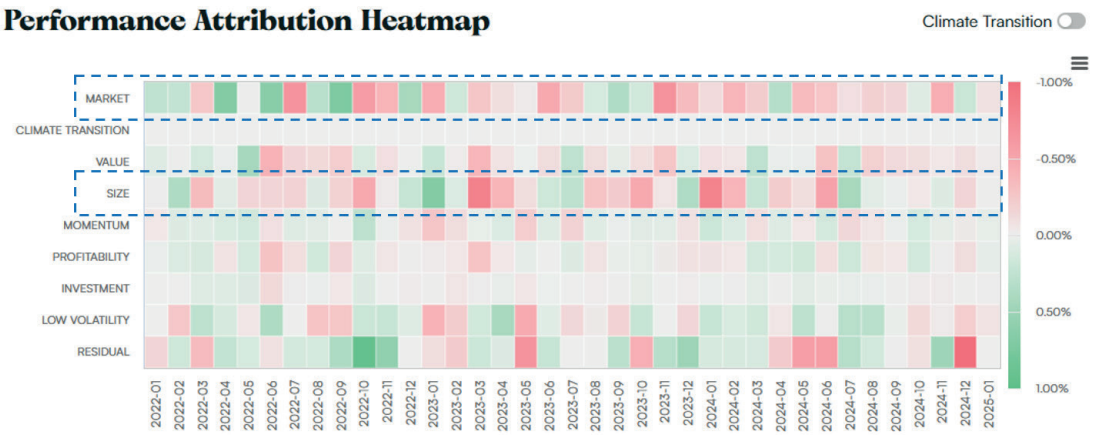
Momentum, Profitability, Low Volatility – and a Residual contribution completing the picture, as shown in the exhibit below.



Note: Each blue rectangle represents an additive contribution to the three-year relative performance of the Index with respect to the reference cap-weighted benchmark. The black vertical rectangle helps quantify the statistical significance of the Residual performance contribution and therefore the likelihood of its persistence; the larger the ratio of the Residual performance (blue rectangle) over the black vertical rectangle, the more significant the Residual performance. The ratio can be seen as a 't-stat' for the Residual performance. A ratio worth approximately 0.66 (respectively 1.00 and 1.65) indicates the presence of a persistent Residual performance with a probability of 50% (respectively 66% and 95%).
Source: Scientific Portfolio platform

Academic research shows that fundamental equity factors are the long-term drivers of performance for passive and well-diversified equity portfolios, which makes them natural candidates to explain the performance of the Russell 1000 Value Index (the Index). The other drivers of performance, namely sector-related risks and stock-specific risks are only expected to contribute to short-term performance, and their contributions to returns are therefore not expected to persist over time. The exhibit above is consistent with this idea, with three systematic drivers of returns (Market, Value and Size) explaining most of the relative underperformance (vs the reference benchmark), and a Residual performance contribution that is not statistically significant. However, large contributions from Size and Market were not necessarily expected (unlike for Value, given the investment objective of the index) and will be investigated further throughout this Case Study.

Overall, the performance attribution displayed above is informative but remains strongly sample-dependent (it is particularly sensitive to the start date and end date of the attribution period), as shown in the performance heatmap below (sections of the heatmap in dark red and dark green are respectively the highly negative and highly positive monthly performance contributions in the three-year period).

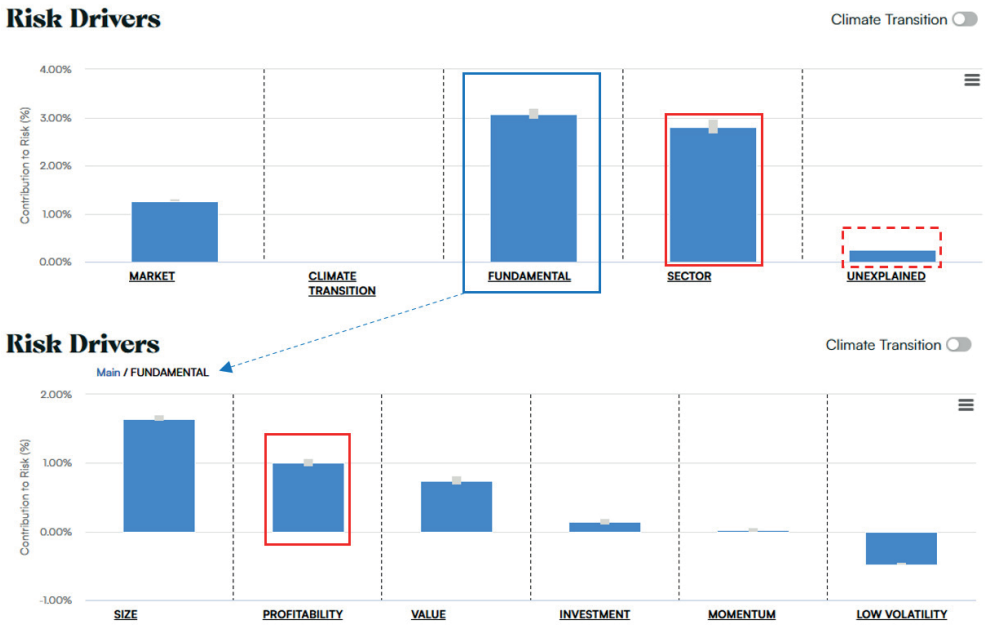


Source: Scientific Portfolio platform

For instance, we see that the Market and Size factors have each historically contributed both negatively and positively to relative performance, depending on the chosen sample period. The heatmap also intuitively shows why risk decompositions are less sample-dependent than performance attributions: the two factors are indeed materially contributing to the overall fluctuations of the portfolio at every period, which implies a lower sensitivity to the choice of start/end dates. We therefore turn to a risk analysis below for more robust insights about the true drivers of performance of the index.

Risk Decomposition

We rely on a factor-based cross-sectional risk model to decompose the relative risk (a.k.a. tracking error) of the Index with respect to the reference benchmark. The cross-sectional approach facilitates the addition of ten sector-related risk factors to the model, leading to a total of 17 systematic factors and a higher risk explanatory power. The decomposition is shown below.



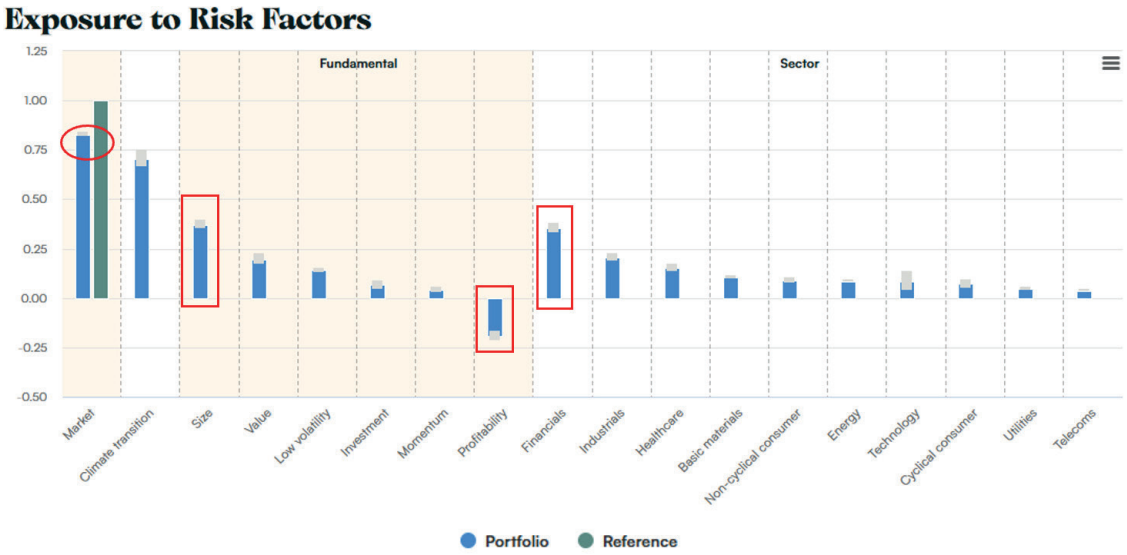
Source: Scientific Portfolio platform

We make three observations. First, the very small Unexplained contribution implies that relative risk has been almost entirely driven by the 17 systematic factors, which is consistent with the passive nature of the Index. Second, the presence of a meaningful Sector contribution implies that the Index's short-term performance has been affected by incidental sector deviations with respect to the reference benchmark. Third, we note a material contribution from the Profitability factor, which was not visible in the earlier performance attribution, indicating another possible unintended tilt that could have affected the long-term returns of the Russell 1000 Value Index. Overall, we note that the main fundamental relative risks (vs the reference cap-weighted benchmark) taken by the strategy (namely Market, Size, Value, and Profitability) in the past three years were not rewarded. We now complete our investigation by reviewing risk exposures.

Factor Profile

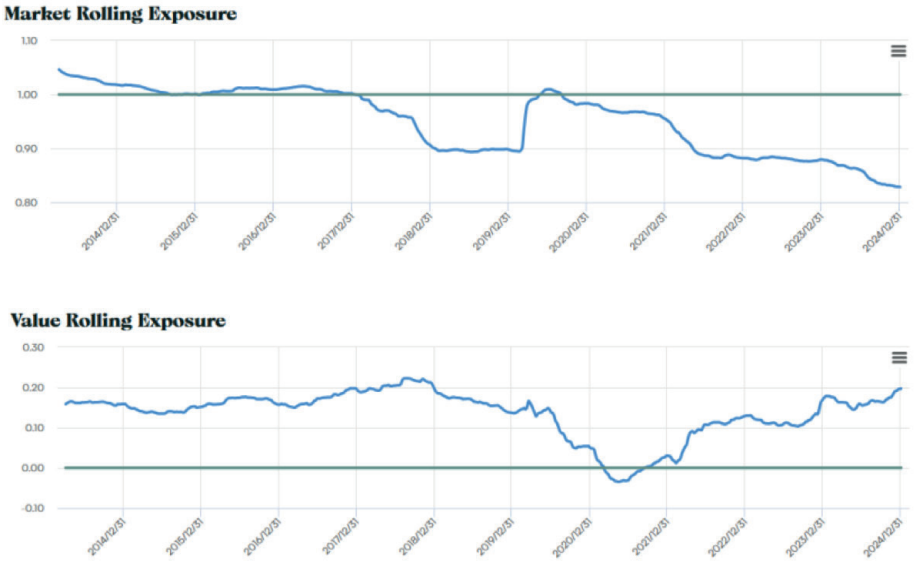
The exhibit below provides a full risk identification card of the Russell 1000 Value Index and allows us to confirm the insights collected from the performance attribution and the risk decomposition.

The Index did indeed tilt beyond Value towards other fundamental factors (a Market beta materially lower than 1.0, and long Size and short Profitability exposures) which had an impact on long-term performance. Additionally, the Index was incidentally exposed to sector risks that caused (and may continue to cause) short-term performance fluctuations.

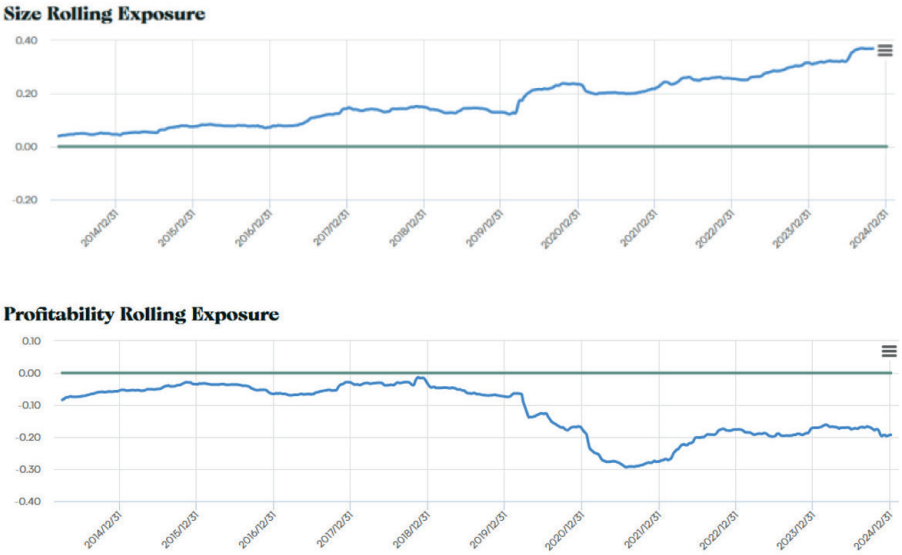


Source: Scientific Portfolio platform

To further qualify the persistence of these insights and the behavior of the Index we monitor the factor exposures over time in the exhibit below. We note some significant variations: the Index did not always follow a low beta strategy, it did not always have a Size tilt and its Value exposure did vary materially during the Covid-19 period but has now reverted back to its pre-Covid average. Given the trends displayed below for Market and Size exposures, the underperformance of the Index will likely persist unless we were to shift to a bearish market environment combined with a comeback of small caps vs large caps. Additionally, a review of the Profitability exposure indicates that the short bias that appeared during Covid should now be seen as a new normal for the Index. Note that the presence of a short Profitability exposure in value-driven strategies is a documented phenomenon in the academic literature[6]: selecting lowly-priced stocks without controlling for their quality often leads to an undesired exposure to unprofitable companies.



6 - See Novy-Marx (2013)

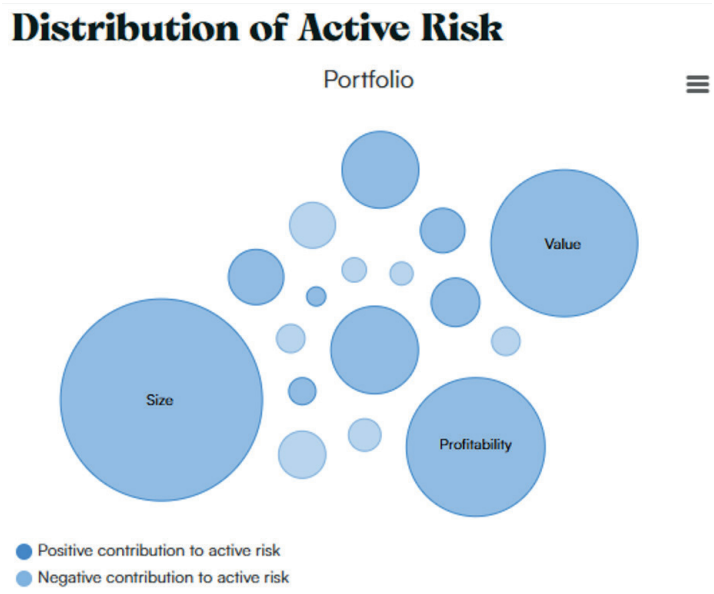


Source: Scientific Portfolio platform

Risk-Based Diversification and Extreme Risks

We conclude the performance analysis of the Russell 1000 Value Index with a review of possible risk concentrations relative to the reference benchmark. Indeed, the financial literature has reported that maintaining a well-diversified set of relative risk contributions stabilizes tracking error and mitigates extreme deviations.[7] On the other hand, a high level of relative risk concentration makes relative returns more unstable and less persistent.

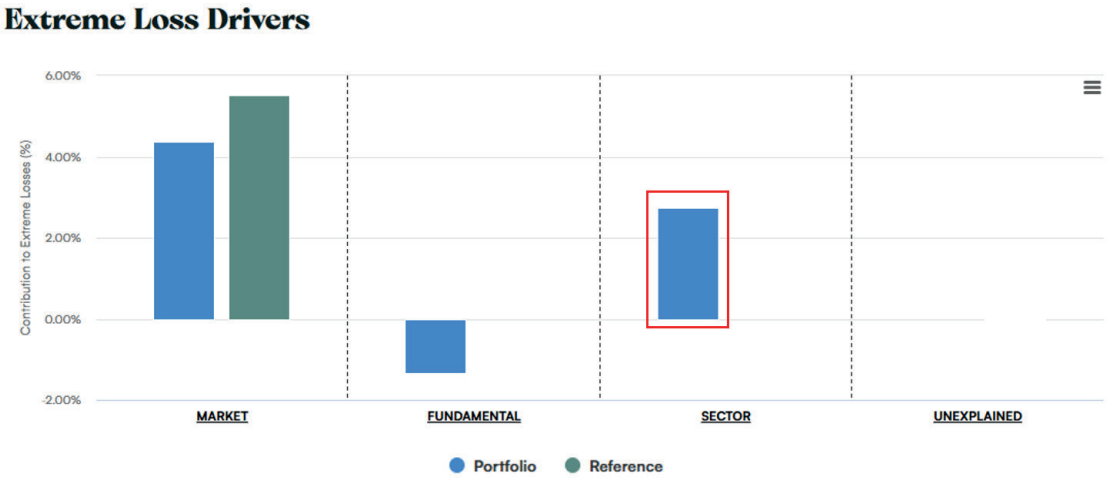
The exhibit below provides a visual and intuitive assessment of the distribution of relative (or active) risk contributions and indicates a relatively well-balanced set of risk drivers.



Source: Scientific Portfolio platform

7 - See Herzog, Jones and Safaee (2023)

A more quantitative assessment, based on a metric commonly used to measure concentration risk, does confirm our earlier conclusion: the level of active risk diversification of the Index is situated in the top quintile (20%) of our database of approximately 5,000 public mutual funds and ETFs. This makes the Russell 1000 Value Index less prone to extreme relative deviations with respect to the (cap-weighted) reference benchmark. A mitigated relative extreme risk (with respect to a reference benchmark) may nevertheless still leave room for a high level of absolute extreme risk, an important consideration for investors who manage multi-asset portfolios and who pay close attention to the potential for drawdowns in their equity allocation. The exhibit below decomposes the 1-week absolute extreme loss[8] of the Index equal to 5.8%, compared to 5.5% for the reference benchmark; this represents a ~1.05x loss multiple mainly explained by sector deviations, despite a lower Market exposure.



Note that a comprehensive review of extreme risk would also require considering different market regimes and examining the potential losses of the portfolio conditional upon a specific regime occurring.[9]

Performance Analysis of An Actively Managed Strategy

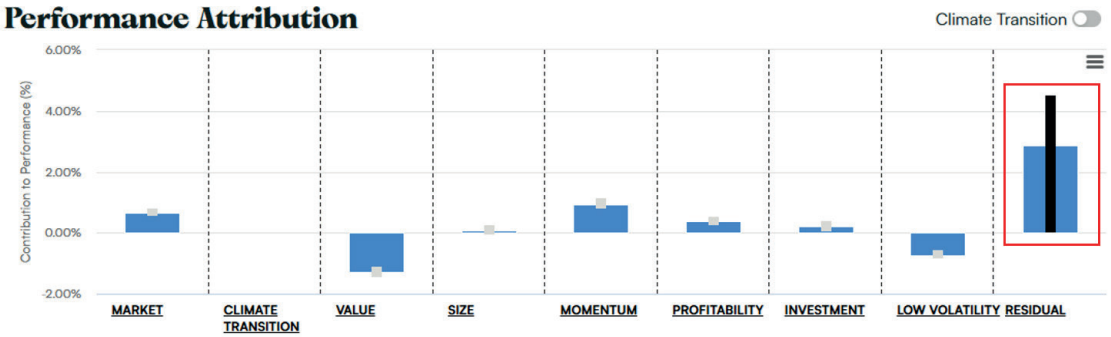
In this section, we conduct a performance analysis of an actively managed ETF, the Avantis US Large Cap Value ETF (the ETF), and compare it to its official benchmark, namely the Russell 1000 Value Index (the Benchmark). Over the past three years (Jan2022 – Jan2025), the ETF outperformed the Benchmark by 3.1% per annum.

Performance Attribution, Risk Decomposition, and Factor Profile

We begin by reporting the same set of analytics as in the previous section and limit our comments to the observable features specific to the ETF and its actively managed nature.

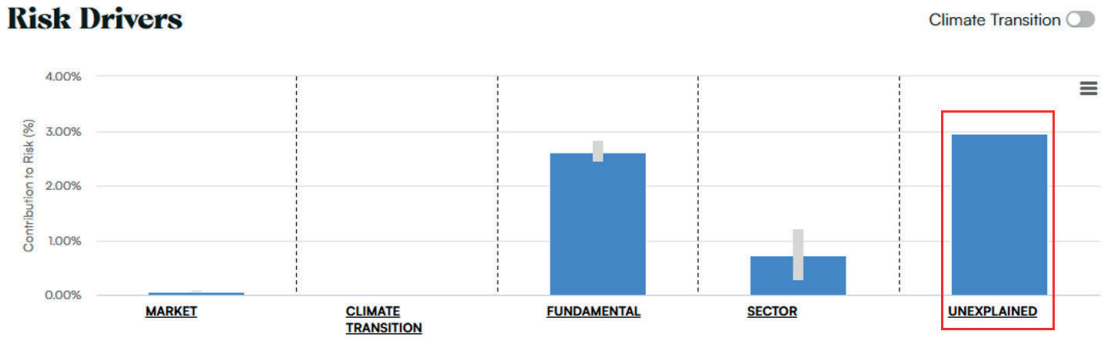
It would be reassuring to conclude that the active manager's long-term outperformance (vs the Benchmark) is not primarily driven by some passive exposures to fundamental equity factors. The time series attribution analysis below seems consistent with this idea, since the Residual term drives the overall performance. Additionally, the strongly positive Residual performance shows some moderate signs of persistence (t-stat ~ 0.66), meaning it cannot be immediately discarded as "luck".

8 - To estimate extreme losses based on its risk model, Scientific Portfolio uses a 2% Conditional Value at Risk (CVaR)
9 - See Bagnara, Herzog and Vaucher (2024)



Note: The black vertical rectangle helps quantify the statistical significance of the Residual performance and therefore the likelihood of its persistence; the larger the ratio of the Residual performance (blue rectangle) over the black vertical rectangle, the more significant the Residual performance. The ratio can be seen as a 't-stat' for the Residual performance. A ratio worth approximately 0.66 (respectively 1.00 and 1.65) indicates the presence of a persistent Residual performance with a probability of 50% (respectively 66% and 95%).
Source: Scientific Portfolio platform

The risk decomposition below does confirm that specific risks (and therefore returns) are the primary drivers of the ETF's deviation with respect to the Benchmark, as one would expect for an actively managed strategy. On the other hand, the impact of sectors is not material. However, we note a significant contribution from some fundamental factors, requiring further investigation via the factor exposures.



Source: Scientific Portfolio platform

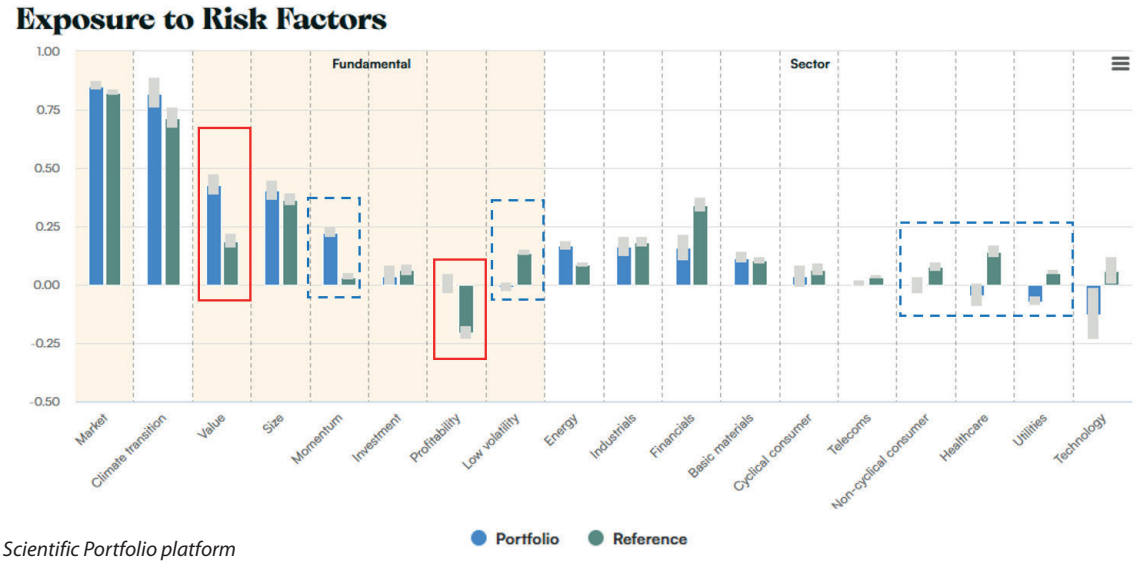
The factor profile reported below provides an answer as to why fundamental factors materially contribute to the ETF's tracking error (vs the Benchmark). It appears that the active manager has mostly attempted to "correct" systematic biases that were originally in the Benchmark and that the manager did not wish to replicate:

• First, the exposure to Value has been increased, probably because the manager deemed the Benchmark's natural exposure to Value too low relative to other factors (e.g., Size), considering the stated investment objective of the Benchmark (i.e., tilting towards value stocks).

• Second, the short Profitability bias has been eliminated, most likely to ensure the value-driven investment thesis does not incidentally lead to a tilt towards unprofitable companies (as explained during the analysis of the passive strategy). This is consistent with the investment objective stated by the ETF manager: "*focusing on firms trading at what we believe are low valuations with higher profitability ratios*".

• Finally, a long exposure to Momentum has been implemented while the long bias towards Low Volatility has been eliminated. This may seem odd intuitively, but it is only a consequence of some

sector-related "corrections" applied by the active manager. Indeed, the Benchmark has an exposure towards several defensive industries (Non-cyclical consumer, Healthcare, Utilities) that are themselves i) positively exposed to Low Volatility, ii) negatively exposed to Momentum. The ETF manager seems to have attempted to neutralize the defensive exposure, which mechanically affected the Low Volatility and Momentum exposures.

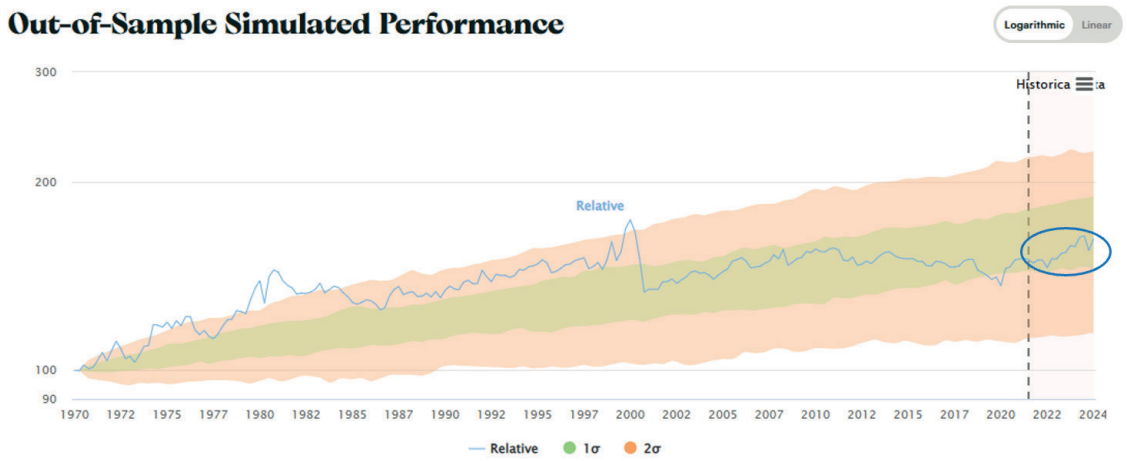


Source: Scientific Portfolio platform

Out-Of-Sample Simulations

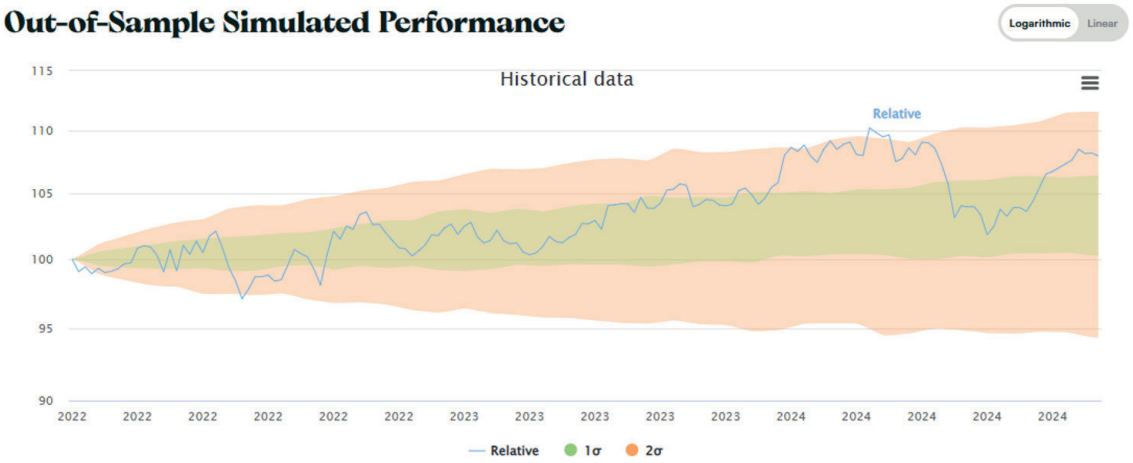
Unfortunately, the ETF has only 3.5 years of track record, so we are not able to extend our analysis to a longer period in order to either more thoroughly test for the presence of "skill" or monitor the evolution of the factor exposures over time, like we did earlier for the Russell 1000 Value Index. These extensions could have helped us determine how persistent and repeatable the last three years of risk and outperformance have been.

To circumvent this limitation, we project the factor profile of the ETF (as observed over the last 3.5 years) in the distant past and simulate a long-dated historical track record for a hypothetical portfolio that would have implemented the ETF's factor profile since the 1970s. The performance of this hypothetical portfolio relative to the Benchmark (Russell 1000 Value Index) is presented in the exhibit below.



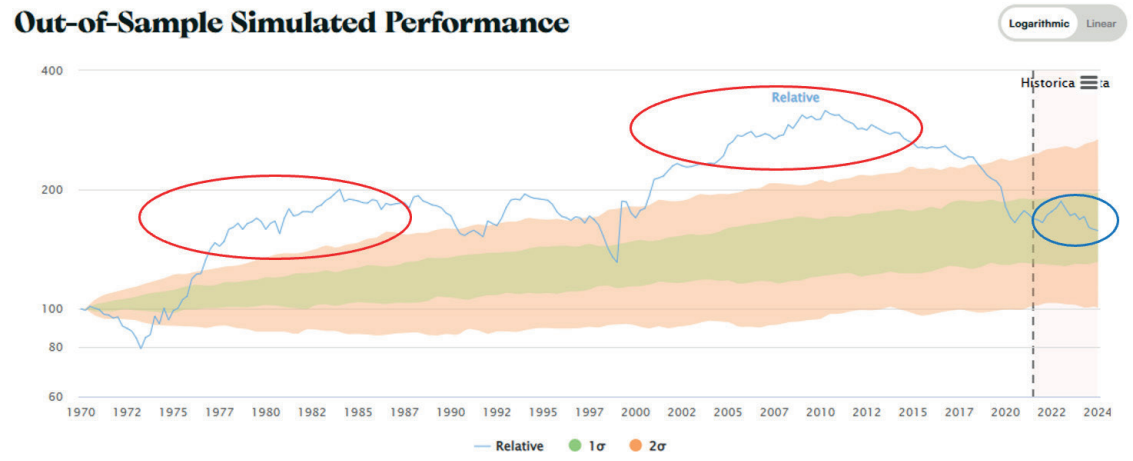
Note: The blue line represents a long-dated performance track record that combines i) the historically simulated track record obtained by projecting the observable factor profile (that of the observable track record of the strategy) in the past, and ii) the actual historical track record. The performance to the right of the dashed vertical line is historical, while the performance to the left of the dashed line is simulated. The 1σ and 2σ envelopes represent respectively 68% and 95% of the alternative track records that could have plausibly occurred based on the long-term distribution of returns inferred from the long-dated performance track record.
Source: Scientific Portfolio platform

This out-of-sample simulation allows to put the recent outperformance into perspective, leading to two observations. First, the systematic factor biases relative to the Benchmark (as implemented by the active manager over the last three years) would have historically been generating outperformance over the Benchmark. Of course, the long-dated historical track record generated does not include non-systematic returns, i.e., those related to the manager's skill, but it is reassuring to see that the systematic factor "corrections" implemented by the manager (and analyzed earlier in this section) have been historically rewarded. Second, the long-dated historical track record overall remaining "inside" the 2σ envelope means that the risk and return characteristics of these systematic factor corrections remain stable over time, implying that the last three years of relative returns have no reason to be considered an outlier outcome. The envelopes re-generated for the last three years only confirm this, see below.



As expected, we observe above that the three-year historical track record stays inside the envelope. Therefore, assuming the ETF active manager maintains similar factor biases against the Benchmark, the risk and return profile of the ETF (relative to the Benchmark) in the last three years is likely to be a reasonable proxy for the out-of-sample risk and return profile (relative to the Benchmark) that the ETF would have experienced since 1970s. Investors concerned that three years of track record are not sufficient to fully assess the risk profile of a strategy will welcome the result of this out-of-sample simulation as a source of comfort.

To further illustrate this point, we generate another long-dated historical track record representing the performance of the ETF relative to the reference cap-weighted benchmark (instead of the Russell 1000 Value Index) this time. The results are presented in the exhibit below.



The two periods (highlighted in red) during which the long-dated historical track record went significantly outside of the 2σ envelope indicate that the performance of the ETF relative to the cap-weighted benchmark may experience material regime changes and that a single (long-term) risk and return profile is not enough to describe the strategy. The possible existence of differentiated regimes implies that the recent (observable) track record of the ETF may not be an appropriate proxy for its long-term behavior relative to the cap-weighted benchmark.

Out-of-sample simulations therefore provide a long-term perspective to the analysis and help qualify the relevance of a given short-term track record: the same (short-term) track record may be deemed relevant or inappropriate depending on the benchmark relative to which the performance is measured.

Conclusion

By using a risk-based approach (as opposed to a Brinson-like approach), we have been able to explain equity performance and put it into perspective. In particular, we have shown how a factor-based risk model can help identify systematic drivers of performance and separate them from specific (non-systematic) ones.

Applying this approach to a passive rules-based index led us to detect unintended/incidental risk exposures and monitor their evolution over time. This helped us explain performance and risk more accurately and form a reasonable view on the persistence of the passive strategy's recent underperformance.

Applying the same risk-based approach to an actively managed fund was equally beneficial. Isolating non-systematic performance helped us test the presence of skill, while we managed to somewhat rationalize the intentions and actions of an active manager thanks to a careful review of factor risk exposures. Finally, our risk-based lens enabled us to address the limitations of a short-dated track record and put recent active outperformance into a longer-dated perspective using out-of-sample simulations.

Users of the Scientific Portfolio platform may access our analytics to conduct their own review of indices or ETFs available in our database but may also upload their own customised equity portfolio for a more personalised analysis.

Access the Scientific Portfolio Platform

About Scientific Portfolio

Scientific Portfolio is the latest commercial venture incubated within the research ecosystem of EDHEC Business School (EDHEC), one of the world's leading business schools.

Scientific Portfolio has assembled a team with a broad range of expertise and backgrounds, including financial engineering, computer science, sustainable and climate finance, and institutional portfolio and risk management. It proudly carries EDHEC's impactful academic heritage and aspires to provide investors with the technology they need to independently analyse and construct equity portfolios from both a financial and extra-financial perspective.

To achieve this, it offers investors three sources of value through its portfolio analysis & construction platform:

- Helping investors to analyse their equity portfolios, identify actionable insights and enhance portfolios with allocation functionalities. Indeed, Scientific Portfolio likes to promote portfolio analysis as a means to the concrete goal of building portfolios that are both more efficient and better aligned with their investment objectives.
- Providing investors with an integrated framework where financial and extra-financial (ESG) considerations are jointly captured in analysis and portfolio construction. The ability to incorporate ESG-related insights in the portfolio allocation process is now a common requirement among many investors.
- Giving investors access to a Knowledge Centre catering to all types of learners and providing guidance through the portfolio analysis and construction process. This aligns with Scientific Portfolio's commitment to remaining connected with its academic roots and bridging the gap between investors and academia.

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