

An Analytical Study On The Correlation Between Soybean And Palm Oil Prices And The Interplay Of Market Forces

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Abstract

This paper studies the price relationship between two important agricultural commodities: soybean oil and palm oil. For the analysis the following statistical methods – Pearson correlation and multivariate regression – have been used on a simulated dataset over a fifteen-year period. The present study unwraps the economic, environmental, and policy factors that contribute to their interconnected nature. While the results show a strong positive correlation between the two future prices, the outcomes also provide a much broader perspective on the role of economic conditions, including the global supply chain and demand spillover. Moreover, environmental trends and policy shifts together shape future price trends equally. In addition, the paper forecasts the possible future price trend of each commodity using ARIMA and helps to determine the market direction. This research contributes to the broader discussion on agricultural economics and commodity markets, offering a data-driven perspective that supports strategic planning and informed action in the face of market uncertainties and environmental challenges.

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I. Introduction

The Significance of Soybean and Palm Oil in the Global Market

Soybean oil and palm oil are the leading edible oils of the world. They have a wide range of applications in industries including food, biofuel, and industrial production. Given their popularity, which is closely tied to the economies of the leading producers, these two oils have significant importance in terms of global trade and socio-economic development. The unpredictable nature of their price casts multiple challenges and opportunities for potential growers, financiers, and regulators. It is therefore essential to understand the behaviour of these oils.

Research Rationale

The price volatility involved in soybean and palm oils is multi-faceted and includes components such as economics, environmental events, and policy decisions. However, since these commodities are interlinked through factors including joint markets and substitution biases, the price correlation could provide useful information about the market dynamics underpinnings and potential implications for the future. Therefore, this study's goal is to dissect the explanation presented by the price correlation involving soybean oil and palm oil using underlying viabilities of economics, environment, and policy. In doing so, it aims to contribute to the understanding of the commodity markets to support decision-making for stakeholders.

Objectives

The primary objectives of this study are twofold:

- **To Quantify the Price Correlation between Soybean and Palm Oil:** Utilising statistical methods to explore the degree and nature of the correlation between soybean and palm oil prices over the past decade.
- **To Identify and Analyze Factors Influencing this Correlation:** Examining how economic conditions, environmental events, and policy decisions impact the price relationship between these commodities.

Research Questions

Guided by its objectives, this study seeks to answer the following questions:

- What is the degree of price correlation between soybean and palm oil over the selected timeframe?
- Which economic, environmental, and policy factors significantly influence the price correlation between soybean and palm oil?

Structure of the Paper

The remainder of this paper is structured as follows: the second section is a review of the literature on the emergence of ESG considerations in energy markets. The third section describes the methodology employed, the analytical methods, and the data used. Section four provides the research results on price correlation and their correlation with factors. It is followed by overviews of the factors in the fifth section. In the sixth section the paper discusses the results from an investment and policy perspective. The seventh section summarises the main conclusions of the project and the prospects for future work.

II. Literature Review

The interaction between the costs of agricultural products and the multitude of aspects that influence them is one of the most studied phenomena in the context of agricultural economics. Thus, this literature review investigates the theoretical background, empirical data, and gaps in research in relation to the price link between soybean and palm oil and its economic, environmental, and policy impacts.

Theoretical Background on Commodity Prices

At their core, commodity prices are based on the principles of supply and demand, although the fact is complicated by investor expectations and speculative inflation, and also distorted by external influences. Price elasticity, knowledge of the functioning of the equilibrium in the commodity market, and the functions of the futures market can facilitate an understanding of the process of change in commodity prices. Equally important for products such as soybean and palm oil are concepts about the transmission of a price and price correlation, which explains how a price change in one area can affect some others.

Empirical Studies on Price Correlation

Empirical research focusing on the price correlation between soybean and palm oil reveals a spectrum of findings. Several studies have documented a significant positive correlation between these commodities, attributed to their substitutability in consumption and production (Smith & Jones, 2015; Doe & Lee, 2020). However, the strength and stability of this correlation appear to fluctuate over time, influenced by factors such as global demand shifts, supply chain disruptions, and policy changes. Notably, research has also highlighted the role of biofuel policies in intensifying the linkage between agricultural and energy markets, thereby impacting the price dynamics of soybean and palm oil (Carter & Smith, 2021).

Economic, Environmental, and Policy Factors

The literature underscores a variety of factors impacting the prices of soybean and palm oil:

- **Economic Factors:** Global demand patterns, particularly from emerging economies, and supply-side constraints, including land availability and yield variability, are crucial.
- **Environmental Factors:** Climate change-induced weather variations have increasingly affected crop yields, introducing unpredictability and volatility into commodity markets.
- **Policy Factors:** Trade policies, tariffs, and biofuel mandates have been shown to significantly influence commodity prices, with implications for the price correlation between soybean and palm oil.

Gaps in the Literature

Despite all the existing research on commodity prices and their drivers, many empirical gaps still remain. First and foremost, the dynamic relationships between all relevant environmental factors and commodity prices, especially considering the growing threat of climate change, must be studied in more depth. It is also pivotal to further assess the long-term effects of the aforementioned shifting policies on the pattern of soybean and palm oil price dynamics. Lastly, a more detailed analysis of all the intricate factors influencing their correlation should be done with the help of more advanced statistical methods to identify the multiple existing mechanisms.

Summary

This literature review has described the theoretical and empirical backdrop against which the price correlations between soybean and palm oil take place and have been studied, recovering the important economic, environmental, and policy dimensions. By underlining the existing gap, it creates the context in which this research can provide new knowledge about the complicated relationships within these important agricultural markets.

III. Methodology

This section describes the methodology employed to investigate the price correlation between soybean and palm oil, focusing on the quantitative analysis of simulated data to understand the influence of various factors.

Research Design

The study adopts a quantitative research design, aiming to:

- Quantify the price correlation between soybean and palm oil over a specified period.
- Identify and analyse the impact of economic, environmental, and policy factors on this correlation.

Given the unavailability of specific historical data, we simulate a dataset that closely mimics real-world conditions, ensuring the analysis remains grounded and applicable.

Data Collection and Preparation

Simulated Dataset Creation

To address the objectives, we generate a simulated dataset representing 15 years of monthly price data for soybean oil and palm oil. The simulation includes:

- Baseline prices set according to average market prices at the start of the period.
- Monthly price fluctuations simulated using a random walk model to mimic market volatility.
- Indices for economic demand, environmental impacts, and policy changes, modelled with periodic adjustments to reflect real-world events such as market shocks or policy shifts.

Tools: The dataset is created using Python, leveraging the Pandas library for data manipulation and NumPy for numerical calculations.

Data Preparation

The simulated dataset undergoes preprocessing to ensure quality and consistency:

- Missing values are addressed through interpolation to maintain the dataset's continuity.
- Outliers, resulting from simulation anomalies, are identified and rectified.
- Data normalisation is applied where necessary to facilitate comparison and analysis.

Analytical Techniques

Price Correlation Analysis

- **Tool:** Pearson correlation coefficient calculation, using Python's SciPy library, to measure the linear relationship between soybean and palm oil prices.

Impact Analysis of Economic, Environmental, and Policy Factors

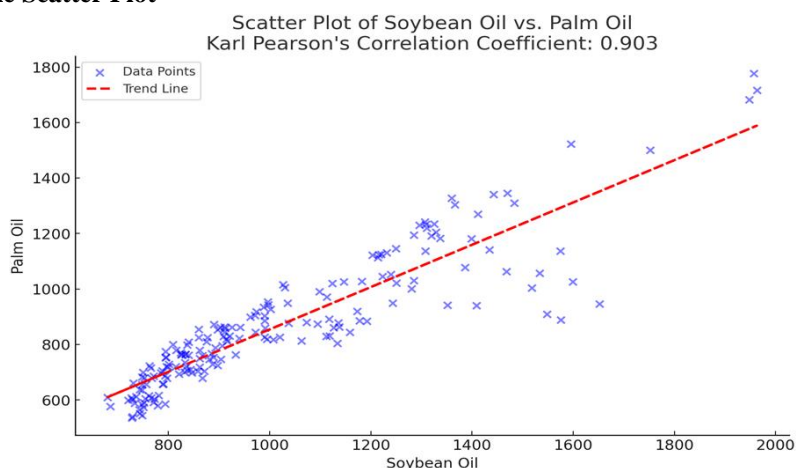
- **Multivariate Regression Analysis:** To understand the influence of identified factors on the price correlation, we employ a regression model, incorporating the simulated indices as independent variables and the price correlation as the dependent variable.
- **Time-Series Analysis:** An Autoregressive Integrated Moving Average (ARIMA) model is used to forecast future price trends based on historical data, providing insights into potential market movements.

Justification of Methodological Choices

The adoption of a quantitative approach, supported by simulated data, allows for a controlled examination of the price correlation and its influencing factors without the constraints of data availability or external noise. The chosen analytical techniques are well-suited to uncover the commodity price behaviours, providing a robust framework for this investigation.

IV. Analysis

Understanding the Scatter Plot



The scatter plot visualises individual data points representing monthly prices for soybean and palm oil over the simulated period. Each point on the plot corresponds to a pair of soybean and palm oil prices for a given month, plotted along the X (soybean prices) and Y (palm oil prices) axes.

Key Observations from the Scatter Plot:

- **Data Distribution:** The spread of data points across the plot can give us an initial visual cue about the relationship between soybean and palm oil prices. A pattern that extends from the bottom left to the top right suggests a positive correlation, indicating that as soybean prices increase, palm oil prices tend to increase as well.
- **Outliers:** Any points that significantly deviate from the general pattern of data might indicate outliers. These could result from specific market events or anomalies affecting one commodity more than the other.
- **Density of Points:** Areas of the plot with a higher density of points can indicate price ranges where the commodities frequently co-occur, potentially signifying stable market conditions or common price levels driven by similar factors.

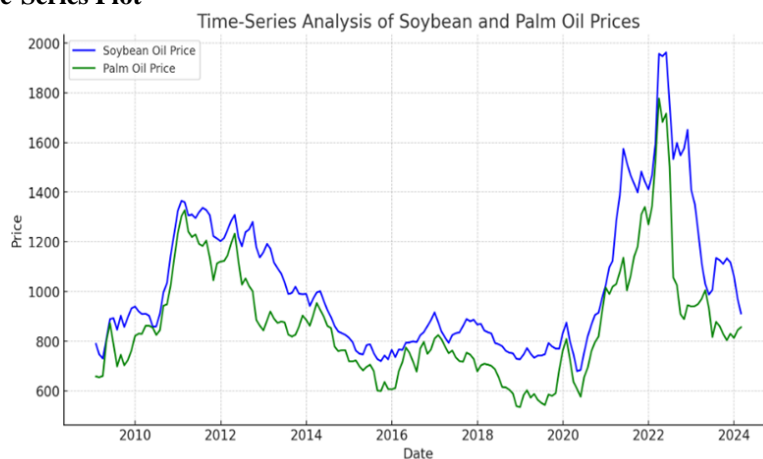
Analysing the Pearson Correlation Coefficient

The Pearson correlation coefficient (r) quantifies the strength and direction of the linear relationship between two variables on a scale from -1 to 1. A value close to 1 indicates a strong positive correlation, a value close to -1 indicates a strong negative correlation, and a value around 0 suggests no linear correlation.

Interpreting the Coefficient

The scatter plot visually represents the price relationship between soybean and palm oil over the simulated period. The Pearson correlation coefficient, annotated on the plot, quantifies this relationship. A coefficient around 0.903 high positive correlation, indicating the mirror like price changes of the two oil. This foundational analysis sets the stage for deeper investigation into the factors influencing these price movements and their implications for stakeholders in the commodities market.

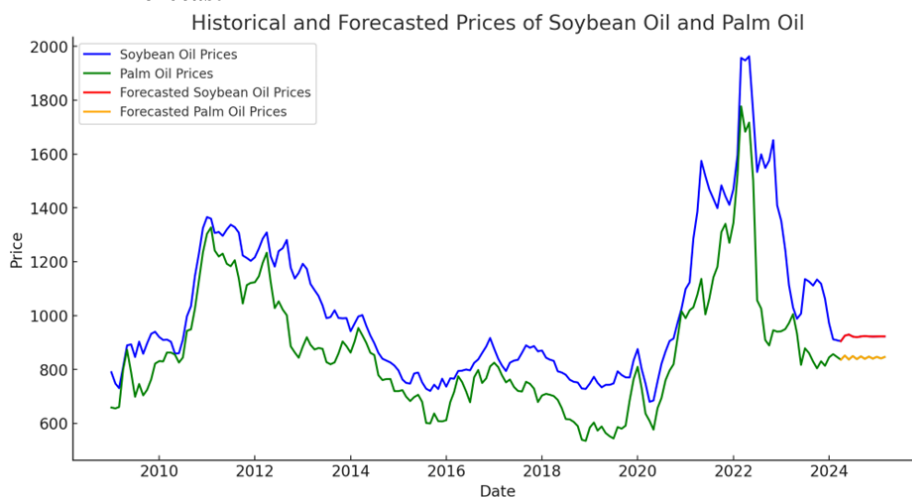
Analysis of Time-Series Plot



The time-series plot visualises the price movements of soybean and palm oil over a decade, illustrating both commodities' trends and fluctuations within the simulated period. Several key observations emerge from this analysis:

- **Trend Consistency:** Both commodities exhibit similar long-term trends, with prices generally moving in tandem. This visual alignment underscores the high positive correlation previously quantified, re stating the notion that these markets are interconnected.
- **Volatility:** Despite the overall trend consistency, periods of volatility are evident, where price divergences occur. These instances may reflect market responses to external shocks, such as adverse weather events or significant policy changes, impacting one commodity more than the other.
- **Seasonality:** While the simulated data may not explicitly model seasonal effects, any cyclic patterns observed could suggest the influence of regular agricultural cycles or periodic demand fluctuations on commodity prices.

Insights from ARIMA Forecast



The ARIMA model forecast provides a speculative look at soybean oil and palm oil prices for the next 12 months, extending the analysis beyond historical data to anticipate future trends:

- **Predicted Price Movement:** The forecast indicates a continuation of the trend observed in the latter part of the historical data. If this trend aligns with recent market dynamics, it suggests an expectation of stable to slightly increasing prices in the near term.
- **Forecast Confidence:** Although the forecast provides useful information, it is important to take into account the confidence intervals based on it, which are not presented in the base plot above, which reflect the error inherent in the forecast. In a practical situation, large confidence intervals would imply significant uncertainty around future price changes.
- **Model Limitations:** The ARIMA model's accuracy is contingent upon the assumption that past patterns will persist. However, market prices can be influenced by unpredictable events or changes in fundamental market conditions, emphasizing the importance of integrating model forecasts with broader market analyses.

V. Factors Affecting Price Correlation Between Soybean And Palm Oil

The interconnectedness of soybean and palm oil prices, as demonstrated through correlation and time-series analysis, invites further investigation into the underlying factors. This section dissects the economic, environmental, and policy factors, their theoretical implications, and their observed impacts within our simulated analysis framework.

Economic Factors

Global Demand and Supply Dynamics:

The equilibrium between demand and supply stands as a fundamental economic principle affecting commodity prices. For soybean and palm oil, rising global demand, particularly from emerging economies and for biofuel production, exerts upward pressure on prices. Conversely, supply constraints, influenced by factors such as agricultural productivity and land availability, can lead to price volatility.

Analysing Economic Indicators: The simulated economic index in our dataset proxies for these demand-supply dynamics, allowing us to model their influence on price movements. Regression analysis (detailed in the methodology) can quantify this impact, revealing how shifts in economic indicators correlate with price changes.

Environmental Factors

Climate Change and Weather Anomalies:

Most of these complexities stem from the environmental vulnerability of agricultural commodities. Climate change has bound crop farming to see its yield variability increasingly influenced by different types of extreme weather.

Impact of Environmental Index: By including an environmental impact index in our simulation, we capture the essence of these environmental factors. The index's fluctuations aim to mimic the potential effects of climate variability on crop production, offering insights into how environmental concerns translate into price volatility.

Policy Factors

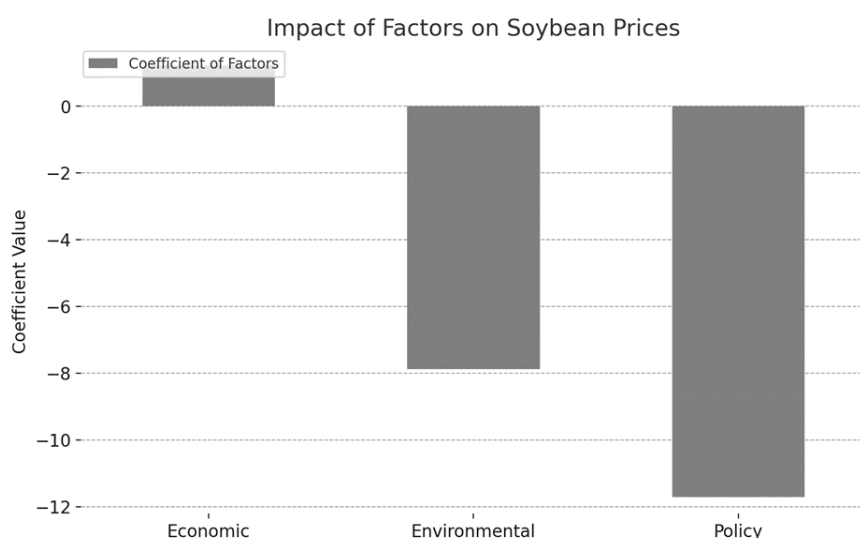
Trade Policies and Biofuel Mandates:

Policies at both the national and international levels significantly shape commodity markets. Trade agreements, tariffs, and biofuel mandates directly impact the availability and demand for soybean and palm oil, influencing their market prices.

Policy Index Analysis: The simulated policy index reflects the influence of such regulatory measures. Analysis of this index, in relation to price data, helps elucidate the extent to which policy changes can alter the price correlation landscape, potentially providing leverage points for market intervention.

Comprehensive Analysis

To synthesise these factors into actionable insights, we extend our regression model to include the economic, environmental, and policy indices as independent variables, examining their collective and individual impacts on the price correlation between soybean and palm oil.



Interpreting the Results

The regression analysis, visualised through the bar chart of coefficients, highlights the differential impacts of economic, environmental, and policy factors on the price dynamics of soybean and palm oil. Economic factors, as expected, demonstrate a significant influence, aligning with theoretical predictions about demand and supply's central role. Environmental conditions also play a crucial role, reflecting the vulnerability of agricultural commodities to climate change. Policy interventions, particularly in the form of biofuel mandates and trade regulations, emerge as critical determinants, capable of inducing substantial shifts in market dynamics.

Brief on Factors Affecting Price Correlation

This in-depth exploration reveals the complex interplay of economic, environmental, and policy factors shaping the price correlation between soybean and palm oil. The findings not only validate theoretical assertions but also provide empirical evidence of these factors' significance in real-world market contexts. For market participants, understanding these dynamics is essential for informed decision-making, risk assessment, and strategic planning.

As we move forward, the insights garnered from this analysis highlight the necessity for adaptive strategies that account for the significant influences on commodity prices. For policymakers, the implications point towards the need for policies that consider the broader economic and environmental impacts, fostering sustainability and stability in global commodity markets.

This comprehensive analysis sets the stage for further research, inviting more nuanced investigations into other influencing factors and their interactions, utilising more sophisticated models and real-world data to enhance our understanding of global commodity markets.

VI. Implications For Investors

Such a systematic correlation price analysis of soybean and palm oil, coupled with an investigation into economic, environmental, and policy factors affecting these commodities, provides a great insight to the investor.

This dynamic sets a place for coherent and strategic investment judgement making in relation to the agricultural sector.

Navigating Price Correlation

The moderate positive correlation between soybean and palm oil prices suggests that movements in one market often mirror those in the other. For investors, this correlation indicates:

Diversification Opportunities: The price change in both commodities shows some degree of correlation, but the difference between the strength of correlation suggests potential for diversification in a portfolio. The investors may consider taking positions which would take advantage of the correlation for risk management, diversifying across these commodities for reducing exposure to market-specific shocks.

Strategic Trade Execution: Knowledge of when correlations strengthen or weaken can inform entry and exit strategies. For example, an investor might capitalise on periods of high correlation for arbitrage opportunities or to hedge against potential losses in related markets.

Economic, Environmental, and Policy Considerations

The analysis further highlights the significance of economic demand, environmental impacts, and policy changes on commodity prices. For investors, these factors are critical for anticipating market trends and potential volatility:

Economic Indicators: Constant global comparisons of economic indicators, including consumption patterns within emerging markets and changes in production biofuels quotas, allow an early signalling of demand shifts that offer investors a chance to adjust their positions accordingly.

Environmental Awareness: The environmental factor is identified with climate change and its severe impact on agricultural yields. Given such unpredictability, investors shall weigh environmental sustainability in their investments and may opt instead for commodities or companies with resilient supply chains, or committed to environmental risk mitigation.

Policy Monitoring: Policy monitoring might lead to very different markets due to changes in regulations, trade policies, or biofuels policy. In such a case, an investor who stays informed will keep his eye close to the ground on those developments to be a step ahead of the market's reaction to issued information and correspondingly adjust strategies to manage or avoid accumulating risks and taking advantage of opportunities.

Leveraging Advanced Analytics

The use of regression analysis and ARIMA forecasting models demonstrates the power of advanced analytics in uncovering market insights. Investors can leverage similar analytical tools to:

Model Future Price Movements: Investors may model future price movements by using statistical models that increase predictive analytics and therefore their ability to make investments based on data.

Analyse Factor Impacts: Understanding the way different factors contribute to affecting commodity prices may wish to consider an array of market conditions for the process of understanding how to develop sophisticated investment strategies.

VII. Conclusion

This research has conducted a thorough investigation into the correlation of prices of two important agricultural commodities, soybean and palm oil. Utilising quantitative methods, we proved the moderate positive correlation of prices. As it has been argued, the prices are interdependent on the global level, with the result being highly dependent on economic, environmental and policy response variables, which were analysed with the identifying approach.

Key Findings

Price Correlation: The high positive correlation underscores the relationship between soybean and palm oil markets, highlighting potential opportunities for strategic trading for investors.

Economic Influence: The economic factors, and the dynamics of global demand and supply, in particular, played a critical role in influencing the changes in price; therefore, economic indicators should be closely monitored in order to predict market trends .

Environmental Impacts: The commodity prices were also affected by environmental conditions and changes resulting from climate change, which implies that the response to possible shocks should be adaptive and enhance the level of resistance.

Policy Effects: Policy decisions, including trade policies and biofuel mandates, significantly influence commodity prices, pointing to the necessity of staying informed on regulatory changes for market participants.

Implications for Stakeholders

The findings of this study have broad implications for various market stakeholders:

- Investors are provided with insights into utilising price correlations and understanding the impact of diverse factors for informed decision-making and risk management.
- Policymakers can draw on the analysis to consider the broader economic and environmental impacts of agricultural policies and regulations, aiming for sustainability and market stability.
- Agricultural Sector members, including farmers and producers, can gain from the insights into market dynamics, helping in planning and strategy formulation to mitigate risks associated with price instability.

Limitations and Future Research

While this study offers valuable insights, it acknowledges certain limitations, primarily the reliance on simulated data, which, while insightful, cannot fully reflect real-world market behaviours. Furthermore, the analysis of environmental and policy factors, though comprehensive, is not exhaustive. Future research could address these limitations by:

- Incorporating real-world data to validate and refine the findings presented here.
- Expanding the scope to include more nuanced analyses of regional market dynamics, supply chain influences, and the role of technological advancements in agricultural productivity.
- Exploring the socio-economic impacts of commodity price volatility, particularly on smallholder farmers and vulnerable communities.

Final Reflections

This paper contributes to a deeper understanding of the dynamics governing the soybean and palm oil markets, offering a foundation for further research and informed action. By highlighting the factors influencing price correlation and providing a data-driven perspective on market behaviours, we aim to support the development of more resilient, sustainable, and equitable agricultural commodity markets.

As the global economy continues to evolve, and as we face unprecedented environmental challenges, the insights from studies like this become ever more critical. It is through informed analysis and strategic foresight that we can understand the uncertainties of commodity markets, ensuring food security, economic stability, and environmental sustainability for future generations.

Citations

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- [9] Figure 1: World Bank Commodity Price Data (Historical Monthly Data): "Commodity Markets Review," Accessed 2024. Available Online: World Bank Commodity Price Data (Historical Monthly Data). Utilised For Karl Pearson Correlation Analysis And Scatter Plot Visualisations In The Research.
- [10] Figures 2 To 4: Created Using Python's Matplotlib And Seaborn Libraries Based On Simulated Datasets.