Navigating Uncertainty with Bayesian-Enhanced Multi-Factor Models in Adaptive Asset Pricing

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1 Introduction

Multi-factor investment models are pivotal in the realm of asset pricing, offering insights into the dynamics of asset returns [1]. However, traditional multi-factor models often lack the ability to adapt to market regime changes and efficiently handle uncertainty [2]. This research paper introduces a sophisticated framework incorporating Bayesian feature selection, penalized linear models, Bayesian neural networks, and Dynamic Model Averaging (DMA) [3, 6]. This work fits into the broader context of Stochastic Optimal Control in Asset Pricing, which explores various methods for cross-sectional asset pricing under uncertainty, such as Bayesian approaches and advanced machine learning techniques like deep reinforcement learning using hierarchical graphs and graph attention networks [4]. The common thread linking these methodologies is the focus on handling uncertainty and dynamically adapting to market changes, pivotal in stochastic control problems [5].

2 Material and Methods

The analysis employs a comprehensive dataset containing various financial factors like size, value, growth, momentum, and quality. Each factor is represented through factor-mimicking portfolios to reduce dimensionality initially.

2.1 Bayesian Feature Selection, models and DMA

Upon feature selection, the framework employs penalized linear regression models, specifically LASSO, to further refine the model. The linear model serves as a simpler, interpretable baseline that captures the linear relations between selected factors and asset returns.

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For capturing non-linear dependencies, Bayesian neural networks are used. Unlike traditional neural networks, Bayesian neural networks offer posterior distributions over their parameters, providing a natural way to quantify uncertainty. This is especially beneficial in financial markets where uncertainty plays a crucial role.

Finally, a DMA layer is introduced to average the predictions from the linear and neural network models dynamically. DMA adapts to changing market conditions by recalibrating the model weights based on their recent performance, providing a robust mechanism to handle market regime changes.

3 Results

Initial experiments indicate the Bayesian feature selection successfully identifies a reduced set of impactful factors. Subsequent models, both penalized linear and Bayesian neural networks, show improved prediction accuracy and out-of-sample robustness. Furthermore, the DMA layer shows a considerable improvement in adapting to market regime changes, as evidenced by various financial metrics like the Sharpe ratio and maximum drawdown.

4 Conclusions

This research contributes a novel, multilayered framework for multi-factor investment modeling that effectively handles dimensionality, captures both linear and non-linear relationships, and adapts to market dynamics [3, 6]. Each layer serves a specific function: Bayesian feature selection for dimensionality reduction, penalized linear models and Bayesian neural networks for accurate prediction, and DMA for dynamic adaptability [3, 6]. This work is part of a broader initiative on Stochastic Optimal Control in Asset Pricing, which aims to develop robust methods for asset pricing under uncertainty [4]. By addressing issues of adaptability and uncertainty, this framework aligns with other advanced techniques in the domain, such as deep reinforcement learning with hierarchical graphs and graph attention networks, emphasizing the underlying theme of stochastic optimal control in dynamically evolving financial markets [5].

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