

ABSTRAK

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Judul : Analisis Pengukuran Risiko Pasar Keuangan Menggunakan Topological Data Analysis

Risiko pasar keuangan berkaitan dengan ketidakstabilan pergerakan return saham. Selain ditunjukkan oleh besarnya fluktuasi return, kondisi pasar yang semakin bergejolak juga dapat menyebabkan perubahan pola dan keterhubungan antar data return yang mencerminkan perubahan kondisi risiko pasar. Perubahan tersebut dapat dianalisis menggunakan *Topological Data Analysis* (TDA). Penelitian ini bertujuan menerapkan TDA untuk menganalisis risiko pasar keuangan dan menginterpretasikan pola data return saham ANTM.JK, BRPT.JK, dan TINS.JK periode 1 Januari 2019 sampai 1 Januari 2022. Data harga penutupan dinormalisasi menggunakan *Min-Max Normalization*, kemudian dihitung return dan volatilitasnya. Kondisi *stress* ditentukan dari satu blok data return yang tersusun secara kronologis, berukuran 50% dari keseluruhan data normal, dan memiliki volatilitas tertinggi. Data return kondisi normal dan *stress* direpresentasikan menjadi *point cloud* melalui *sliding window embedding* dengan dimensi embedding $m = 6$ dan lag $\tau = 3$. Struktur topologi dibentuk menggunakan *Vietoris-Rips Complex* dan dianalisis melalui *persistent homology* pada dimensi H_0 , H_1 , dan H_2 . Hasil analisis divisualisasikan menggunakan *persistence diagram* dan *persistence barcode*. Perbedaan struktur topologi antara kondisi normal dan *stress* diukur menggunakan *Euclidean Distance* pada setiap dimensi homologi dan digabungkan menjadi *Total Euclidean Distance*. Hasil penelitian menunjukkan *Total Euclidean Distance* ANTM.JK sebesar 2,2510, BRPT.JK sebesar 5,0322, dan TINS.JK sebesar 2,5674. Perbedaan terbesar pada ketiga saham terdapat pada dimensi H_1 . TINS.JK memiliki volatilitas tertinggi sebesar 0,3507, sedangkan BRPT.JK menghasilkan *Total Euclidean Distance* tertinggi dengan volatilitas sebesar 0,1782. Hasil tersebut menunjukkan bahwa volatilitas menggambarkan penyebaran return, sedangkan TDA menangkap perubahan struktur topologi antara kondisi normal dan *stress*. Dengan demikian, TDA dapat digunakan sebagai pendekatan pendukung dalam analisis risiko pasar keuangan.

Kata Kunci: risiko pasar keuangan, *Topological Data Analysis*, *persistent homology*, *Euclidean Distance*.

ABSTRACT

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Title : *Analysis of Financial Market Risk Measurement Using Topological Data Analysis*

Financial market risk is associated with instability in stock return movements. In addition to being reflected in the magnitude of return fluctuations, increasingly volatile market conditions may also lead to changes in the patterns and connectivity among return data, which can reflect changes in market risk conditions. These changes can be analyzed using Topological Data Analysis (TDA). This study aims to apply TDA to analyze financial market risk and interpret the patterns of stock return data for ANTM.JK, BRPT.JK, and TINS.JK from 1 January 2019 to 1 January 2022. The closing price data were normalized using Min-Max Normalization, after which the returns and volatility were calculated. The stress condition was determined from a contiguous block of return data comprising 50% of the normal data and having the highest volatility. Return data under normal and stress conditions were represented as a point cloud using sliding window embedding with an embedding dimension of $m = 6$ and a lag of $\tau = 3$. The topological structure was constructed using the Vietoris-Rips Complex and analyzed through persistent homology in dimensions H_0 , H_1 , and H_2 . The results were visualized using persistence diagrams and persistence barcodes. Differences in topological structure between normal and stress conditions were measured using Euclidean Distance for each homology dimension and combined into the Total Euclidean Distance. The results show that the Total Euclidean Distance values for ANTM.JK, BRPT.JK, and TINS.JK were 2.2510, 5.0322, and 2.5674, respectively. The largest difference for all three stocks occurred in dimension H_1 . TINS.JK had the highest volatility of 0.3507, while BRPT.JK produced the highest Total Euclidean Distance with a volatility of 0.1782. These findings indicate that volatility describes the dispersion of returns, while TDA captures changes in topological structure between normal and stress conditions. Therefore, TDA can be used as a supporting approach in financial market risk analysis.

Keywords: *financial market risk, Topological Data Analysis, persistent homology, Euclidean Distance.*