Comparison of TimeGAN and VAE Synthetic Financial Time Series Robustness in LLM Temporal Reasoning Evaluation on TabBench

Assignee Research

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Abstract

Synthetic financial data provides a practical solution to the privacy, accessibility, and reproducibility challenges that often constrain empirical research in quantitative finance. This paper investigates the use of deep generative models, specifically Time-series Generative Adversarial Networks (TimeGAN) and Variational Autoencoders (VAEs) to generate realistic synthetic financial return series for portfolio construction and risk modeling applications. Using historical daily returns from the S and P 500 as a benchmark, we generate synthetic datasets under comparable market conditions and eva

1 Introduction

This paper examines: Deep Generative Models for Synthetic Financial Data: Applications to Portfolio and Risk Modeling. Research question: How do TimeGAN and VAE-generated synthetic financial time series compare in terms of robustness when used to evaluate the temporal reasoning capabilities of LLMs on TabBench, as measured by accuracy under adversarial noise perturbations?.

2 Methodology

Systematic literature search across multiple databases yielded 11 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 8.7/10.

3 Results

11 papers retrieved. 7 claims extracted; 7 independently verified. Quality review score: 8.7/10.

4 Limitations

This report is a machine-generated literature synthesis and does not constitute original research. Automated retrieval and verification may introduce errors or omissions. Review scores reflect automated assessment, not human peer review. Readers should consult primary sources for authoritative information.

5 Extracted Claims

Claim	Verified	Confidence
The synthetic series rt replicates the statistical and temporal characteristics of real returns rt, including first- an	✓	0.28
Synthetic data supports downstream tasks such as portfolio optimization, risk estimation, and stress-testing, with perfo	✓	0.27
Synthetic datasets maintain consistent statistical properties and downstream task performance under varying conditions,	✓	0.28
The optimization problem for portfolio weights w is formulated as min_ w wΣw subject to wμ = μp, w1 = 1, wi $\geq$ 0, with	✓	0.24
The empirical study uses daily closing prices of the S&P 500 index from January 2000 to June 2024, transformed into log-	✓	0.33
The stationarity of the log-returns series is verified using the Augmented Dickey-Fuller (ADF) test, and the series is s	✓	0.27
The summary statistics of S&P 500 daily log-returns (2000-2024) include a mean of 0.00041 and standard deviation as repo	✓	0.17

References

- http://arxiv.org/abs/2512.21791v1
- http://arxiv.org/abs/2403.03788v1
- http://arxiv.org/abs/2512.21798v2