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Capturing management signalling using non-linear interactions

Matus Mrazik, Investment Manager, and Amadeo Alentorn, Head of Systematic Equities at Jupiter, explain the latest enhancement introduced by the team.

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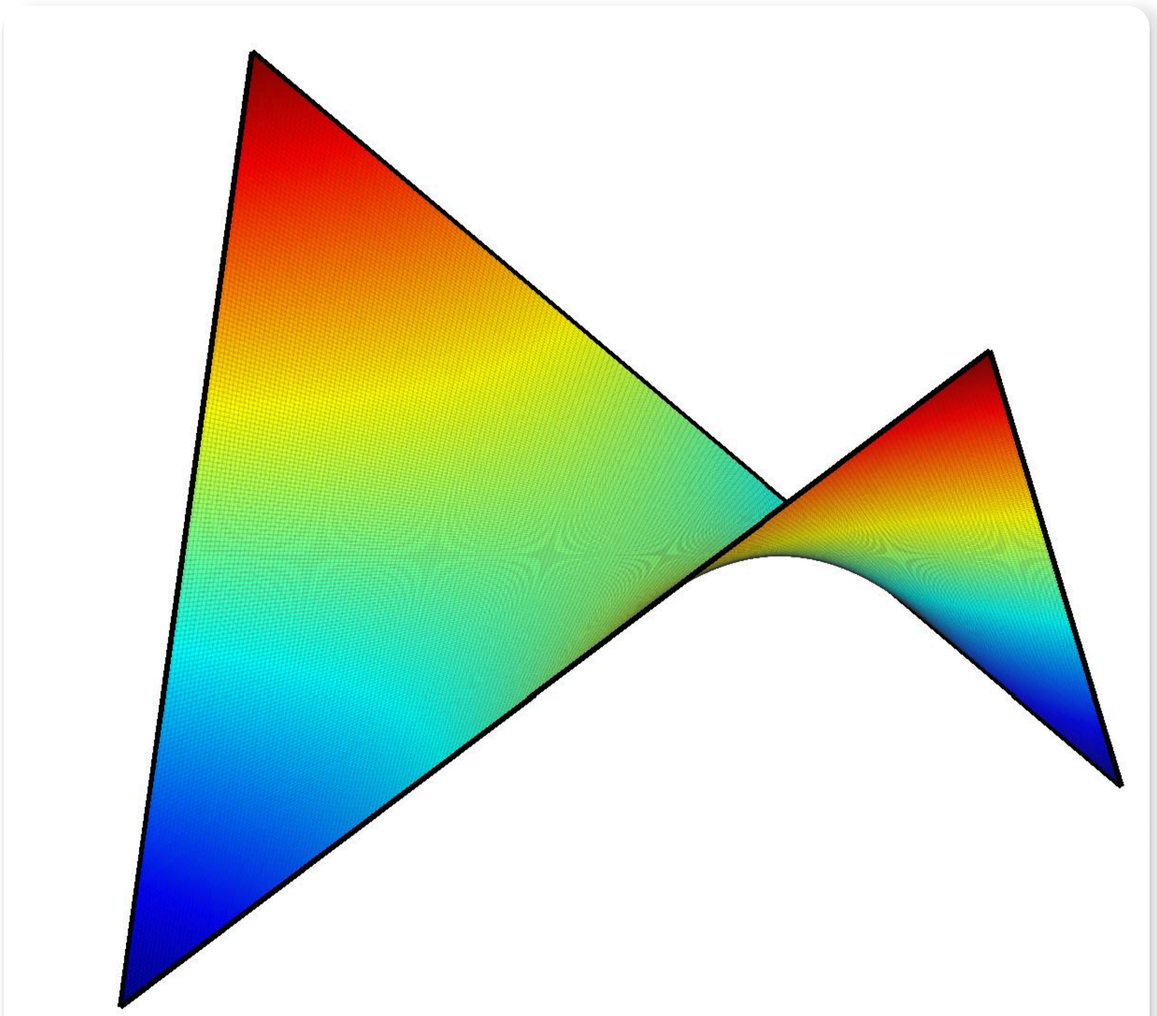
Systematic equity models are often built by combining different signals, such as value, momentum, and quality, into a single score. In most cases, this is constructed in a linear way, where each signal contributes independently and proportionally to the final result. While this approach is simple and effective, it assumes that each signal works the same way regardless of the broader context. In reality, this is not always the case.

As part of the statistical learning research (Alentorn & Mrazik, 2025) within our academic programme, we have been exploring how non-linear interactions between investment signals can be captured more effectively using, for example, decision trees and neural networks as well as more traditional techniques. In this instance, we have opted for a model that captures non-linearities while still being interpretable, and where we can validate the investment insight being implemented.

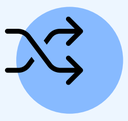
Non-linear interactions, or state dependence, allow the model to capture situations where the effectiveness of one signal depends on another. Instead of treating signals in isolation, the model can recognise that certain combinations of characteristics are particularly important.

The benefit of this approach is that it allows the model to focus on the parts of the market where signals are most meaningful. Rather than spreading predictive power evenly across all stocks, non-linear approaches help identify specific conditions where returns are more predictable. This can deliver a more targeted and informative signal, better aligned with how markets actually behave. In essence, non-linear relationships provide a way to extract additional insight from existing signals, without needing entirely new data, by understanding how those signals work together rather than separately.

Non-linear interactions can capture patterns that evade linear models.



Source: Jupiter. For illustrative purposes only.



What is non-linearity?

A linear relationship between a response variable and a predictor means that the expected response is modelled as a straight-line function of that predictor, holding other terms fixed. With one predictor this gives a straight line; with two predictors, a plane; with many, a hyperplane.

Many real-world relationships are non-linear, meaning that curvature provides a better fit. An example discussed by James et al. (2023, Chapter 3) is the relationship between miles per gallon and horsepower for cars. Fuel efficiency tends to fall as horsepower rises, but the decline is not perfectly straight-line. This is an example of non-linearity.

Polynomials are one way to model curvature, but they are not the only way: step functions, piecewise polynomials and splines are among other approaches.

Another example is the relationship between temperature and ice cream sales. A higher temperature helps sales, but not at a constant rate. A 1-degree increase on a cold day may have little effect, while the same increase on a warm day may raise sales a lot. At very high temperatures, sales may level off.

What are interaction effects?

Interaction effects are common in everyday life and in economics. One example discussed by James et al. (2023, Chapter 3) uses radio and TV advertising to predict product sales. Suppose each channel has a positive effect on sales on its own, but the effect of radio advertising is greater when TV advertising is already high, and vice versa. In that case, a model that includes an interaction term between radio and TV may fit the data better than a model that includes only main effects.

The key idea is that the effect of one predictor depends on the level of another predictor.

Combining behavioural and informational effects

Our new non-linear signal falls within our Company Management stock selection strategy, which seeks to assess the quality of a management team through the data that comes out of their decision-making. The new signal blends existing signals into an interaction term designed to enhance the information already present in each component. Specifically, it combines the informational effect of management signalling with the impact of price behaviour.

The key insight is that the interdependencies between these two effects can be more informative than either signal on its own. It can capture meaningful divergence or convergence between the external perceptions of market participants and the internal conviction of management. Divergent cases may be more likely to reveal mispricing, for example.

By explicitly modelling subtle structural relationships, our new signal is able to identify cases where divergence or convergence are most meaningful. The model can better capture situations where market expectations and underlying fundamentals may be misaligned. This leads to a richer and more economically intuitive signal. For example, weak price behaviour combined with poor management signalling (convergence) might reinforce expectations of a negative outcome; whereas weak price behaviour combined with strong management signalling (divergence) might in some cases point to a mispricing and potentially a positive outcome.

Benefits of the new enhancement

The addition of the new management signalling interaction within the model's Company Management stock selection strategy represents a meaningful extension. By capturing conditional relationships and economically intuitive functional dependencies between signals, it provides access to incremental alpha that is not fully captured by linear frameworks. When implemented carefully, this can:

1 enhance model diversification

By incorporating a new uncorrelated signal that operates on a different dimension from existing signals

2 improve risk management

Especially in the handling of price behaviour information which can experience periods of sharp reversals, particularly in stressed

3 strengthen the model's ability to source alpha

By producing a refined and more robust stock selection process.

Continually enhancing the systematic process

Central to the Jupiter Systematic philosophy is a continuous and disciplined research effort to ensure that our investment process improves over time. For over 20 years, this philosophy has resulted in a regular stream of evolutionary changes to our investment process, leading to improvements in our expected risk-adjusted returns over time. We currently have several other exciting research projects under way, including the development of further non-linear signals, and we look forward to bringing you more details of these in due course.

The team's investment process has been implemented for more than two decades and is continuously refined. Recent enhancements are shown below. These enhancements follow extensive research undertaken by the team.

Recent enhancements

Introduced to each of the three parts of the investment process

Stock level	Market level	Portfolio level
Stock selection characteristics	**Dynamic weighting scheme**	**Portfolio construction and risk management framework**
Directors' Deals (Apr-2020): new component added to Company Management to extract information from directors' trades in own company shares. **ESG (Jun-2020):** new component added to Company Management to incorporate granular E, S and G metrics, while avoiding accidentally tilts. **Management sentiment (Nov-2020):** new component added to Sentiment to capture sentiment and quality signals from transcripts of management earnings calls. **Fund Flows (Nov-2021):** new component to extract information from flows into equity funds and ETFs. **Global Industry Fund Flow (Oct-2023):** new signal to enhance a component in Price Action to benefit from industry level equity fund flow. **Patent data (Nov-2024):** a new signal added to Company Management to measure the efficiency of a company's innovation. **Short-term dislocations (Sep-2025):** enhancement to an existing Sentiment component. **Management signalling (Mar-2026):** capturing the non-linear impact of management decisions on price action trends.	**Conditional Downside Risk (Sep-2019):** improving the process of dynamic allocation between factors to include consideration of the conditional downside risk of factors in different types of market environment. **Value Quality decoupling (Sep-2019):** allowing more flexibility in the deployment of Value and Quality within Dynamic Valuation, to better navigate periods where both styles are out of favor. **High conviction rotation (Mar-2021):** better identification of relationships between market environment indicators and factor return expectations, allowing larger rotations where model has higher conviction. **Dynamic Valuation (Mar-2025):** enhancement to better navigate more extreme market environments when investors are focusing on either deep value or expensive quality stocks.	**Statistical risk model (Sep-2019):** addition of PCA-based risk model to bolster existing factor-based risk model framework to identify and control transitory sources of risk without the need to prespecify them. **Revised constraints (Jan-2020):** enhancements to how country, sector and industry effects are controlled at the factor design stage, portfolio construction stage, to improve risk-adjusted returns. **Reputational Risk (Dec-2022):** Monitoring of ESG related reputational risk based on news items to identify stocks driven by non factor-based characteristics. **Expansion of trading universe (Oct-2023):** expansion of trading universe by 500+ stocks to benefit from market liquidity and breadth for alpha opportunity. **Volume forecasting (Dec-2025):** better capturing of volume fragmentation across trading venues. **Trade thresholds (Feb-2026):** increase efficiency of alpha implementation by optimising sizing of trades.

References

James G, Witten D, Hastie T, Tibshirani R & Taylor J. **An Introduction to Statistical Learning**, 2023. Available at https://www.statlearning.com/

Alentorn A & Mrazik M. **Fooled by noise?** Why statistical learning, not hype, drives our process, Jupiter, 2025. Available at https://www.jupiteram.com/uk/en/professional/insights/why-statistical-learning-not-hype-drives-our-process/

The value of active minds – independent thinking: A key feature of Jupiter's investment approach is that we eschew the adoption of a house view, instead preferring to allow our specialist fund managers to formulate their own opinions on their asset class. As a result, it should be noted that any views expressed – including on matters relating to environmental, social and governance considerations – are those of the author(s), and may differ from views held by other Jupiter investment professionals.

Important information