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Uncovering Nonlinear Patterns in Stock Returns Using Gated Recurrent Unit (Gru) Models

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Abstract

The increasing complexity of financial markets has led to a growing adoption of advanced machine learning techniques, particularly deep learning models, to uncover hidden patterns and enhance predictive accuracy. Traditional methods often fall short in capturing the nonlinear and intricate nature of market behavior.

Deep learning models, such as Gated Recurrent Units (GRUs), are highly effective at modeling complex, nonlinear relationships in financial time series data. This is critical since stock returns often exhibit nonlinear patterns that cannot be captured by traditional linear models. Research by Fama and others supports the Efficient Market Hypothesis (EMH), which suggests that stock prices follow a random walk, making them unpredictable. However, subsequent studies have identified persistent patterns and nonlinear relationships that challenge the EMH.

Advanced models like GRUs can better identify these patterns, offering significant advantages for forecasting stock returns and enhancing investment strategies. These models address the limitations of traditional statistical methods by leveraging their ability to detect and model nonlinear trends. By integrating such sophisticated techniques, investment managers can improve risk management, portfolio optimization, and decision-making processes, potentially uncovering opportunities that conventional methods might overlook. This research highlights the transformative potential of deep learning in challenging the assumptions of market efficiency.

The findings of this study reveal significant deviations from the traditional assumption of market efficiency, suggesting that stock returns exhibit patterns that cannot be fully captured by linear models. An R^2 value of 0.35 indicates that the GRU model successfully explains a substantial portion of the variability in stock returns, highlighting its capacity to uncover latent nonlinear structures. Despite this progress, certain complexities remain unexplained, underscoring the need for further refinement in predictive models. These results emphasize the growing importance of integrating advanced machine learning methodologies, such as GRUs, into financial market analysis to enhance forecasting accuracy and support data-driven investment strategies.

Keywords: Neural Networks, Gated Recurrent Unit, Efficient Market Hypothesis, Nonlinearity