Investigating the Correlation Between Stock Market Performance and Temperature Changes

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1 Introduction

1.1 Motivation

This project aims to investigate the potential relationship between the stock market performance of huge tech companies like Amazon and Apple and temperature changes across various countries, exploring if stock prices can predict future temperature changes. The idea is based on the notion that generating more revenue might increase environmental pollution, thus resulting in higher temperatures on Earth.

1.2 Questions

- Is there a correlation between stock market performance and temperature changes?
- Can stock market prices predict future temperature changes?

2 Data Sources and Licenses

2.1 Temperature Change Data

- **Source**: FAOSTAT
- **URL**: Kaggle sevgisarac temperature-change
- **License**: Data are based on the publicly available GISTEMP data, the Global Surface Temperature Change data distributed by the National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA-GISS).
- **Usage**: Data was used to obtain historical temperature change information.

2.2 Stock Market Data

- **Source**: Public stock market data of Apple and Amazon
- **URL**: Kaggle aayushmishra1512
- **License**: CC0: Public Domain
- **Usage**: Data was used to obtain historical stock prices for Amazon and Apple.

3 Data Pipeline Description

3.1 Overview

This data pipeline integrates daily stock data for Apple and Amazon with temperature data for various regions, transforming them into a format suitable for analysis and correlation studies. The primary goal is to prepare these datasets for combined analysis to investigate potential correlations between stock prices and temperature changes.

3.2 Technologies Used

- **Python**: The core programming language used for data manipulation and analysis.
- **Pandas**: For data handling and transformation.
- **SQLite**: For temporary data storage.
- **Matplotlib**: For data visualization.
- **Kaggle API**: For downloading datasets from Kaggle.
- **Statsmodels**: For statistical tests such as the Granger causality test.

3.3 Transformation and Cleaning Steps

3.3.1 Data Acquisition

- Download daily stock data for Apple and Amazon and temperature data using the Kaggle API.

3.3.2 Data Preparation

- **Stock Data**:
  - **Aggregation**: Convert daily stock data into monthly aggregates using Pandas resampling to align the time granularity with temperature data.
  - **Trimming**: Filter the data to include only the desired date range (1998-01-01 to 2020-07-01).

- **Column Handling**: Calculate the average price and filter the relevant columns ('Date' and 'price').

- **Temperature Data**:
  - **Cleaning**: Remove unnecessary rows and apply a month mapping to convert month names to numerical format.
  - **Date Creation**: Combine 'Year' and 'Month' into a single date column.
  - **Aggregation**: Group data by date and area, keeping only the necessary columns.

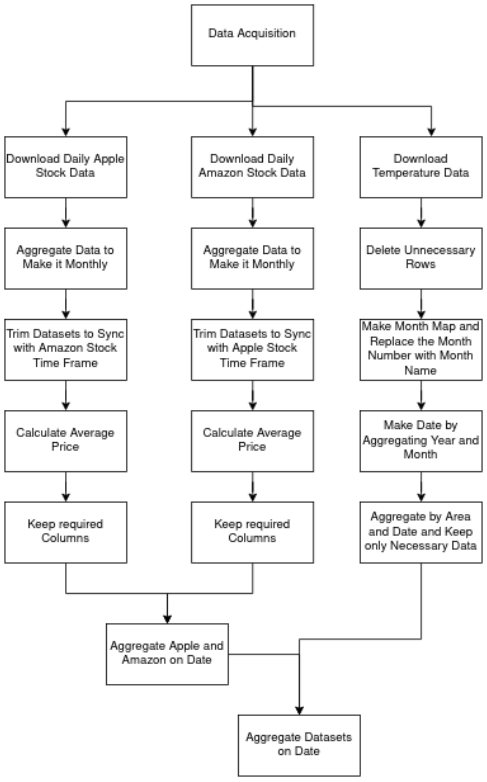

Figure 1: Data Preprocessing and Pipeline

3.3.3 Data Integration

- Merge the monthly aggregated stock data for Apple and Amazon.
- Merge the stock data with the temperature data on the 'Date' column.

3.3.4 Handling Missing Values

- Drop any rows with missing values to ensure data integrity for subsequent analysis.

3.3.5 Correlation and Causality Analysis

- Calculate the correlation matrix to explore relationships between stock prices and temperature.
- Perform Granger causality tests to examine if past values of temperature can predict stock prices.

3.3.6 Data Storage

- Store the cleaned and processed data in an SQLite database for further analysis or retrieval.

3.4 Final Pipeline Flow

1. **Data Acquisition**: Download datasets using Kaggle API.
2. **Data Transformation**:
   - Aggregate stock data to monthly.
   - Align datasets to common time frames.
   - Clean and aggregate temperature data.
3. **Data Integration**: Merge stock and temperature datasets.
4. **Analysis**: Conduct correlation and causality analysis.
5. **Storage**: Save the final datasets in SQLite for further use.

4 Results and Limitations

4.1 Results

4.1.1 Correlation Analysis

The correlation analysis between stock prices for Apple and Amazon and temperature changes reveals a weak but positive relationship. This suggests that while there is a slight tendency for stock prices to be associated with temperature changes, the influence is not strong.

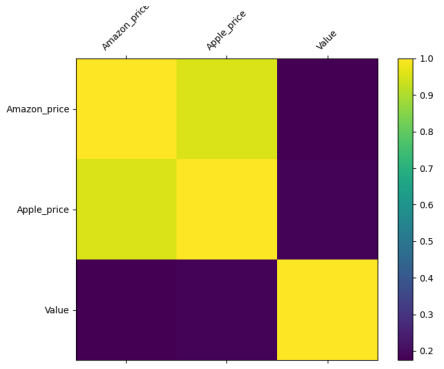

Figure 2: Correlation Heatmap between Stock Prices and Temperature

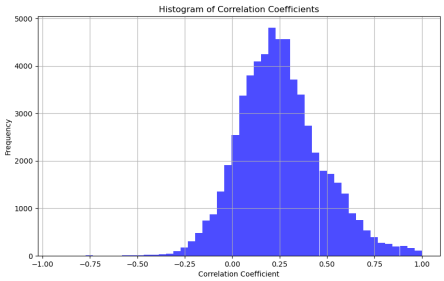

Figure 3: Histogram of Correlation Coefficients for Temperature

Figure 2 illustrates the correlation between Amazon and Apple stock prices and temperature values. The positive correlations suggest that stock prices and temperature tend to move in the same direction, but the relationship is modest. Figure 3 displays the distribution of correlation coefficients across different regions' temperature values. Most coefficients cluster around 0.25, indicating that the overall correlation between stock prices and temperature changes is generally weak.

4.1.2 Granger Causality Test

The Granger causality test examines if past stock prices can predict future temperature changes. The results for various lag intervals are shown in Table 1.

Lag	ssr_ftest	ssr_chi2test	p-value
1	4.4430	4.4432	0.0350
2	2.2999	4.6002	0.1003
3	1.9235	5.7711	0.1233

Table 1: P-values from Granger Causality Test for Various Lags

As shown in Table 1, the p-values generally increase with higher lag intervals, indicating weaker predictive power of past stock prices for future temperature changes over longer periods. Lower p-values at smaller lags suggest that short-term stock price data may have some predictive power for temperature changes.

4.2 Limitations

- **Data Quality**: The temperature data and stock data cover different periods and resolutions, which can introduce potential inconsistencies when aligning them for analysis.
- **Causality Interpretation**: The Granger causality test identifies predictive relationships but does not imply direct causation. This means while past stock prices may help predict future temperature changes, it does not necessarily mean that stock prices cause temperature changes.

4.3 Interpretation of Results

Is there a correlation between stock market performance and temperature changes?
Yes, the analysis reveals a weak positive correlation between stock prices and temperature changes. This implies that while stock market performance and temperature are related, the strength of this relationship is modest and not strong enough to suggest a significant impact of one on the other in the short term.
Can stock market prices predict future temperature changes?
According to the Granger causality test, past stock prices exhibit some predictive power for future temperature changes, especially in the short term. The decreasing p-values for smaller lag intervals suggest that recent stock prices could provide useful information about upcoming temperature changes. However, this does not imply causation but rather indicates a temporal relationship worth exploring further.

4.4 Conclusion

The analysis suggests that there is a weak positive correlation between stock market performance and temperature changes. Additionally, the Granger causality test indicates that past stock prices have some predictive power for future temperature changes, particularly over shorter periods. These findings are preliminary and highlight the complexity of relationships between economic activities and environmental factors.
Further research could involve:

- Using longer time series data to capture more extended trends and relationships.
- Incorporating additional environmental variables to enrich the analysis.
- Applying more sophisticated modeling techniques to better understand the dynamics between stock prices and temperature changes.

These steps could provide deeper insights into the interactions between economic activities and climate variables, contributing to a more comprehensive understanding of their relationships.