CHAPTER 1

INTRODUCTION

1.1 Background

Cryptocurrency has become one of the greatest financial innovations in recent decades, with a global market capitalization reaching Rp 59.51 quadrillion (approximately $3.8 trillion) as of January 2025. Its popularity continues to grow due to its decentralized and transparent financial system based on blockchain technology. According to CoinMarketCap, Bitcoin and Ethereum dominate the market with a significant combined share, with Bitcoin accounting for 56.8% and Ethereum for 11.0%. Hasani et al. (2022) describe cryptocurrency as a digital currency built using blockchain technology, which eliminates the need for third-party intermediaries, making transactions more transparent.

Ethereum is an open blockchain platform for building decentralized applications (DApps). DApps, also known as smart contracts or smart contract code, are programs that determine how value moves (Macedo, 2018). According to CoinMarketCap, Ethereum is the second-largest cryptocurrency by market capitalization after Bitcoin. One of Ethereum's advantages over Bitcoin is its greater flexibility, as it can execute smart contracts, enabling a wide range of decentralized applications (dApps) to be built on its platform (Reku.id, 2024).

In terms of transaction speed, Ethereum processes new blocks every 12–14 seconds, significantly faster than Bitcoin, which takes about 10 minutes per block (Antonopoulos & Wood, 2018). Furthermore, with the transition to Ethereum 2.0, which implements the Proof of Stake (PoS) consensus mechanism and sharding technology, Ethereum demonstrates much greater scalability potential compared to Bitcoin, which still

relies on Proof of Work (PoW) (Buterin, 2020). As a result, Ethereum is now considered more adaptable for future applications requiring blockchain as their technological foundation.

Predicting Ethereum's price is crucial for helping brokers/traders make investment decisions. This is particularly relevant given discussions suggesting that Ethereum's price could reach $10,000 within the next two years, indicating significant growth potential (Blockchainmedia.id, 2024). Additionally, there are projections that Ethereum's price could rise to $13,500 (Blockchainmedia.id, 2024). Therefore, predictive analysis is essential for identifying market trends and potential price movements, enabling more effective investment strategies.

While Ethereum's advanced technological infrastructure and growing potential make it a prime candidate for predictive analysis, it's important to place its behavior within the broader context of financial instruments. Understanding how cryptocurrencies compare to traditional assets—such as stocks—can offer valuable insight into how forecasting models should be applied. This comparison not only highlights their structural and functional differences but also underscores the unique challenges that arise when predicting price movements in highly volatile, decentralized markets like that of Ethereum.

Stocks and cryptocurrencies are both considered financial instruments, yet they differ fundamentally in structure, ownership, and regulatory frameworks. Stocks represent partial ownership in a company and entitle shareholders to a portion of the company's profits, typically through dividends. They are traded on regulated exchanges and are overseen by government financial authorities, making them relatively stable and secure investment options. Cryptocurrencies, on the other hand, are decentralized digital assets that operate on blockchain technology and are not tied to any company or central institution. They do not confer ownership rights and are primarily used as a medium of exchange or investment asset. The cryptocurrency market is highly volatile and operates 24/7 with limited regulatory oversight, making it more sensitive to external factors such as market sentiment, technological updates, and regulatory developments. These differences are crucial to consider when applying forecasting models such as Singular Spectrum Analysis (SSA), especially given the unique behavior and unpredictability of cryptocurrency price movements compared to traditional

financial assets like stocks.

Time series analysis is a quantitative forecasting method that considers time, where data is collected regularly over intervals to identify patterns in historical data (Amrullah et al., 2022). Basari and Ahmad (2021) define time series analysis as the study of data patterns within a chronological sequence. This approach leverages past data to predict future values, with data collected at fixed intervals (e.g., hourly, daily, weekly, monthly, or yearly) and analyzed using appropriate forecasting methods.

Various forecasting methods can be applied, with ARIMA being one of the most common. However, time series patterns can often be decomposed into sub-patterns, which can improve forecasting accuracy (Safitri et al., 2023). While ARIMA models are unable to decompose time series data into its underlying components, Singular Spectrum Analysis (SSA) offers an alternative approach that can effectively break down the series into interpretable parts such as trends, seasonality, and noise. SSA is a time series analysis technique that decomposes the original series into independent, interpretable components such as trend, oscillation, and noise (Hassani, 2007).

Several studies have applied SSA, including Teriska et al. (2024), who used it to forecast the LQ45 stock index from July 25, 2022, to November 14, 2022. By implementing SSA with a window length (L) of 30, they identified four component groups and achieved a Mean Absolute Percentage Error (MAPE) of 1.69%, indicating high forecasting accuracy. Another study by Purnama (2022) used SSA to forecast rainfall data in Gorontalo Province from 2014 to 2021. With a window length (L) of 36, the out-of-sample forecast yielded a MAPE of 0.029 (2.9%), demonstrating that SSA is highly accurate for such predictions.

A summary from elicit.com highlights several applications of SSA in financial forecasting, though none directly focus on Ethereum price prediction. A review of five studies reveals that while SSA has not yet been directly applied to Ethereum forecasting, two studies reported positive results using SSA for stock index prediction, with Teriska et al. (2024) achieving a MAPE of 1.69% for short-term forecasts. The remaining studies explored other forecasting methods, including ARIMA, Vector Autoregression, and Support Vector Regression, for cryptocurrency and traditional currency predictions.

While Singular Spectrum Analysis (SSA) has been successfully applied to tradi-

tional financial time series such as stock indices, its application to cryptocurrency markets—specifically Ethereum—remains largely unexplored. This presents a distinct research gap that this study aims to address. Technically, SSA is well-suited for the high-noise, non-stationary nature of Ethereum time series. Its core strength lies in its ability to decompose a time series into trend, periodic, and noise components without requiring strong prior assumptions about the data structure. Given that cryptocurrency markets are significantly affected by speculative behavior, media influence, and external shocks, such denoising capability is particularly valuable.

Furthermore, Ethereum data offers an additional layer of complexity through on-chain metrics (e.g., transaction count, gas usage, active addresses), which can be integrated into future extensions of SSA-based models. These features distinguish Ethereum from traditional stocks, reinforcing that this study is not merely a substitution of variables, but rather an attempt to apply SSA to a data environment with both overlapping and unique statistical properties. Therefore, this research is exploratory in nature and contributes to the broader field of financial forecasting by evaluating SSA's potential in a novel domain—cryptocurrency.

Based on the background outlined above, this study will explore the implementation of Singular Spectrum Analysis (SSA) for forecasting Ethereum cryptocurrency prices using Python. The research is expected to assist brokers/traders in making informed trading decisions, particularly regarding Ethereum, in the future.

1.2 Problem Formulation

Based on the background previously presented, the following research questions can be formulated:

1. How are the principal components grouped in forecasting the daily closing price of Ethereum cryptocurrency in USD using the Singular Spectrum Analysis (SSA) method?

2. What is the accuracy of forecasting the daily closing price of Ethereum cryptocurrency in USD using Singular Spectrum Analysis (SSA)?

3. What are the forecasting results for the next 20 periods of the daily closing price

of Ethereum cryptocurrency in USD using the Singular Spectrum Analysis (SSA) method?

1.3 Research Scope

The data used in this study are the daily closing prices of Ethereum cryptocurrency in USD. The daily closing price data of Ethereum cryptocurrency is limited to the period from February 3 to April 23, 2025. The in-sample data consists of 75% (February 3 – April 3, 2025), and the out-sample data consists of 25% (April 4 – April 23, 2025).

1.4 Research Objectives

Based on the background and problem formulation outlined above, the objectives of this research are as follows:

1. To obtain component groupings from Ethereum cryptocurrency forecasting using Singular Spectrum Analysis (SSA).
2. To determine the accuracy of Ethereum cryptocurrency forecasting using Singular Spectrum Analysis (SSA).
3. To obtain forecasting results for Ethereum cryptocurrency using Singular Spectrum Analysis (SSA).