3rd Edition

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Forecasting meets Portfolio Theory: A Bibliometric Approach to Decision-Making under Uncertainty

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INTRODUCTION

Decision-making under uncertainty is central in fields such as economics, operations research, and engineering. Real-world choices rely on **incomplete**, **noisy**, and **evolving information**, creating challenges for both **predictive accuracy** and **decision quality** [1] . Even with advances in data and modelling, human judgement remains affected by **biases**, **heuristics**, and limited awareness of uncertainty [2].

Over the past two decades, research in **forecasting** and **portfolio theory** has developed tools such as **shrinkage**, **model averaging**, **adaptive weighting**, and **robust optimisation** to address **estimation error**, **model misspecification**, and **structural instability**. Yet insights across these areas remain scattered (e.g. [3-4]). This review analyses **503 publications** (2000–2025) to map thematic intersections and identify shared strategies for more **resilient**, **uncertainty-aware** decision-making.

METHODS AND MATERIALS

01 — Search & Data Import

A structured Scopus search on forecasting and portfolio theory retrieved **2,970 publications** (2000–2025). Metadata for titles, abstracts, keywords, and citations were extracted.

02 — Keyword Cleaning and Filtering

Keyword fields were standardised through text preprocessing. A total of **491 publications** were removed due to missing or low-frequency keywords. **2,479 publications** remained for clustering.

03 — Keyword Clustering Pipeline

High-frequency keywords were clustered using **both linear (PCA + K-Means)** and **non-linear (UMAP + HDBSCAN)** methods. After removing unmatched entries, **2,448 publications** were retained.

04 — Identification of Relevant Publications

Targeted bridging keywords were used to identify publications linking forecasting, optimisation, and portfolio theory. A total of **871 publications** contained at least one bridging keyword.

05 — Final Selection & Eligibility

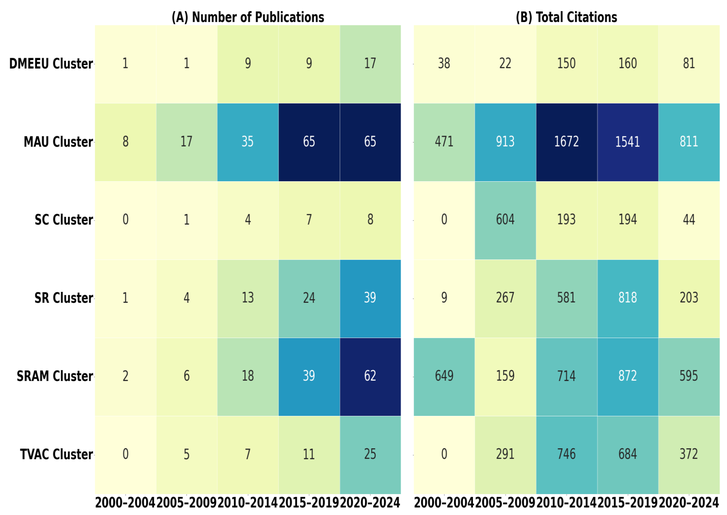
Publications spanning **at least three thematic clusters** were retained. Abstract screening identified **six thematic themes**, resulting in a final analytical dataset of **503 publications**.

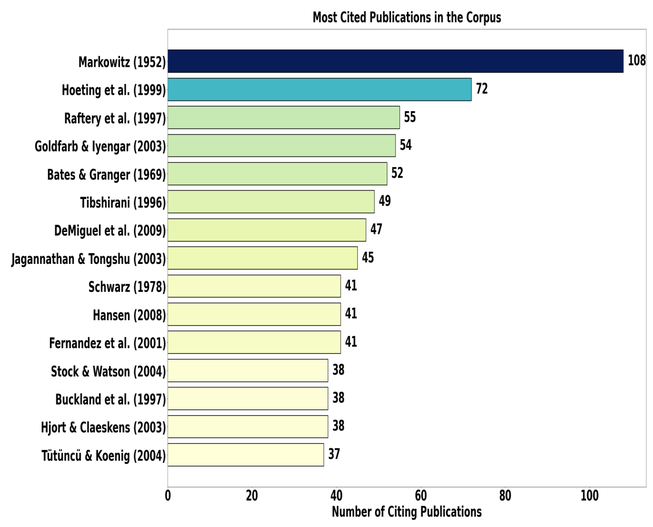
RESULTS AND DISCUSSION

Six thematic areas were identified that capture the main points of intersection between **forecasting** and **portfolio theory**.

Theme	Description
Stochastic & Robust Aggregation Methods (SRAM)	Approaches that address uncertainty and model misspecification using stochastic or robust optimisation, including robust portfolios and worst-case forecasting.
Shrinkage & Regularisation (SR)	Techniques that mitigate overfitting and estimation error through penalisation, sparsity, or other regularised weighting and portfolio construction methods.
Model Averaging under Uncertainty (MAU)	Strategies that spread model risk by averaging across multiple models rather than relying on a single specification.
Time-Varying & Adaptive Combinations (TVAC)	Dynamic methods that adjust model weights or selections as new information arrives.
Simplicity vs. Complexity (SC)	Comparisons of simple heuristics versus complex optimisation approaches, focusing on robustness, interpretability, and performance under limited data.
Decision-Making & Estimation Error under Uncertainty (DMEEU)	Frameworks that incorporate estimation risk into forecasting and optimisation, including parameter learning, regime detection, and uncertainty propagation.

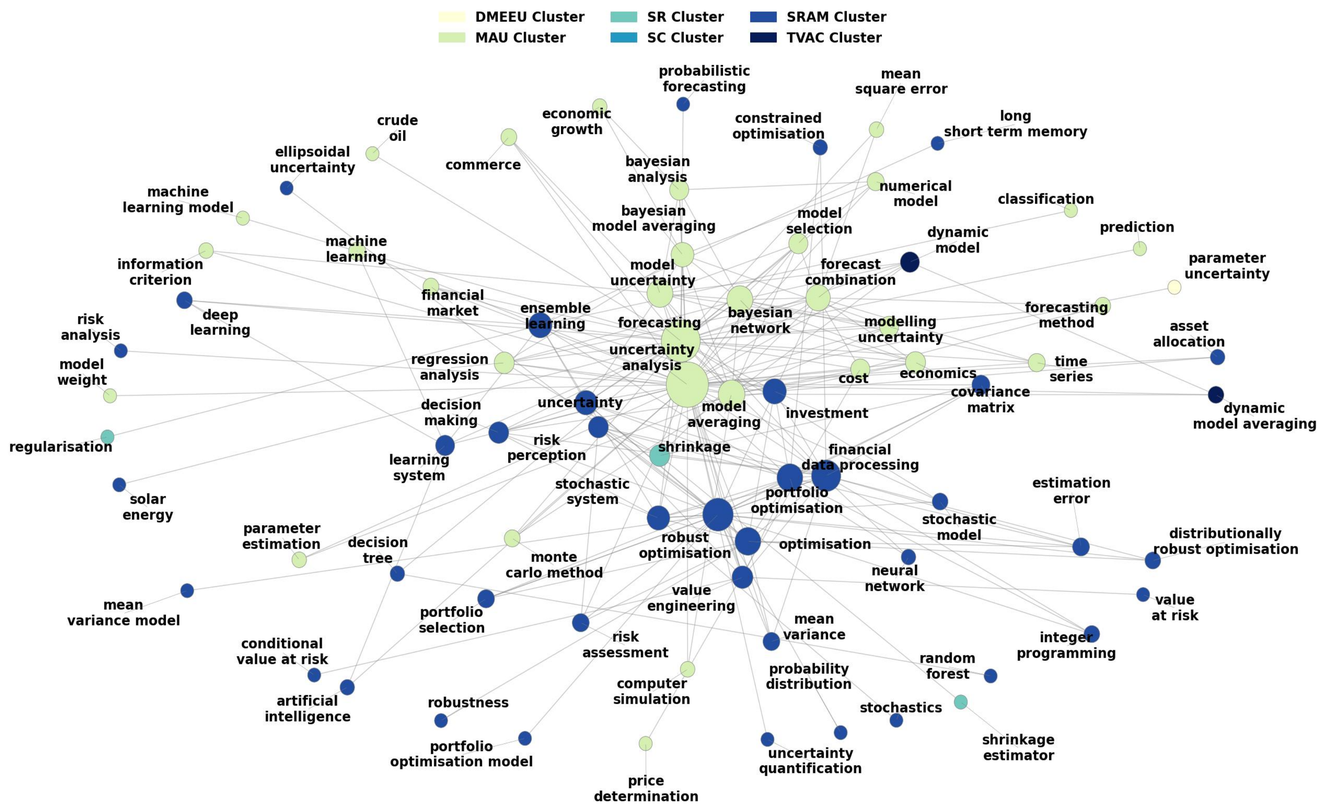
Thematic Trends in Research Output and Citations





***Final bin includes data up to Apr 2025**

Thematic Keyword Network (Top 100 keywords; co-occurrences ≥ 5 publications)



CONCLUSION

Thematic convergence: Forecasting and portfolio theory rely on similar strategies for handling uncertainty, yet these links have rarely been examined jointly. This research shows that shrinkage, aggregation, robustness, and adaptive weighting form a shared foundation across both fields, revealing common principles for designing resilient decision systems.

Limitations: The analysis reflects Scopus coverage, field-specific citation norms, and keyword-based clustering. Some methodological connections may not be fully captured by titles, abstracts, or author-provided keywords.

Future directions: Promising avenues include integrating aggregation with optimisation through bi-level frameworks that model uncertainty endogenously, developing asset-level strategy aggregation for more robust and adaptive portfolios, and advancing decision-focused learning methods that align predictions more closely with policy, allocation, and statistical-arbitrage decisions.

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