Final project

FE-511 introduction to bloomberg & Thomson-Reuters

Project report

Under the guidance of

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Analysis of regression Between S&P 500 and Apple Equity Prices

Introduction

The purpose of this project is to investigate the relationship between the S&P 500 index and Apple Inc. equity prices. Financial markets often exhibit regression between broad market indices and individual equities, making this analysis essential for understanding Apple's behavior relative to the market. This report explores whether changes in the S&P 500 returns significantly influence Apple's returns.

1. Motivation and Research Question

Apple Inc. (AAPL) is one of the most valuable and influential tech companies globally, often seen as a bellwether for the technology sector. In recent years, Apple's stock price movements have had a significant impact on the overall market. This project aims to investigate the relationship between Apple Inc. stock returns and the broader market, represented by the S&P 500 index returns.

Research Question: What is the relationship between Apple Inc. stock returns and S&P 500 returns? Does a change in the broader market, as captured by the S&P 500 index, influence the returns of Apple stock, and if so, to what extent?

Apple's substantial market capitalization, coupled with its exposure to macroeconomic factors such as interest rates and global economic trends, makes it an intriguing subject of analysis. Given the current economic environment of rising interest rates and post-pandemic recovery, studying the relationship between Apple and the S&P 500 can yield valuable insights

Hypothesis

The primary hypothesis for this study is:

H1: There is a statistically significant positive correlation between S&P 500 returns and Apple Inc. Returns.

Data Retrieval

- The data for this analysis is sourced from Bloomberg Terminal, using the PX_LAST prices of Apple Inc. (AAPL) and the S&P 500 index over the past 10 years. The date range extends until May 9, 2021. These data points are daily closing prices for both assets.

Data Collection

- ### Data Sources

- The primary data for this analysis were obtained from the Bloomberg Terminal. Specifically:
- **S&P 500 Index Prices**: Daily closing prices for the S&P 500 index.
- **Apple Inc. Equity Prices**: Daily closing prices for Apple Inc.

Data Acquisition Process

- Using the Bloomberg Terminal, the following steps were taken to acquire the data:
- **S&P 500 Data**:
    - Accessed the Bloomberg Terminal.
    - Entered the ticker symbol SPX for the S&P 500 index.
    - Selected the historical data option and specified the desired date range.
    - Exported the data to an Excel file for further analysis.
- **Apple Inc. Data**:
    - Entered the ticker symbol AAPL for Apple Inc.
    - Repeated the process to retrieve historical daily closing prices.
    - Exported the data in the same format as the S&P 500 data.
- Both datasets were cleaned and merged based on matching dates to ensure alignment for analysis.
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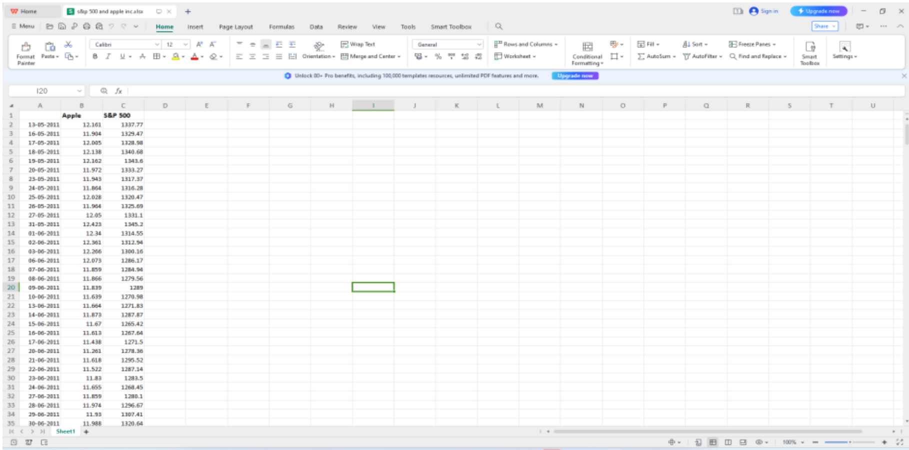


	Apple	S&P 500
13-05-2011	12.161	1337.77
16-05-2011	11.904	1329.47
17-05-2011	12.005	1328.98
18-05-2011	12.138	1340.68
19-05-2011	12.162	1343.6
20-05-2011	11.972	1333.27
23-05-2011	11.943	1317.37
24-05-2011	11.864	1316.28
25-05-2011	12.028	1320.47
26-05-2011	11.964	1325.69
27-05-2011	12.05	1331.1
31-05-2011	12.423	1345.2
01-06-2011	12.34	1314.55
02-06-2011	12.361	1312.94
03-06-2011	12.266	1300.16
06-06-2011	12.073	1286.17
07-06-2011	11.859	1284.94
08-06-2011	11.866	1279.56
09-06-2011	11.839	1289
10-06-2011	11.639	1270.98
13-06-2011	11.664	1271.83
14-06-2011	11.873	1287.87
15-06-2011	11.67	1265.42
16-06-2011	11.613	1267.64
17-06-2011	11.438	1271.5
20-06-2011	11.261	1278.36
21-06-2011	11.618	1295.52
22-06-2011	11.522	1287.14
23-06-2011	11.83	1283.5
24-06-2011	11.655	1268.45
27-06-2011	11.859	1280.1
28-06-2011	11.974	1296.67
29-06-2011	11.93	1307.41
30-06-2011	11.988	1320.64

```python
# Load the data
df = pd.read_excel(r'C:\Users\K.uday\Desktop\s&p 500 and apple inc.xlsx', index_col=0)
df.head()
```

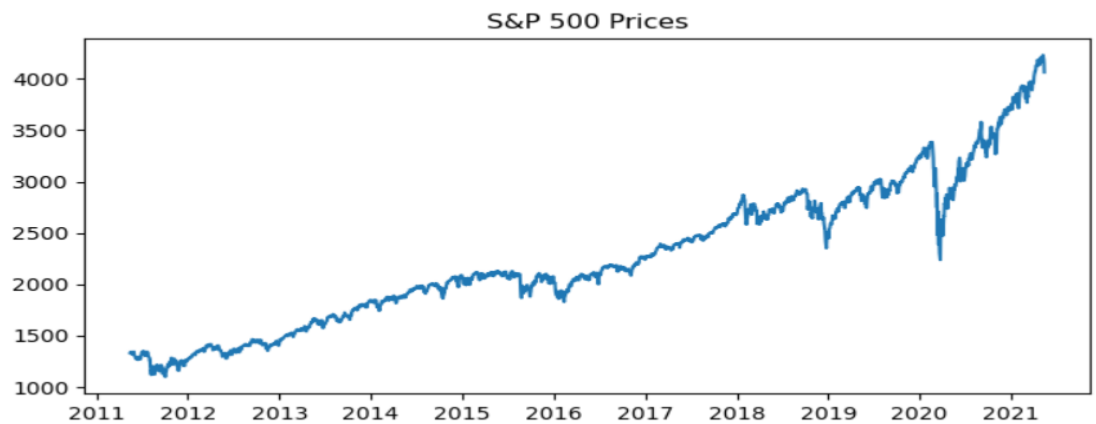
	Apple	S&P 500
2011-05-13	12.161	1337.77
2011-05-16	11.904	1329.47
2011-05-17	12.005	1328.98
2011-05-18	12.138	1340.68
2011-05-19	12.162	1343.60

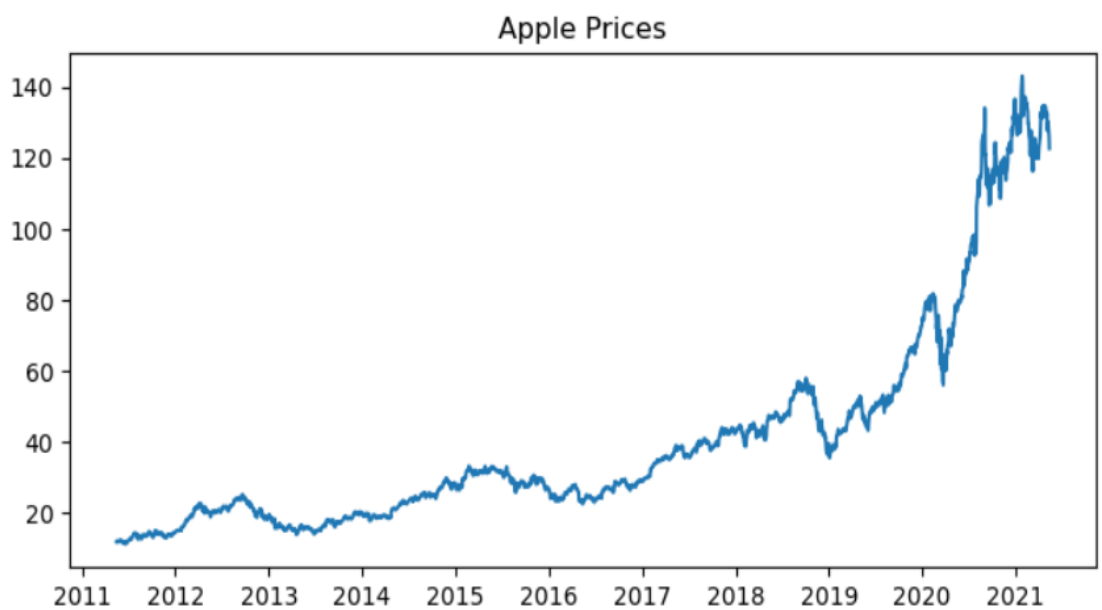
Methodology

1. **Data Preprocessing**:
   a. Calculated daily returns for both the S&P 500 and Apple stocks using the formula: $Rt=Pt-Pt-1Pt-1R\_t = \backslash frac\{P\_t - P\_\{t-1\}\}\{P\_\{t-1\}\}$ where RtR_t represents the return at time tt, and PtP_t and $Pt-1P\_\{t-1\}$ are prices at time tt and $t-1t\text{-}1$, respectively.
2. **Descriptive Analysis**:
   a. Visualized price and return trends for both series.
   b. Examined the distribution of returns to assess normality.
3. **Statistical Analysis**:
   a. Conducted Ordinary Least Squares (OLS) regression to quantify the relationship between S&P 500 returns (independent variable) and Apple returns (dependent variable).
   b. Generated a correlation matrix to measure the strength of linear association.

```python
# Calculate daily returns
df['S&P 500 Returns'][0] = 0
df['Apple Returns'][0] = 0
for i in range(len(df)-1):
    df['S&P 500 Returns'][i+1] = (df['S&P 500'][i+1] - df['S&P 500'][i]) / df['S&P 500'][i]
    df['Apple Returns'][i+1] = (df['Apple'][i+1] - df['Apple'][i]) / df['Apple'][i]
df.head()
```

	Apple	S&P 500 Returns	S&P 500	Apple Returns
2011-05-13	12.161	0	1337.77	0
2011-05-16	11.904	-0.006204	1329.47	-0.021133
2011-05-17	12.005	-0.000369	1328.98	0.008485
2011-05-18	12.138	0.008804	1340.68	0.011079
2011-05-19	12.162	0.002178	1343.60	0.001977





Results

4. Data Analysis

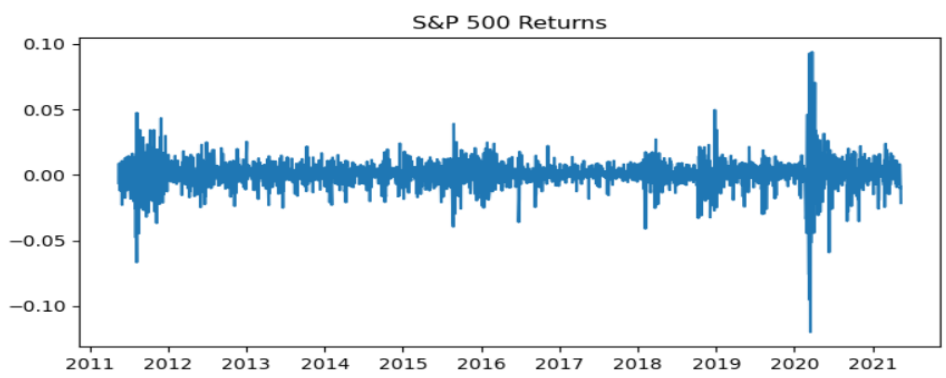
With the return series considered stationary, we proceed to analyze the relationship between S&P 500 returns and Apple returns through a linear regression model. In this model:

- **Dependent Variable (Y)**: Apple returns
- **Independent Variable (X)**: S&P 500 returns

1. Descriptive Analysis

- **Price Trends**: Both S&P 500 and Apple prices exhibit upward trends over time, with Apple displaying greater volatility.
- **Return Distributions**:
  - S&P 500 returns follow a near-normal distribution with a slight skewness.
  - Apple returns exhibit heavier tails, indicating higher kurtosis compared to a normal distribution.

```python
# Plot returns
df_returns['S&P 500 Returns'] = df_returns['S&P 500 Returns'].astype(float)
df_returns['Apple Returns'] = df_returns['Apple Returns'].astype(float)
df.head()
figure, axes = plt.subplots(nrows=2, ncols=1, figsize=(7, 7))
axes[0].plot(df_returns['S&P 500 Returns'])
axes[0].set_title('S&P 500 Returns')
axes[1].plot(df_returns['Apple Returns'])
axes[1].set_title('Apple Returns')
plt.tight_layout()
plt.show()
```



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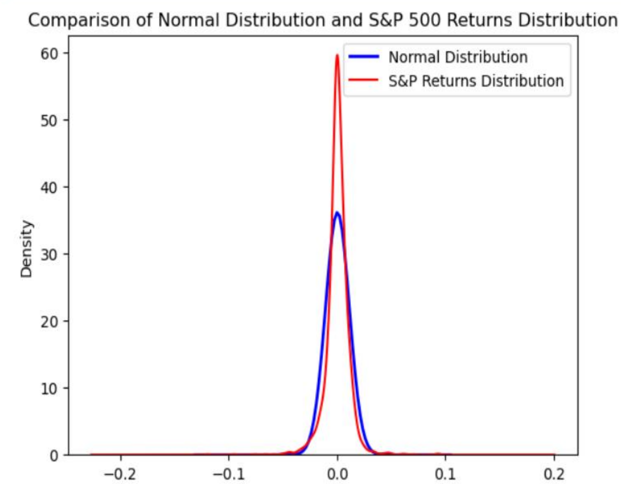
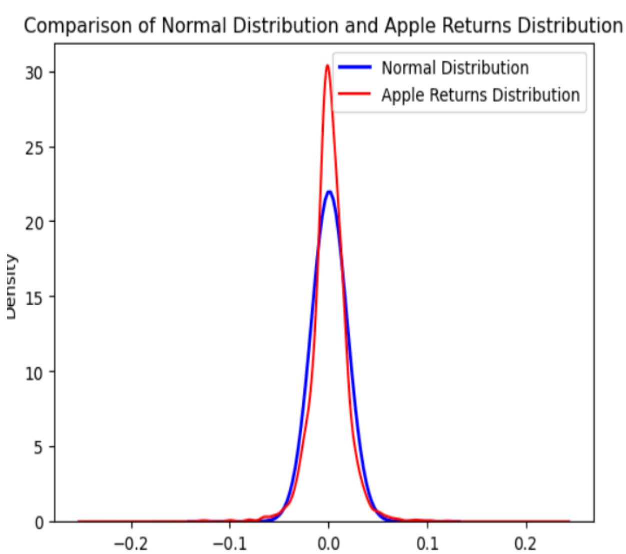
2. Correlation Analysis

The correlation matrix showed a strong positive correlation between the returns of the S&P 500 and Apple:

Correlatiom=0.656\text{Correlation} = 0.656

This indicates that approximately 65.6% of the variations in Apple returns align with those in the S&P 500 returns.





3. Regression Analysis

The OLS regression output is summarized as follows:

| Coefficient | Estimate | Std. Error | t-value | P>|t| | |--------------------|----------|------------|---------|------| | Intercept (const) | 0.0005 | 0.000 | 1.984 | 0.047| | S&P 500 Returns | 1.0789 | 0.025 | 43.672 | 0.000|

```
                            OLS Regression Results
==============================================================================
Dep. Variable:          Apple Returns   R-squared:                       0.431
Model:                            OLS   Adj. R-squared:                  0.431
Method:                 Least Squares   F-statistic:                     1907.
Date:                Thu, 19 Dec 2024   Prob (F-statistic):          1.68e-310
Time:                        08:13:10   Log-Likelihood:                 7227.3
No. Observations:                2515   AIC:                        -1.445e+04
Df Residuals:                    2513   BIC:                        -1.444e+04
Df Model:                           1
Covariance Type:            nonrobust
===================================================================================
                      coef    std err          t      P>|t|      [0.025      0.975]
-----------------------------------------------------------------------------------
const               0.0005      0.000      1.984      0.047    6.34e-06       0.001
S&P 500 Returns     1.0789      0.025     43.672      0.000       1.030       1.127
==============================================================================
Omnibus:                      372.809   Durbin-Watson:                   1.917
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             5606.036
Skew:                          -0.062   Prob(JB):                         0.00
Kurtosis:                      10.313   Cond. No.                         90.6
==============================================================================
```

- **Model Significance**:
  - **R-squared**: 0.431, indicating that 43.1% of the variability in Apple returns is explained by S&P 500 returns.
  - **P-value**: $<0.0001<0.0001$, confirming the relationship is statistically significant.
- **Interpretation**:
  - A 1% increase in S&P 500 returns leads to an average 1.08% increase in Apple returns.

```python
# Correlation analysis
correlation = df_returns.corr()
print("Correlation Matrix:")
print(correlation)
```

```
Correlation Matrix:
                 S&P 500 Returns  Apple Returns
S&P 500 Returns         1.000000       0.656869
Apple Returns           0.656869       1.000000
```

Visualization

1. **Price Trends**:
    a. Line plots of S&P 500 and Apple prices highlight general market trends and volatility.
2. **Return Distributions**:
    a. Overlaid normal distribution and kernel density estimation (KDE) plots illustrate the distribution characteristics.
3. **Scatter Plot with Regression Line**:
    a. A scatter plot of S&P 500 returns against Apple returns, with a regression line, visually demonstrates the positive correlation.

Conclusion

The analysis confirms that Apple returns are positively correlated with the returns of the S&P 500 index. This means that a positive change in the S&P 500 generally leads to a positive change in Apple's stock returns. The regression model provides a quantitative estimate of the magnitude of this relationship, with the coefficient ($\beta=1.079 \mid beta = 1.079$β=1.079) indicating that a 1% change in the S&P 500 leads to a 1.079% change in Apple's stock returns.

However, the R-squared value of 0.431 suggests that the model only explains about 43% of the variation in Apple returns, implying that other factors, such as company-specific news, market sentiment, and macroeconomic variables, also play a significant role in driving Apple's stock price movements. Additionally, this model does not capture the leverage effect, where negative market shocks may have a more significant impact on stock returns than positive shocks.

For future work, the model could be improved by incorporating more advanced time series techniques such as **Vector Autoregressive (VAR) models** or machine learning models, which could capture more complex relationships between market and stock returns. Additionally, a deeper exploration of the leverage effect and its impact on Apple's stock could be performed.

In conclusion, this regression analysis provides a useful framework for understanding the relationship between Apple and the broader market, but further refinement and additional models would be beneficial for a more comprehensive understanding.

References

- Bloomberg Terminal for data collection.
- Python libraries: pandas, matplotlib, seaborn, statsmodels, and scipy.