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Modeling the Recovery Time of Stock Prices using Accelerated Failure Time Model

Introduction

In financial markets, the assessment of recovery time for stock prices is of paramount importance for investors and stakeholders alike. This is especially true in the context of distressed securities, where understanding the expected timeframe for a return to normalcy can inform crucial decision-making. One statistical approach that has shown promise in this regard is the Accelerated Failure Time (AFT) model. Originally developed in the field of survival analysis, the AFT model has been successfully applied to various areas, including finance and economics.

Problem statement

In the world of finance, how long it takes for a stock's price to go back up after a market downturn is important for making smart investments and managing risk. However, there is currently no good way to estimate how long this will take or to measure the uncertainty around these estimates. Additionally, it is not well understood how things like inflation rates, exchange rates, and sector performance can affect how quickly a stock's price recovers.
This project aims to solve these problems by creating a method for accurately estimating the time it takes for a stock's price to recover after a market downturn. The method will also measure the uncertainty around these estimates and look at how different factors, such as inflation rates, exchange rates, and sector performance, can affect the recovery time. This will help investors and financial professionals make better decisions and manage risk more effectively.

Research Objectives

General Objectives

In this study, we aim to model recovery time of a stock following decreases in share prices of companies listed on the Nairobi Stock Exchange during three distinct time periods: 2008-2009, 2011-2013, and 2020-2023. These periods were chosen due to their significance in recent market history, marked by notable market downturns and subsequent recoveries.

Specific objectives

1. To calculate the rate at which investments increase or decrease in value over time.
2. Transform the stock data into a format that can be used to analyze the time until a specific stock price recovery.
3. To fit Accelerated Failure Time model.

4. To test adequacy of the model.

5. To test the accuracy of the Accelerated Failure Time model.

Methodology

The Accelerated Failure Time (AFT) model is a type of survival analysis model used to analyze time-to-event data, where the event of interest is the failure or recovery of a system or process. The AFT model assumes that the survival time of a system or process is affected by a set of covariates, represented by the parameter θ.

$$\ln(T) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \epsilon \tag{1}$$

where :
T_i is the survival time.
u_i is the intercept.
$x_1, x_2 \ldots x_p$ are the covariates
$\beta_0, \beta_2 \ldots \beta_p$ are the coefficients of covariates.

Data Description

The study is based on the dataset of 61 companies listed in NSE for the period 2018 to 2023. There are five variables: inflation, exchange rates, closing price, duration, events that occurred, and sectors which are a category of 3 macrosectors (industry, finance and service). The data sources are as follows:

- **Exchange Rates:** Central Bank of Kenya (CBK) provides exchange rates data. The data can be accessed at `https://www.centralbank.go.ke/rates/forex-exchange-rates/`.
- **Inflation Rate:** Inflation rate data for a similar period is obtained from the Central Bank of Kenya. The data can be accessed at `https://www.centralbank.go.ke/inflation-rates/`.
- **Stock Market Data:** Stock market data is sourced from the Wall Street Journal. Historical prices for the Nairobi Securities Exchange (NSE) can be found at `https://www.wsj.com/market-data/quotes/KE/XNAI/NSE/historical-prices`.

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