INVENTOPIA 2025

FBM-SEREMBAN INTERNATIONAL INNOVATION COMPETITION (FBM-SIIC)

INNOVATION IN ACTION: TURNING IDEAS INTO REALITY

Chapter 23
Machine Learning Predictions of Stock Market Pattern Using Econophysics Approach

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ABSTRACT
A financial market collapse is the failure of a financial organisation, whereas a stock market crash is usually characterised as a sudden, large decrease in the price of stocks or stock market indexes. A speculative bubble, in which prices increase unreasonably before overvaluation causes a fall, may set this off. A stock market collapse is specifically caused by the panic that hits the market as a result of an excessive number of sell orders executed at once. According to Econophysics, interrelated behaviours and newly forming patterns in the market system are what propel market crashes, which are seen as a component of a bigger cycle of stability and instability. This research outlines the study of stock market patterns using the Econophysics approach. There are various techniques for identifying and observing the stock market patterns, one of the techniques is to use Python programming to evaluate and possibly forecast stock market behaviour through predictive modelling, combining both machine learning and Econophysics insights. Hence, this research will be using Monte Carlo Simulation and identify which machine learning algorithm is suitable for predicting stock market patterns. By leveraging machine learning algorithms, such as Long Short-Term Memory (LSTM), the predictions generated closely follow the actual stock price movements for Inari Amertron Berhad. The predicted stock prices correctly reflect whether the market is moving upward or downward and they correspond with actual market trends. Furthermore, there is a strong correlation between the model's buy or sell recommendations and the actual and anticipated price trends. In conclusion, the study of Econophysics principles with Python programming and machine learning algorithms has indicates that the predictive framework is reliable and effective in capturing stock price fluctuations, enhancing decision-making for investors based on data-driven insights.

Key Words: econophysics, stock market pattern, Python, machine learning, forecast

1. INTRODUCTION

The potential of econophysics, an interdisciplinary science that combines economics and physics, to analyze intricate financial systems has drawn a lot of interest. Econophysics uses

ideas from statistical physics and complex systems theory to examine market dynamics, providing a deeper understanding of speculative bubbles, market crashes, and stock price variations then traditional economic models, which rely on statistical techniques. This field improves market forecasts and risk assessments by identifying underlying patterns in financial markets using technologies such as computational modelling, network theory, and fractal analysis.

This study integrates Long Short-Term Memory (LSTM) models and Monte Carlo simulations with Econophysics principes to enhance stock market prediction accuracy and uncover key market cycles, such as speculative bubbles and crashes. Treating the market as a complex system, it leverages Python tools like pandas, NumPy, and matplotlib for data processing and visualization. By combining machine learning with probabilistic modelling, this research provides valuable insights for traders and researchers while advancing Econophysics by bridging physics and finance for more reliable market forecasting.

2. LITERATURE REVIEW

To overcome the constraints of conventional economic models, econophysics merges physics-based methods with financial market analysis. It developed during the second half of the 20th century and uses statistical physics, complex systems theory, and mathematical modelling to study market behaviour such as trends, trading volumes, and price fluctuations. Statistical techniques such as time series analysis, network theory, and fractal analysis are used by Econophysicists to study vast datasets of financial data. While evidence usually refuses this assumption, many stock market models rely on Gaussian statistics (Turcaș et al., 2022). Nonlinear and interrelated behaviour of economic systems are also studied using econophysics, which shows how small interactions can lead to extreme events like crashes. Stock prices are driven by investor expectations which are buying when a stock is undervalued and selling when it's overvalued. Such interaction defines the price dynamics, making investor forecasting a key issue in financial economics. Various tools, like chart patterns, are used by traders to identify trends and make well-informed decisions.

Monte Carlo method is a mathematical technique that uses random sampling to estimate probabilities in uncertain processes. It allows for the estimation of risk and supports informed decision-making across various field, including business, artificial intelligence, engineering, and stock prices. It provides valuable insights into complicated systems through uncertainty modelling and multiple simulations. It predicts the changes in asset prices through mimicking the stochastic processes, such as Geometric Brownian Motion, similar to particle movements in physics (Khamnei et al., 2023). This makes it relevant for quantifying investment risk. Python completes the process using libraries like 'numpy', 'scipy', and 'matplotlib', facilitating economical simulation, finance automation, and risk analysis relating physics and finance under Econophysics.

3. METHODOLOGY

The simulation procedure involves developing a machine learning model using Monte Carlo simulations and Python. The dataset of Inari Amertron Berhad (INARI), obtained from Yahoo Finance, is used throughout the process. Data preprocessing such as cleaning, normalization, and feature engineering is applied to ensure quality and consistency. An LSTM model, built

with TensorFlow and Keras, is selected for its effectiveness in forecasting stock prices. The model is trained on 80% of the data and tested on the remaining 20%, adjusting parameters to improve accuracy. Results are visualized using Matplotlib and Plotly, while Streamlit adds interactivity for real-time data visualization. The experimental flowchart outlines the overall process clearly.

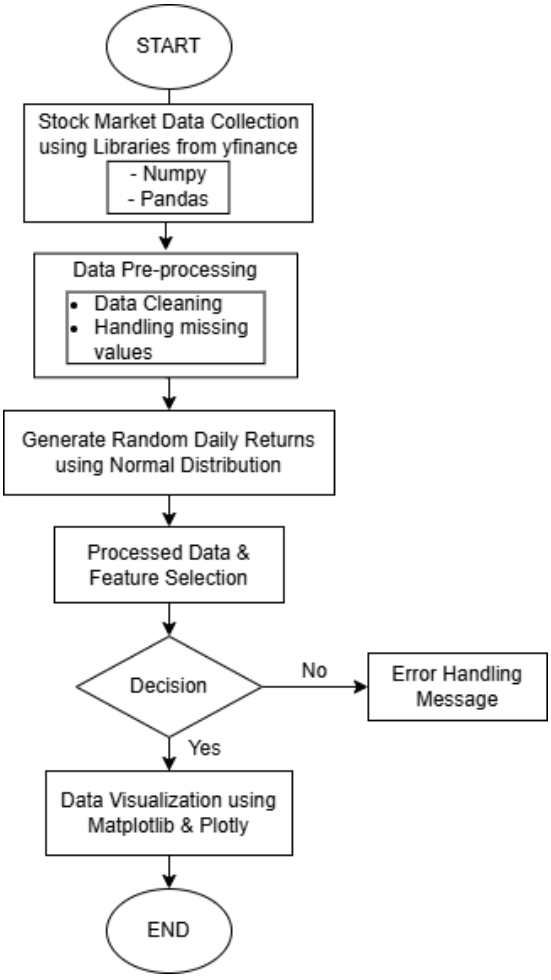

Figure 1: Project Flowchart

4. RESULTS & DISCUSSION

The simulation results are shown in the graph from matplotlib below, demonstrating several lines that demonstrate several probable stock price patterns over time of Inari Amertron Berhad. Each line in the graph signifies a potential scenario for the stock price, with the distribution of outcomes serving as an indicator of risk in the forecasts.

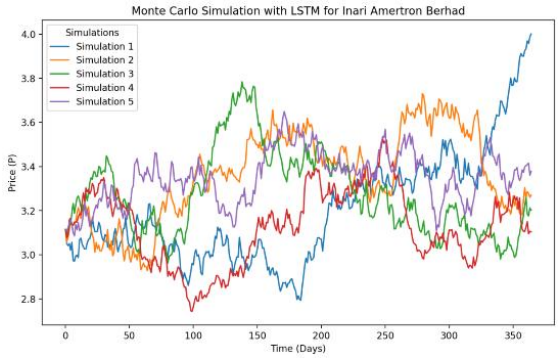

Figure 2: Monte Carlo Simulation for INARI

After analyzing the comparison graphs, the next phase in implementing the LSTM model for future stock price predictions starting September 2024. Predictions will cover 14, 30, 60 days, and beyond, offering insights into decision-making and financial planning using past data and learned parameters. Future analysis of the results of predictions will be shown in figure 4, figure 5, and figure 6 below.

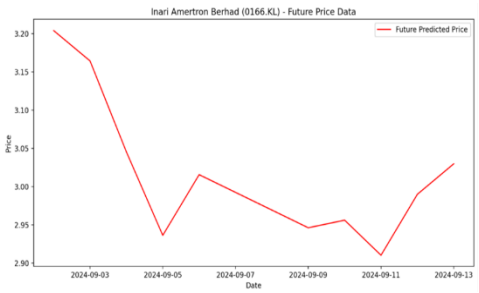

Figure 3: Graph of Analysis for 14 Days

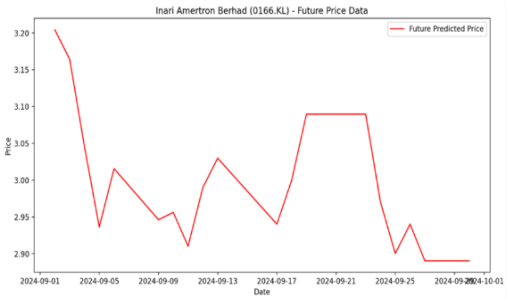

Figure 4: Graph of Analysis for 30 Days

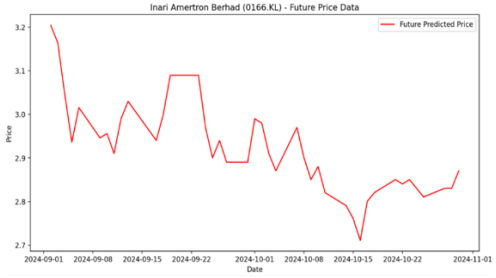

Figure 5: Graph of Analysis for 60 Days

The final phase involves integrating all observed data into an interactive dashboard using Streamlit, a user-friendly Python library for data visualization. The dashboard features an intuitive interface with a sidebar (Figure 6) where users can input criteria such as Stock Ticker, Company Name, and date ranges. Users can also adjust Time Intervals, Iterations, and Future Predicted Days via sliders to customize their stock market analysis.

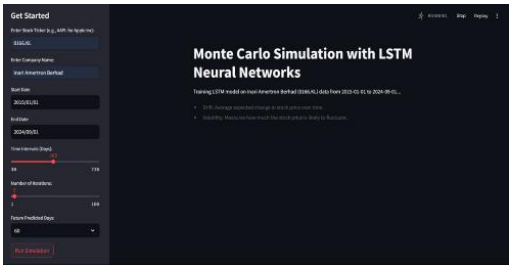

Figure 6: Pre-Simulation on Streamlit

5. CONCLUSION AND RECOMMENDATIONS

This study successfully achieved its objectives by applying Econophysics and machine learning to analyze stock market patterns. By combining statistical physics with data-driven models like Monte Carlo simulations and LSTM networks, it provided valuable insights into the complex and unpredictable nature of financial markets. The interdisciplinary approach proved effective in identifying trends, bubbles, and crashes, with LSTM emerging as the most accurate model for stock prediction, supporting better decision-making in uncertain market conditions.

Recommendations:

1. **Real-time Monitoring**: Implement an API to integrate live-stock market data for instant predictions and patterns updates.
2. **Expanded Dataset & Timeframe**: Improve accuracy by incorporating longer historical data, diverse industries, and external factors like economic cycles and geopolitical events.
3. **Improved Data Visualization**: Develop an integrated interface displaying Monte Carlo simulations, predictions, and recommendations for a more intuitive user experience.

REFERENCES

Khamnei, H. J., Nikannia, S., Fathi, M., & Ghorbani, S. (2023). Modeling income distribution: An econophysics approach. *Mathematical Biosciences and Engineering*, *20*(7). https://doi.org/10.3934/mbe.2023587

Turcaș, F., Dumiter, F. C., & Boiță, M. (2022). Econophysics Techniques and Their Applications on the Stock Market. *Mathematics*, *10*(6). https://doi.org/10.3390/math10060860