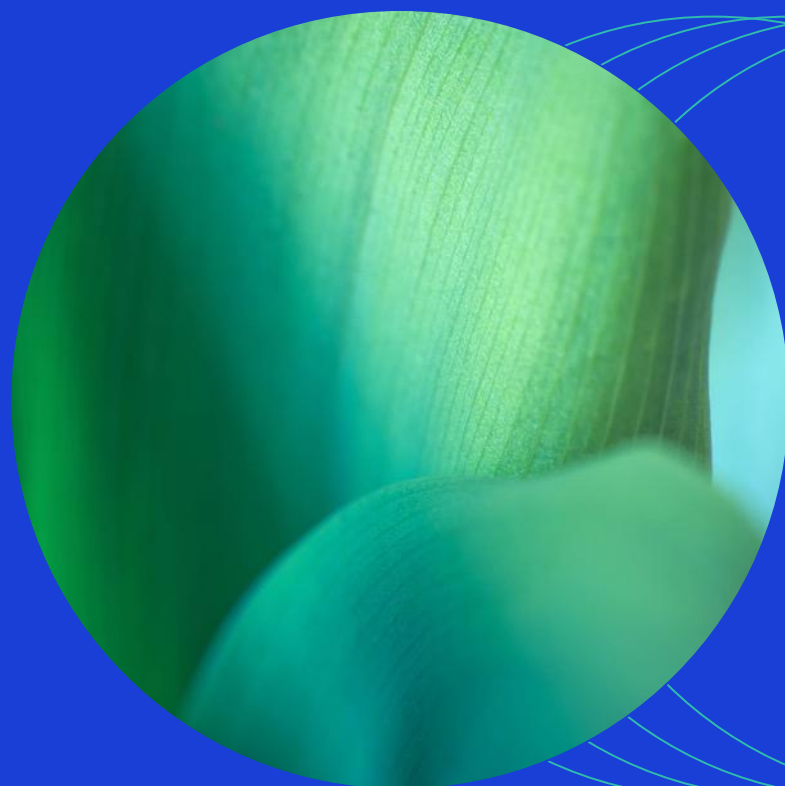


The Common Language of Portfolio Construction

A Unified Workflow for Asset Managers



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1 Executive summary

Portfolio construction is the procedure of translating the purpose of an investment strategy to an investable portfolio. Across investment teams, this translation is shaped by the same structural challenges: multiple goals, including return expectation, risk target, transaction costs and many more, must be satisfied simultaneously under various constraints. Despite the seemingly different strategies, teams across the investment spectrum — from fundamental managers to quant strategists and index portfolio managers — all operate within this shared domain.

This paper introduces a unified workflow for portfolio construction built on four components:

- **Investment intent**, which describes what to achieve
- **Portfolio exposures**, which define what to (or not to) hold
- **Risk control**, where we set how to size the holdings
- **Trade execution**, which consists of implementation and ongoing management of the strategy

Within this framework, we use optimization. By explicitly defining the objective, we formalize investment intent. A set of constraints encodes investment policy and a factor risk model provides a common language for measuring and controlling risk. The resulting portfolios are implementable expressions for these constrained optimization problems. This structured approach integrates the investment process where trade-offs are explicit.

We demonstrate this workflow through four investment challenges. For fundamental equity, optimization preserves alpha potential from stock selection, while offsetting risk from unintended factor exposures. It delivered higher returns at similar tracking error over the analysis period. For multi-factor strategies, the approach ensures that signals translate into balanced exposures, avoiding factor risk concentration and improving risk-adjusted performance. For indexed strategies the trade-off between tracking error and transaction costs becomes explicit. The portfolio manager can thoughtfully select the best-fitting implementation approach by understanding the dimensions of their challenge. For direct indexing, structuring client portfolios as variations of a shared optimization template enables scalable customization. It cut per-job processing time 38-fold compared with optimizing each portfolio individually across the full client-portfolio book.

Across all cases, a common optimization workflow reveals which constraints bind, how trade-offs are resolved and where strategies can be improved. As investment processes become more complex and interconnected, different teams can use this framework to establish a shared analytical language and focus their expertise on what matters most.

2 A workflow that connects investment challenges

Building a portfolio is more than selecting securities; it is the process of translating investment intent into positions that satisfy multiple objectives and constraints simultaneously. Every investment team must balance business goals with regulatory requirements, risk budgets, cost limits and mandate-specific constraints at scale.

The problem is structural: Tracking error limits, factor exposure controls and liquidity requirements and client-specific exclusions must be satisfied together — not sequentially. On top of that, implementation costs, capital usage and turnover drag on realized performance in ways that are rarely visible and difficult to control without a structured analytical framework.

In this paper we demonstrate an integrated approach that addresses challenges throughout the whole investment process. Despite operating across different domains, investment teams need a robust and scalable framework. Their challenges look different, but the priorities and limitations are part of the same underlying structure.

We formalize the investment workflow and demonstrate it through four investment challenges:

1. a fundamental equity manager balancing high-conviction stock picks against unintended risk
2. a quantitative investment strategist testing multifactor signals in a realistic construction setting
3. an indexed manager navigating the cost of replication
4. the head of a direct-indexing desk scaling hundreds of custom mandates without adding headcount

The challenges differ, but all strategies are parts of the same workflow.

2.1 Conviction and risk allocation

Fundamental equity strategies are driven by security selection. Alpha originates in specific knowledge from company analysis, sector insights or deep understanding of investment themes. Portfolios are often concentrated around high-conviction stocks that portfolio managers expect to drive excess returns.

The challenge is translating conviction into position size when risk budgets, sector-concentration rules and liquidity constraints all apply at once. When these limits are handled through heuristics rather than a disciplined framework, conviction may erode before it reaches the portfolio.

2.2 Multifactor signals and exposure control

Systematic investment and quantitative teams formalize investment views as signals in single or multiple factors or proprietary alpha models. The main challenge is converting signal strength into balanced exposures while controlling risk. Unintended tilts can arise from two sources: correlations among target factors that cause separate signals to reinforce the same underlying bet and individual securities that load on multiple factors simultaneously (Ghayur, Heaney and Platt 2018). Both make position sizing difficult without contaminating other exposures. Either effect can allow a subset of risk drivers to dominate the portfolio, particularly during periods of factor crowding or market stress. Without explicit factor-risk control, these unintended exposures dilute signal strength (Doole, et al. 2015).

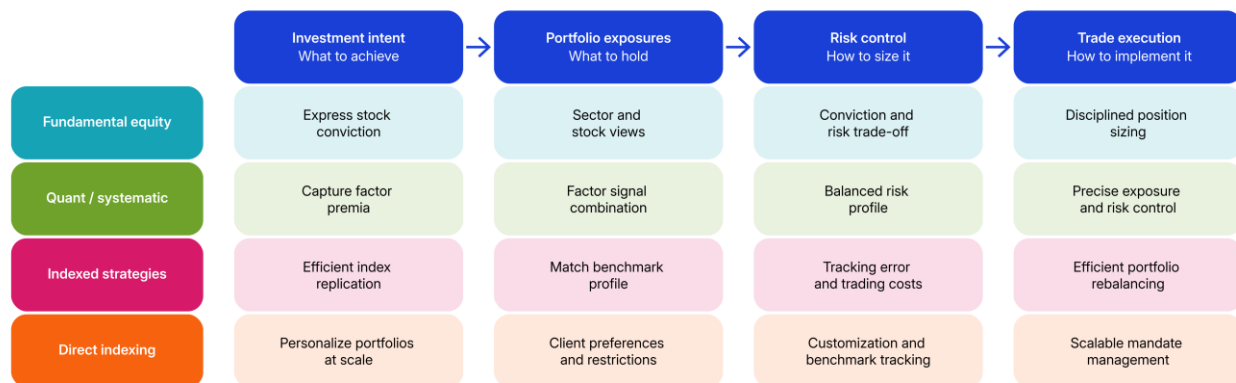
2.3 Replication under cost constraints

Indexed strategies prioritize efficient and consistent benchmark tracking. While replication may appear straightforward, practical implementation is more complex. Periodic rebalancing of the underlying index generates turnover and transaction costs that erode performance. These strategies face the trade-off between tracking precision and transaction costs, which is more challenging in less liquid universes. Costs directly drag down performance while higher tracking error leads to higher unrewarded drift from the benchmark.

2.4 Managing hundreds of custom client portfolios

Direct-indexing platforms manage large numbers of customized portfolios that follow exclusions, tilts and thematic overlays. Manual construction ceases to scale once the mandate book grows beyond a few dozen portfolios. The main objective is alignment with a parent strategy but in a scalable way. Without a structured workflow, scale is achievable only by adding headcount in proportion to mandate growth.

Active and indexed strategies are part of the same unified workflow



Different objectives, similar structural patterns. This end-to-end process describes challenges of asset managers from various domains.

Across these teams, the objectives differ, yet the structural pattern is consistent. Each one must translate investment intent into portfolios that simultaneously satisfy multiple constraints, like risk budgets, cost limits, factor controls and customization parameters. Balancing several constraints and objectives significantly increases complexity.

3 The optimization advantage

Different as they appear, all four challenges share the same mathematical structure: Each is a constrained optimization problem with multiple objectives and limits that must be satisfied

simultaneously. Optimization incorporates constraints directly into the portfolio-construction process from the start.

The general formulation of the investment challenge is similar for all four investment teams. Maximize (or minimize) an objective function over the portfolio weights subject to a set of constraints — risk limits and operational requirements that encode investment policy, for example (Grinold and Kahn 2000). In the next section we break down these components: the objectives, constraints and risk models that describe the covariance among the assets.

3.1 The objective function describes investment intent

The canonical mean-variance framework, introduced by Markowitz (1952), formalizes the objective as a utility function that rewards higher expected returns while penalizing portfolio variance. Risk-aversion parameters govern how aggressively the optimizer trades off return for risk reduction. This expression becomes more complex once additional objectives are introduced.

The objective function has three components:

- **Alpha term** encodes expected returns, expressed as forecasts or scores at the market, asset or factor level.
- **Risk term** penalizes portfolio variance, scaled by the risk-aversion parameters.
- **Additional terms** complement the objective when the strategy considers more aspects. Diversification, transaction costs and liquidity are the most widespread examples.

A conviction score, a quantitative signal or a tracking-error target each represents the objective in the optimization problem. Strategies might have different goals, but the structure remains the same. The mathematical formulation of the objective function and its extensions are detailed in Appendix A.

3.2 Constraints as investment policy

If the objective function encodes investment intent, constraints encode investment policy. In practice, the constraint set is where the complexity of modern portfolio construction is expressed:

- **Risk constraints** limit total or active risk, factor or idiosyncratic risk or risk contribution.
- **Asset and group constraints** define limits for positions or sector caps within mandate guidelines.
- **Turnover, transaction cost or liquidity constraints** incorporate market impact and implementation efficiency.
- **Regulatory and client-specific constraints** introduce exclusions, concentration limits or custom tilts that are external to the investment model but binding on the portfolio.

By adding all constraints, we have defined the optimization problem. By using optimization, we can evaluate their joint feasibility and identify the portfolio that best satisfies the objective with respect to the full constraint set. We can examine how much the constraints affect the optimal solution. These diagnostics are often as valuable as the solution itself: They reveal which constraints are binding, how

much they cost in expected return or risk efficiency and where relaxing constraints would generate the greatest improvement.

3.3 Factor risk models as a common language

A multi-factor risk model forms a coherent basis of the framework. A factor model decomposes portfolio risk into systematic and idiosyncratic components, enabling precise attribution and control of risk at the factor level. Investment intent expressed as factor exposures translates into measurable risk contributions.

By mapping each security to a common set of systematic factors, the model creates a shared vocabulary for expressing and measuring portfolio risk. It makes the risk consequences of any portfolio position transparent, showing how exposures aggregate at the factor level and where risk concentrates.¹

These components form a single framework, which serves as the common implementation layer across the investment teams. The optimization workflow reveals which constraints are binding, how objectives compete and what we sacrifice when we impose additional restrictions.

4 Investment challenges within the same workflow

The preceding sections described the framework in the abstract. We show it in practice across four teams, each facing a distinct investment challenge, each resolved through the same workflow. We compare common industry approaches that do not use optimization with ones where we describe the strategies in our holistic workflow, using at least 10 years of historical data.²

We introduce a range of strategies, from fundamental stock selection through multi-signal factor strategies to index replication and direct indexing. All four share the same optimization workflow, but differ in which constraints bind and which objectives compete. The workflow makes visible where the cost of each restriction falls.

The table below maps each team to its core challenge and the workflow solution that addresses it.

Challenges emerge at various stages of the portfolio-construction process

Team	Goal	Challenge
Fundamental equity	Earn excess returns from stock picks from fundamental research	Conviction positions carry unbalanced risk
Quantitative/systematic	Systematic, signal-driven outperformance	Signals may hold unintended factor risk
Indexed strategies	Efficient replication of the benchmark	Balancing transaction costs and tracking error

¹ Find out more about MSCI [Equity Factor Models](#) and [Multi-Asset Class Factor Models](#).

² In each case, the longest available analysis period is used, depending on the availability of security- and factor-level risk-model data.

Direct indexing

Manage many custom client portfolios simultaneously

Scale portfolios without significant headcount increase

In the following sections, we translate each of these abstract problem statements into a concrete portfolio-construction exercise.

4.1 Fundamental equity: Preserving conviction in the risk budget

A European fundamental equity manager running a 40-asset concentrated strategy faces a recurring challenge: Conviction picks concentrate in specific sectors and factors. The investment universe and benchmark are both the MSCI Europe Index. The portfolio manager selects 15 stocks at the beginning of each year that they expect to generate excess return.³ Fundamental managers translate conviction into positions in different ways: tiering their picks, following analyst recommendations or sizing positions incrementally. These approaches focus on individual names but lack portfolio-level risk control.

Our baseline is a heuristic approach: Each conviction pick receives an equal 4% weight. This high-conviction sleeve accounts for 60% of total portfolio value. The remaining 40% is risk control: It is invested in an index ETF to maintain diversification and reduce tracking error. The portfolio is rebalanced quarterly. The index hedge is a blunt instrument. It reduces tracking error mechanically without offsetting the factor and sector concentration of the alpha stock positions. The risk budget is spent, not allocated.

A factor risk model makes it possible to construct the risk-offsetting sleeve deliberately. It maps the factor and sector exposures and covariance structure of the alpha stocks, making it possible to balance risk explicitly. The portfolio manager's edge lies in stock selection, not in taking active factor risk. Minimizing active factor risk concentrates the active risk budget on stock-specific positions. The conviction picks drive returns while the rest of the portfolio manages the risk (Roisenberg, Subramanian and Bonne 2017) (Clarke, de Silva and Thorley 2002, Roisenberg, Subramanian and Bonne 2017). Rather than holding an index ETF to control active risk, holdings are selected from the benchmark universe and sized to offset the factor exposures introduced by the alpha sleeve. Unlike the baseline, which carries unbalanced factor exposures as a byproduct of the alpha picks, the optimized portfolio actively offsets them.

We compared two approaches to the baseline between January 2009 and December 2025.

- The first (blue line on the chart "Optimized risk control lifted information ratio consistently" below) keeps the same equally weighted alpha portion within the 40-asset limit but replaces the index ETF with an optimized risk-balancing sleeve. We minimize the benchmark-relative *factor* risk and keep the portfolio manager's conviction weights intact. The resulting strategy achieved 1 percentage point higher annual active return with 1 percentage point lower tracking error.

³ For illustrative purposes we choose a simplified approach for stock selection, which serves as a controlled input, not a model of fundamental research. We use the prior year's fifteen best-performing stocks to avoid look-ahead bias and hold the selection fixed for the calendar year. The case study isolates the effect of portfolio construction on a given set of conviction positions. The source of those positions does not affect the conclusions.

- The second (green line on the chart “Optimized risk control lifted information ratio consistently” below) strategy demonstrates how the portfolio manager can increase conviction without increasing active risk. The manager weights each alpha pick at 5%, raising the active sleeve to 75% of the portfolio. The remaining 25% balances the risk. Because the optimizer manages factor exposures explicitly, the additional conviction translated into higher active return rather than higher uncompensated risk over the analysis period. Annual active return was 1.5 percentage points higher than the baseline at a similar tracking error level.

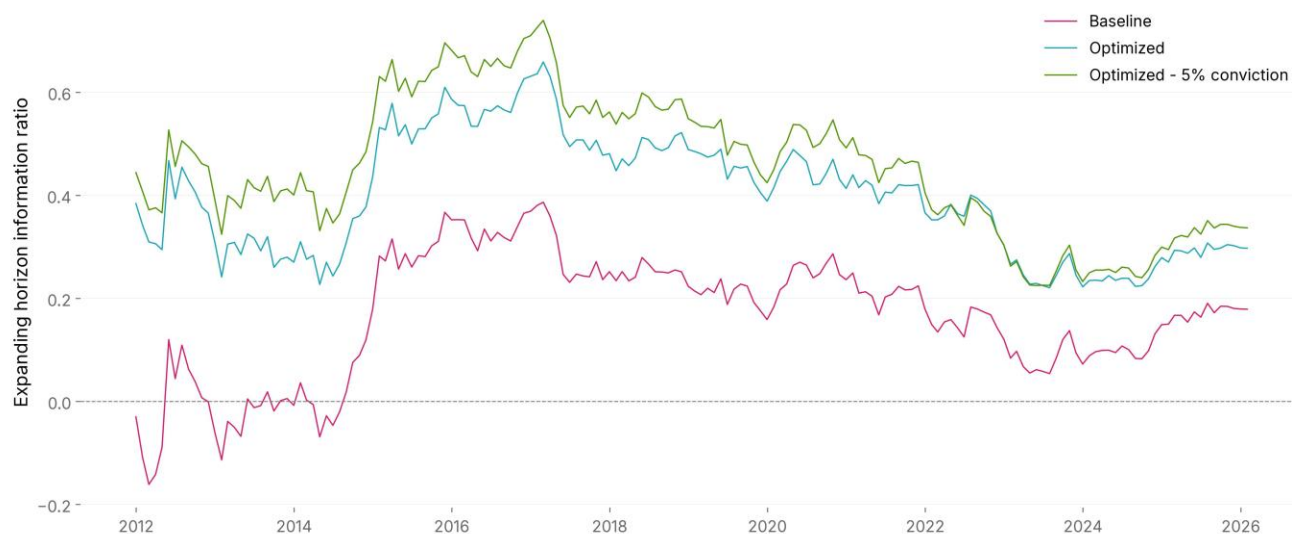
Optimized risk allocation lifted active returns at similar tracking error

Strategy	Annual active return	Tracking error	Information ratio
Baseline	1.94%	10.96%	0.18
Optimized	2.92%	10.00%	0.29
Optimized - 5% conviction	3.68%	10.99%	0.34

Analysis period from Jan. 1, 2009, to Dec. 31, 2025.

The optimized approaches achieved a higher information ratio than the baseline over the analysis period. The index ETF diversifies the factor exposures introduced by the alpha stocks but does not offset them. The optimized approaches directly limit the risk contribution from those exposures, freeing up active risk capacity for the intended bets, which can therefore be held with greater concentration.

Optimized risk control lifted information ratio consistently



Expanding-window information ratio from inception, minimum 36-month observation period. Analysis period from Jan. 1, 2009, to Dec. 31, 2025. All strategies are compared to the MSCI Europe Index. We used a new-generation risk model, the MSCI Global Equity Long Term Model (EFMGEMTLT).

Controlling the active risk efficiently resulted in consistent outperformance compared to the baseline. The expanding-horizon information ratio confirms the improvement holds across most regimes, except

between 2023 and 2024, when both optimized strategies decreased more than the baseline. During that period, leaving more unhedged factor exposures and using the index-ETF hedge was more beneficial than the risk-balancing sleeves in the optimized strategies.

The portfolio manager's picks drive the portfolio in all three strategies. What changes is how the rest of the portfolio handles the risk those picks introduce.

4.2 Multi-factor strategy: Signal integration into the construction framework

A quantitative strategist is working on a multifactor strategy. They examine several signals constructed from combinations of momentum, value and quality factors. The core challenge is translating signal strength into balanced exposures across all target factors without inadvertently tilting the portfolio's risk profile. The investment universe is the MSCI World Index; however, they compare the portfolios to a baseline, which is an equal-weighted composite portfolio of MSCI World Momentum, Value and Quality Indexes.⁴ This is a common approach, straightforward to build with transparent allocation logic. The top-down allocation, however, does not consider the relationship among the target factors. It adds three single-factor portfolios together but does not blend them. Optimization accounts for these interconnections directly by examining the factor profile of each security and sizes positions according to the investment objective.

The signal determines the expected source of excess return; the portfolio construction determines how efficiently it is captured. Two strategies using the same signal, but different construction approaches, can produce materially different outcomes. To isolate the effect of signal design, all optimized strategies share the same construction framework. Each maximizes expected alpha while minimizing factor and idiosyncratic risk, keeping non-target style exposures neutral relative to the MSCI World Index and applying a flat 20-basis-point transaction cost. Portfolios are rebalanced quarterly on standard MSCI index-review dates. Only the multi-factor signal differs.

To illustrate how signal choices affect outcomes, we compare three optimized strategies built on factor signals against the baseline.

- The first is the MSCI World Core Multiple-Factor Index (CMF) which uses only factor exposures in signal construction (Katiyar, Lodh and Gosar 2025). The security scores are the equal-weighted combination of momentum, value and quality factor exposures.
- The second uses exposure-weighted construction and factor returns: each security's factor exposures weighted by 12-month risk-adjusted factor returns form the security scores. The scores are translated directly into portfolio weights, with position sizes driven by signal strength (Gupta and Kelly 2019).
- The third uses the same factor returns but constructs alpha scores as a covariance-weighted combination of factor exposures, with weights chosen to equalize factor risk contributions. This accounts for differences in factor volatility, so higher-risk factors do not dominate the portfolio even when their stand-alone signal scores are strong (Maillard, Roncalli and Teiletche 2010).

⁴ Find out more about [MSCI Factor Indexes](#).

Optimized strategies achieved higher returns and comparable drawdowns

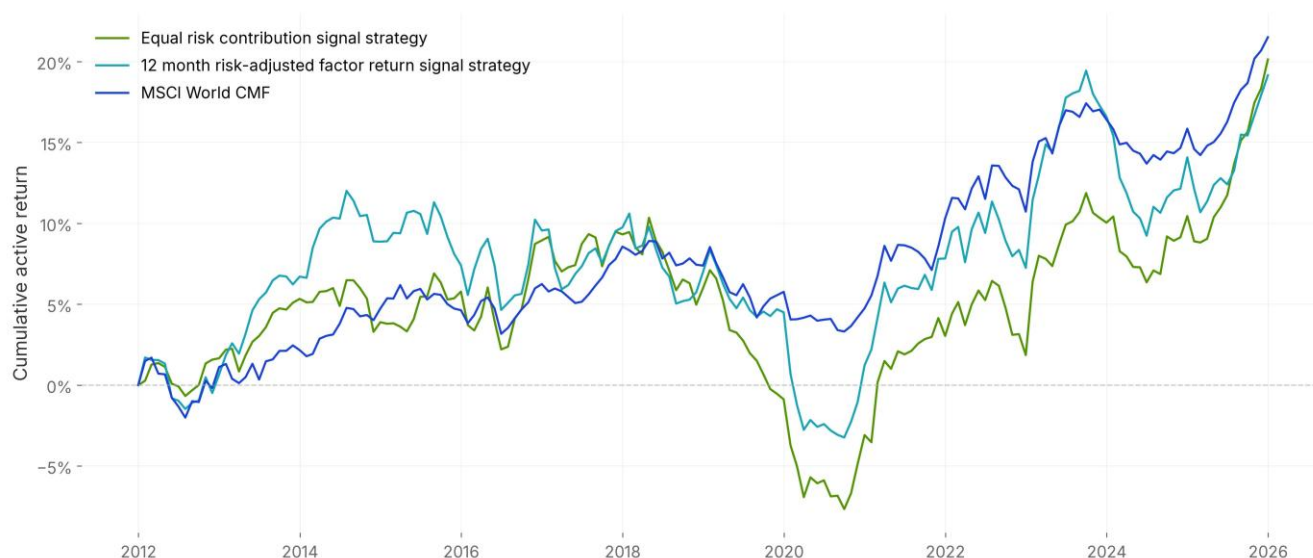
Strategy	Annual return	Annual volatility	Sharpe ratio	Max drawdown
Baseline	12.8%	14.30%	0.74	-23.90%
MSCI World CMF	14.5%	14.30%	0.85	-23.90%
Risk-adjusted return	14.2%	15.80%	0.75	-26.90%
Equal risk contribution	14.0%	15.30%	0.76	-23.30%

Analysis period from Jan. 1, 2012, to Dec. 31, 2025. We used a new-generation risk model, the MSCI Global Equity Short Term Model (EFMGEMLTS). The figures shown are transaction-cost-corrected returns.

All three strategies outperformed the baseline by more than 1 percentage point annually on average. Optimized strategies refine the factor blending while explicitly accounting for unintended factor exposures.

The difference between the strategies matters more than the absolute performance. The CMF index equalizes the target factor exposures, providing a balanced tilt toward momentum, value and quality. The risk-adjusted factor return strategy prefers whichever factor has the best risk-return ratio over the previous 12 months. This pays off in trending markets and hurts during reversals. Besides strong rallies the strategy also experienced sharp falls, especially at the beginning of 2024. The equal-risk-contribution strategy holds risk contribution constant across the three factors. It delivered similar Sharpe ratio through different trend capture. The chart below shows cumulative performance compared to the baseline.

Different strategies produced distinct performance paths



Analysis period from Jan. 1, 2012, to Dec. 31, 2025.

The CMF index delivered the highest risk-adjusted return during the analysis period with lower volatility and comparable maximum drawdown to the other strategies.⁵ During the COVID-19 stress period, the baseline strategy was the most resilient, although all three optimized strategies rebounded afterward.

We illustrated how signal design and portfolio construction are related. The same target factors produced different outcomes across the three strategies depending on how scores were formed and how risk was allocated.

4.3 Index fund: The replication-cost dilemma

An index portfolio manager faces a replication trade-off between tracking error and transaction costs. The objective of these strategies is to replicate the benchmark's return and risk profile as closely as possible while keeping implementation costs under control.

Factor risk models map the securities' exposures and provide the covariance structure that the optimizer needs. The portfolio manager aims to minimize tracking error and transaction costs simultaneously, to keep the portfolio aligned with the benchmark.

The challenge lies in the implementation stage of the workflow. Full replication of a broad benchmark requires holding every constituent at its benchmark weight. Periodic rebalancing of the index generates turnover across hundreds or thousands of securities. In less liquid market segments, the cost of executing these trades can materially erode fund performance. Not every trade contributes equally to tracking precision. The optimization workflow identifies which trades are essential for tracking precision and which can be deferred. Replication efficiency depends on the liquidity profile of the benchmark universe and on fund size, where replication costs can scale non-linearly with assets under management (Nishimura and Arany 2025).

We illustrate this challenge through an index fund tracking the MSCI Europe Small Cap Index. Index replication in a small-capitalization investment universe is more challenging compared to a large-mid-capitalization counterpart. Smaller companies tend to be more volatile and less liquid. This translates into wider bid-ask spreads and larger market impact. The baseline strategy fully replicates the index and rebalances quarterly with a one-day execution window.

We backtested physical-replication strategies between Jan. 1, 2016, and Dec. 31, 2025.

Rebalancing frequency is an important aspect in index tracking. We focus on monthly rebalancing in our study, because we found that it resulted in universally lower annual transaction costs than quarterly adjustments. With monthly rebalancing, the portfolio cannot drift as far from the benchmark between rebalances. The resulting trades are smaller and fewer than at quarterly frequency.

Larger funds exploit the market depth more with their trades, so the physical replication is more costly for these strategies. Tracking precision and trade execution impose more complex trade-offs.

⁵ Find out more about the [MSCI World Core Multiple-Factor Index](#).

We consider three main dimensions in this balancing act:

- Fund size of EUR 100 and EUR 500 million
- Active risk budget between 0 to 50 basis points of tracking-error limits
- Trade-execution window from one to three days

By observing different fund sizes, we examine how the market impact varies for a smaller and a larger fund. We measured replication quality through tracking error and compared transaction costs across execution periods.

While multiday execution provided universally lower average transaction costs, the longer execution window may carry heightened active risks for short periods. When the portfolio is under rebalance, the interim portfolios might track the benchmark more loosely. Over the analysis period, this risk was negligible across the examined tracking-error levels. On average it increased the tracking error of the strategies by 0.1 to 0.3 basis points annually.

The middle ground in tracking-error limit brought the lowest transaction costs



Analysis period from Jan. 1, 2016, to Dec. 31, 2025. The figures reflect a EUR 500 million fund size.

The transaction costs follow a U-shaped pattern as we allow increased deviation from the benchmark. Full replication of the underlying index is costly, because the portfolio manager must match the benchmark composition exactly. Transaction costs also increase from a 40-basis-point tracking-error limit, since even small composition differences between the portfolio and the index cause greater drift between rebalances, making monthly corrections more costly than in strategies that track more precisely.

When the closest-tracking strategies cost only slightly more

Tracking-error limit per rebalance	Average annual tracking error	Maximum annual tracking error	Average annual transaction cost	Annual transaction cost saved vs. baseline
0	3.5	7.1	12.3	4.1
10	13.1	17.7	11.3	5.1
20	25.5	33.7	11.2	5.3
30	37.3	50.1	11.1	5.4
40	47.4	65.0	11.5	4.9
50	57.9	75.4	11.7	4.7

Measured in basis points. Analysis period from Jan. 1, 2016, to Dec. 31, 2025. The figures reflect EUR 500 million fund size and three-day execution.

Larger fund sizes brought transaction costs of different tracking limits closer to each other. The transaction-cost range across all tracking-error levels narrows to only 1.2 basis points annually. Risk is materially different among the cases, however. The average annual realized tracking errors are higher than the tracking-error limits in each case. The optimizer targets active risk before transaction costs apply, so the cost of trades further increased the tracking error.

During the COVID-19 sell-off in 2020, tracking error reached its peak in the analysis period, with an almost linear increase across the examined tracking-error limits. Over the analysis period, more closely tracking strategies were more efficient, and delivered lower active risk at comparable cost.

In all cases, the realized tracking error exceeded the set post-rebalance tracking-error limits. Many strategies cannot go beyond a specified tracking-error threshold. Portfolio managers may therefore be cautious in handling these market-driven deviations. A buffer on tracking error limit or ad-hoc rebalancing are the most common tools managers use. Ultimately, implementation is a discretionary decision for the portfolio manager: The U-shaped cost curve shows a non-linear relationship between tracking precision and transaction cost. The range between 10 and 40 basis points tracking error delivered the lowest average annual transaction costs, while, below 10 basis points of tracking error, the analysis showed slightly elevated costs for lower active risk.

4.4 Direct indexing: Personalization at scale

The head of the direct-indexing business oversees the mandates the firm manages. They want to scale up the business, without a cost increase of similar magnitude. These customized portfolios often arrive through wealth-management platforms, RIAs or wirehouse programs. The management of these

portfolios is similar to indexed portfolios, but across hundreds of client portfolios. Each mandate tracks a parent strategy that we can think of as a benchmark. The portfolio is shaped for the individual's values, exclusions and investment preferences, however (Sharma and Wickremasinghe 2025).

When the portfolio book is small, construction often starts with base weights derived from the parent portfolio and applies client-specific adjustments through simple rules. As the book grows, quality becomes a function of capacity rather than methodology. Two clients with similar preferences may end up with materially different risk profiles depending on when their portfolio was last reviewed or which analyst performed the adjustment. Manual adjustments cannot scale without introducing inconsistency.

What differs from the single-portfolio cases is how the problem is organized. As most of the mandate characteristics — the parent portfolio, the exclusion list, the exposure bounds or any additional requirements — are systematic, we can describe the client portfolios using a shared template. The optimization workflow helps to translate client requirements, and the factor risk model ensures consistency by serving as the common language across different client portfolios.

Both the translation of client preferences and the scalability are key elements of a successful direct-indexing platform. We focus on the latter and illustrate this through a book of 500 portfolios, all tracking the MSCI USA Index as their parent, across six main personalization requirements.

Hundreds of similar, but not identical custom portfolios

Personalization requirement	Number of client portfolios
Core tracking	200
Industry or sector tilt	80
Single security exclusions	50
Thematic	50
Business involvement screening	20
Combinations	100

We grouped client portfolios into six groups, although each portfolio is unique despite being benchmarked to the same index.

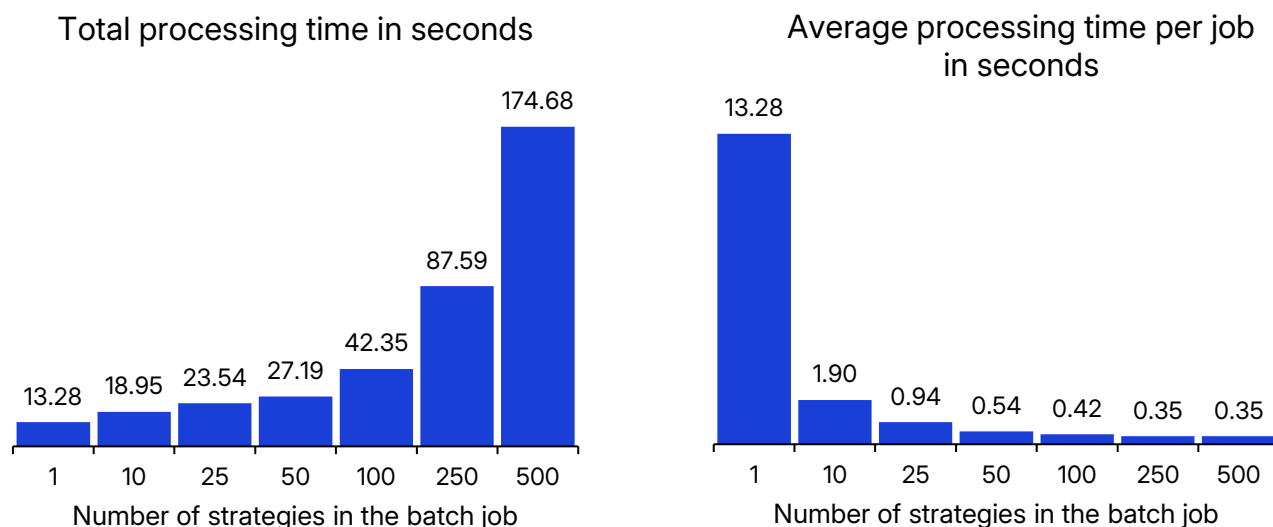
The book contains a wide range of client portfolios. Core tracking aims to minimize tracking error with a limited number of assets. There are industry- or sector-tilted portfolios that are generally easy to construct. For mandates with additional restrictions, exclusions or with the combinations of the above, customizations are typically more complex to solve.

When accounts share the parent portfolio, the optimization problems are structurally identical — only the constraint sets differ. This makes batch processing the natural approach. We construct the shared analytical inputs once and set the client-specific characteristics. The framework maintains each portfolio, requiring intervention only when customization parameters change. Each portfolio-rebalancing action is submitted as a job to the [MSCI Quantitative Investment Solutions \(QIS\) platform](#), which processes

requests through a batch queue organized by similarity. Jobs sharing the same benchmark and risk model are grouped and solved in sequence, where shared market and risk data is loaded once per group rather than per job.

We run the batch at increasing sizes, from 1 to 500 mandates to observe how processing time scales.

Processing time optimized to a large set of mandates



Rebalance date of the example batch is Feb. 27, 2026.

The bottleneck in single-portfolio processing is data loading, not optimization. One job takes 13.28 seconds; most of that is initialization. Batch processing splits this fixed cost: 10 portfolios average 1.90 seconds per job, and 500 portfolios average 0.35 seconds, which is a 38-fold improvement compared to single-job processing. The curve flattens beyond roughly 50 mandates.

We run the same optimization workflow across every portfolio. Onboarding a new client adds no analyst time, making the approach operationally sustainable as the book grows. Consistency is built into the process, not dependent on who rebalances the portfolio. The team defines the portfolio's profile once, and the platform absorbs it into the next production run.

5 End-to-end workflow for modern investment challenges

An optimization workflow does more than solve. It reveals the trade-offs that different investment teams face. We showed how an integrated workflow describes the investment process of various investment teams facing different challenges. We presented four case studies separately, yet each reduces to the same constrained optimization problem. Only parameterization differs. As the boundaries among these teams are increasingly fluid, the value of a structured process becomes apparent at each stage.

Investment intent alone does not determine the outcome. We showed in the multi-factor case that three strategies with the same target factors and portfolio-construction frameworks produced different outcomes. Signal design and portfolio construction are not separable; they should align.

Factor risk models serve as a common language in the workflow by decomposing risk into systematic and idiosyncratic components. Strategies direct risk where their edge lies. Fundamental managers concentrate on idiosyncratic risk, driven by their stock picks. Systematic strategies aim to minimize stock-specific risk and allocate their budget only to intended factor exposures.

How risk is distributed matters as much as which exposures are held. We demonstrated that actively offsetting factor exposures of high-conviction positions elevated returns and lowered risk. The multi-factor signal that balances factor-risk contributions across target factors outperformed the benchmark with a stable risk profile.

At the implementation stage, the indexed-portfolio-construction case showed tracking error and transaction costs do not move in the same direction. The middle ground in the tracking-error range delivered the lowest cost.

In direct indexing, the same optimization logic extended across 500 portfolios. The batch framework reduced per-job processing time by a factor of 38 relative to sequential single-portfolio rebalances. This templated approach scales with book size without linear headcount growth.

The four investment challenges in this paper differ in objective, universe and constraints — yet all reduce to the same optimization problem. That is the purpose of a common workflow: not to impose uniformity, but to give every investment team a shared language for formalizing their views, making trade-offs explicit, and for focusing analytical effort where it matters most. The same framework may be extended to more complex strategies — multi-asset-class, absolute-return or hybrid mandates — without requiring a different process for each.

Appendix A: The optimization objective function

Portfolio optimization seeks to navigate the trade-off between maximizing expected return and controlling risk. The canonical mean-variance formulation, introduced by Markowitz (1952), expresses this as:

$$\text{Maximize } f(w) = \alpha^T w - \lambda w^T \Sigma w$$

where w is the vector of portfolio weights, α is the vector of expected excess returns (or alpha scores), Σ is the covariance matrix of asset returns estimated from a multi-factor risk model and λ is the risk-aversion parameter that governs the trade-off between the return and variance terms.

The first term rewards portfolios with higher expected alpha. The second term penalizes portfolio variance, pushing the optimizer toward more diversified solutions. The risk aversion parameter λ controls the aggressiveness of this trade-off: Higher values produce more conservative portfolios; lower values allow greater risk in pursuit of return.

This base formulation is extended across teams to address mandate-specific objectives:

- For strategies that target active risk relative to a benchmark (fundamental equity, index replication, direct indexing), the risk term is expressed in benchmark-relative terms. The covariance matrix operates on the active weight vector ($w - w_b$), where w_b is the benchmark weight vector.
- For multi-factor strategies, α is replaced by a composite signal derived from standardized factor scores. The idiosyncratic risk aversion is higher than factor risk aversion to concentrate the portfolio's risk budget in systematic factor exposures rather than stock-specific bets.
- Transaction-cost terms may be added to the objective or introduced as constraints.

In all cases, the solution must satisfy the constraint set that encodes investment policy, as described in the main text.

References

- Clarke, Roger G., Harindra de Silva, and Steven Thorley. 2002. "Portfolio Constraints and the Fundamental Law of Active Management." *Financial Analysts Journal* 58 (5): 48-66.
- Doole, Stuart, Chin-Ping Chia, Padmakar Kulkarni, and Dimitris Melas. 2015. "Maximizing Factor Exposure While Controlling Volatility." MSCI Research & Insight.
- Ghayur, Khalid, Ronan Heaney, and Stephen Platt. 2018. "Constructing Long-Only Multifactor Strategies: Portfolio Blending vs. Signal Blending." *Financial Analysts Journal* 74 (3): 5-23.
- Grinold, Richard C., and Ronald N. Kahn. 2000. *Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk*. 2nd. New York: McGraw-Hill.
- Gupta, Tarun, and Bryan Kelly. 2019. "Factor Momentum Everywhere." *The Journal of Portfolio Management* 45 (3): 13-36.
- Katiyar, Saurabh, Ashish Lodh, and Chirag Gosar. 2025. *Efficient Multi-factor Indexing and Concentrated Markets*. New York: MSCI Inc.
- Maillard, Sébastien, Thierry Roncalli, and Jérôme Teiletche. 2010. "The Properties of Equally Weighted Risk Contribution Portfolios." *The Journal of Portfolio Management* 36 (4): 60-70.
- Markowitz, Harry. 1952. "Portfolio Selection." *The Journal of Finance* 7 (1): 77-91.
- Nishimura, Naoya, and László Arany. 2025. "A Practical Approach for Analyzing Fund Capacity." MSCI Research & Insight.
- Roisenberg, Leon, Raman Aylur Subramanian, and George Bonne. 2017. "Anatomy of Active Portfolios: How Factor Exposures Affect Fund Performance." MSCI Research Insight.
- Sharma, Dhruv, and Joseph Wickremasinghe. 2025. "Factor-Based Portfolio Alignment for Direct Indexing." *The Journal of Beta Investment Strategies* 16 (3).

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