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SI 206

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APPLE and JP Morgan Stock Price and Volume Variation With Interest Rate

1. Goals

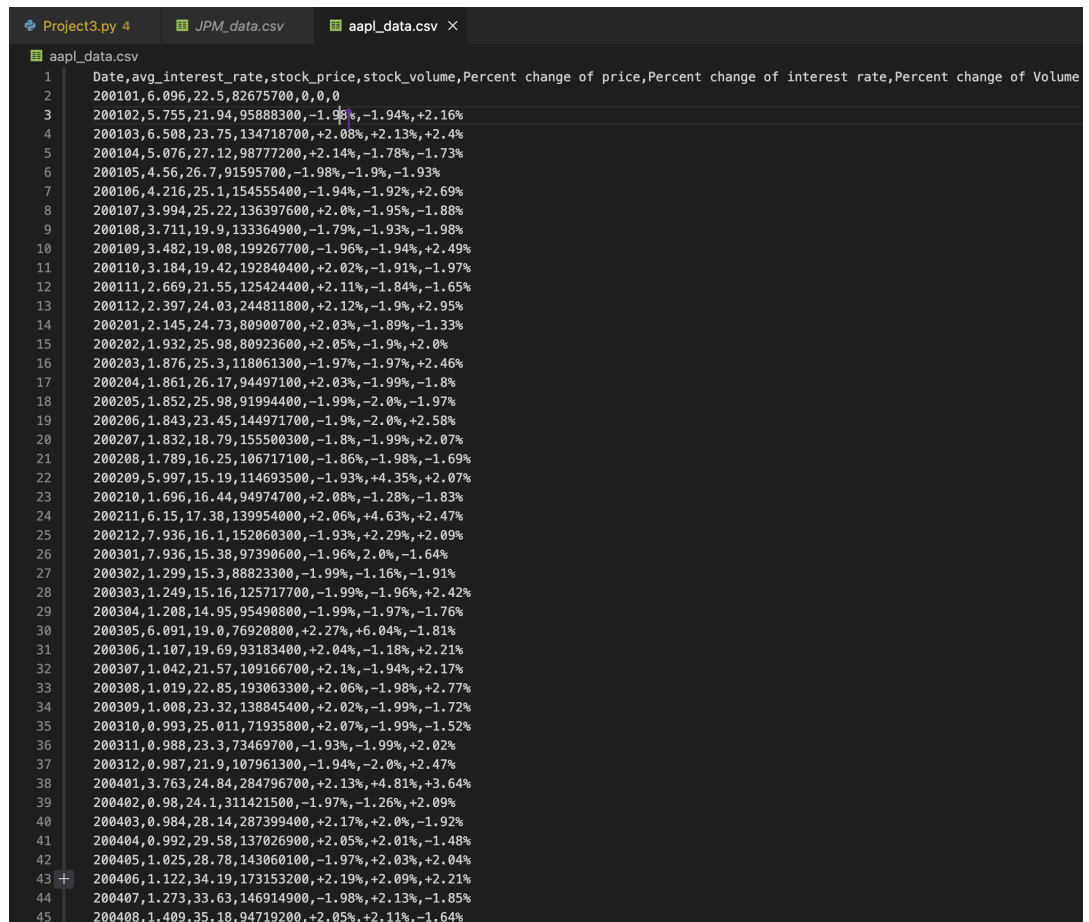
- a. Original Goals: The original goal of our project was to calculate and quantify the relationship between the monthly variation of stock prices of companies in 4 different fields shown below with the change of interest rate of the United States by the Federal Reserve Bank.
 - i. Technology: Tesla, Apple, Amazon, Google
 - ii. Medical: Johnson & Johnson, Intuitive, Merc Corporation, Pfizer
 - iii. Leisure: Delta Airlines, Spirit Airlines, Life Group Holdings, Hilton Hotels
 - iv. Financial Firms: Goldman Sachs, Morgan Stanley, Citadel, Wells Fargo

We planned to create a line graph for comparing different stock prices and interest rates by using time as a variable. Furthermore, we intended to create a bar chart showing the stock price of a company before and after the interest rate variation.
- b. Achieved Goals: Throughout the course of the project, we have encountered some problems and hardships which will be discussed in the following section, and thus resulted in modifying the objective of the project. Instead of focusing on stock price variation in 4 different fields each fields represented with 4 different well known stocks, we chose to focus on 2 fields, technology and financial firms, which are represented with one main well known stocks: Apple (AAPL) and JP Morgan (JPM). Furthermore, we have also decided to investigate and quantify the relationship between the monthly variation of stock volume, along with price variation, and change of interest rates and visualize them.

2. Problems

- a. One major problem we faced was having overwhelming amount of data given and number of APIs. For example, stock information of each company has different API links as well as the API for the interest rate. Each API consisted of monthly data from 1999-12-31 until 2023-04-14 which is roughly 300 rows of data per API. If we decided to pursue with the original dataset, we would have needed total of 17 APIs or 5100 rows of data, which we thought would require more time than we have for this project. Thus, to ensure quality output, we chose to focus on two main company's stock price data: Apple(AAPL) and JP Morgan(JPM). Furthermore, to have more thorough analysis, we decided to utilize stock volume data against interest rate variation along with stock price.

- b. Another problem we faced was that stock price and volume has numerous confounding variables other than interest rate variation. For example, price and volume of AAPL could increase due to technological advancement that Apple has achieved instead of due to
3. Calculations
 - a. Calculation Logistics:
 - i. Percent change of Interest Rate: $(\text{Interest Rate of previous month} + \text{Interest Rate of current month}) / \text{Interest Rate of previous month}$
 - ii. Percent change of Price: $(\text{Price of previous month} + \text{Price of current month}) / \text{Price of previous month}$
 - iii. Percent change of Volume: $(\text{Volume of previous month} + \text{Volume of current month}) / \text{Volume of previous month}$
 - b. Calculation File:
 - i. AAPL_Processed_Data.csv



	Date	avg_interest_rate	stock_price	stock_volume	Percent change of price	Percent change of interest rate	Percent change of Volume
1	200101	6.096	22.5	82675700	0.0%	0.0%	0.0%
2	200102	5.755	21.94	95888300	-1.93%	-1.94%	+2.16%
3	200103	6.508	23.75	134718700	+2.08%	+2.13%	+2.4%
4	200104	5.076	27.12	98777200	+2.14%	-1.78%	-1.73%
5	200105	4.56	26.7	91595700	-1.98%	-1.9%	-1.93%
6	200106	4.216	25.1	154555400	-1.94%	-1.92%	+2.69%
7	200107	3.994	25.22	136397600	+2.0%	-1.95%	-1.88%
8	200108	3.711	19.9	133364900	-1.79%	-1.93%	-1.98%
9	200109	3.482	19.08	199267700	-1.96%	-1.94%	+2.49%
10	200110	3.184	19.42	192840400	+2.02%	-1.91%	-1.97%
11	200111	2.669	21.55	125424400	+2.11%	-1.84%	-1.65%
12	200112	2.397	24.03	244811800	+2.12%	-1.9%	+2.95%
13	200201	2.145	24.73	80900700	+2.03%	-1.89%	-1.33%
14	200202	1.932	25.98	80923600	+2.05%	-1.9%	+2.0%
15	200203	1.876	25.3	118061300	-1.97%	-1.97%	+2.46%
16	200204	1.861	26.17	94497100	+2.03%	-1.99%	-1.8%
17	200205	1.852	25.98	91994400	-1.99%	-2.0%	-1.97%
18	200206	1.843	23.45	144971700	-1.9%	-2.0%	+2.58%
19	200207	1.832	18.79	155500300	-1.8%	-1.99%	+2.07%
20	200208	1.789	16.25	106717100	-1.86%	-1.98%	-1.69%
21	200209	5.997	15.19	114693500	-1.93%	+4.35%	+2.07%
22	200210	1.696	16.44	94974700	+2.08%	-1.28%	-1.83%
23	200211	6.15	17.38	139954000	+2.06%	+4.63%	+2.47%
24	200212	7.936	16.1	152060300	-1.93%	+2.29%	+2.09%
25	200301	7.936	15.38	97390600	-1.96%	-2.0%	-1.64%
26	200302	1.299	15.3	88823300	-1.99%	-1.16%	-1.91%
27	200303	1.249	15.16	125717700	-1.99%	-1.96%	+2.42%
28	200304	1.208	14.95	95490800	-1.99%	-1.97%	-1.76%
29	200305	6.091	19.0	76920800	+2.27%	+6.04%	-1.81%
30	200306	1.107	19.69	93183400	+2.04%	-1.18%	+2.21%
31	200307	1.042	21.57	109166700	+2.1%	-1.94%	+2.17%
32	200308	1.019	22.85	193063300	+2.06%	-1.98%	+2.77%
33	200309	1.008	23.32	138845400	+2.02%	-1.99%	-1.72%
34	200310	0.993	25.011	71935800	+2.07%	-1.99%	-1.52%
35	200311	0.988	23.3	73469700	-1.93%	-1.99%	+2.02%
36	200312	0.987	21.9	107961300	-1.94%	-2.0%	+2.47%
37	200401	3.763	24.84	284796700	+2.13%	+4.81%	+3.64%
38	200402	0.98	24.1	311421500	-1.97%	-1.26%	+2.09%
39	200403	0.984	28.14	287399400	+2.17%	+2.0%	-1.92%
40	200404	0.992	29.58	137026900	+2.05%	+2.01%	-1.48%
41	200405	1.025	28.78	143060100	-1.97%	+2.03%	+2.04%
42	200406	1.122	34.19	173153200	+2.19%	+2.09%	+2.21%
43	200407	1.273	33.63	146914900	-1.98%	+2.13%	-1.85%
44	200408	1.409	35.18	94719200	+2.05%	+2.11%	-1.64%
45							

ii. JPM_Processed_Data.csv

	date	avg_interest_rate	stock_price	stock_volume	Percent change of price	Percent change of interest rate	Percent change of Volume
1	200101	6.096	57.33	180358700	0.0%	0.0%	0.0%
2	200102	5.755	55.85	150775700	-1.97%	-1.94%	-1.84%
3	200103	6.508	51.19	205630000	-1.92%	+2.13%	+2.36%
4	200104	5.076	49.54	175067700	-1.97%	-1.78%	-1.85%
5	200105	4.56	49.9	135245300	+2.01%	-1.9%	-1.77%
6	200106	4.216	49.06	131864500	-1.98%	-1.92%	-1.98%
7	200107	3.994	45.56	157719500	-1.93%	-1.95%	+2.2%
8	200108	3.711	43.82	149322200	-1.96%	-1.93%	-1.95%
9	200109	3.482	40.28	167154700	-1.92%	-1.94%	+2.12%
10	200110	3.184	38.08	204257600	-1.95%	-1.91%	+2.22%
11	200111	2.669	40.3	154547500	+2.06%	-1.84%	-1.76%
12	200112	2.397	40.95	247102800	+2.02%	-1.9%	+2.6%
13	200201	2.145	39.68	203658000	-1.97%	-1.89%	-1.82%
14	200202	1.932	34.05	243834500	-1.86%	-1.9%	+2.2%
15	200203	1.876	36.49	372556800	+2.07%	-1.97%	+2.53%
16	200204	1.861	37.95	308858000	+2.04%	-1.99%	-1.83%
17	200205	1.852	38.75	247681100	+2.02%	-2.0%	-1.8%
18	200206	1.843	36.25	350909700	-1.94%	-2.0%	+2.42%
19	200207	1.832	33.73	177232000	-1.93%	-1.99%	-1.51%
20	200208	1.789	27.4	150664200	-1.81%	-1.98%	-1.85%
21	200209	5.997	25.75	189633900	-1.94%	+4.35%	+2.26%
22	200210	1.696	21.61	211048800	-1.84%	-1.28%	+2.11%
23	200211	6.15	25.7	285216300	+2.19%	+4.63%	+2.35%
24	200212	7.936	26.14	225098800	+2.02%	+2.29%	-1.79%
25	200301	7.936	28.29	145825100	+2.08%	2.0%	-1.65%
26	200302	1.299	23.87	119712400	-1.84%	-1.16%	-1.82%
27	200303	1.249	24.9	201848900	+2.04%	-1.96%	+2.69%
28	200304	1.208	29.69	173570000	+2.19%	-1.97%	-1.86%
29	200305	6.091	33.07	183969800	+2.11%	+6.04%	+2.06%
30	200306	1.107	36.52	198713700	+2.1%	-1.18%	+2.08%
31	200307	1.042	38.26	210944900	+2.05%	-1.94%	+2.06%
32	200308	1.019	35.43	204510000	-1.93%	-1.98%	-1.97%
33	200309	1.008	35.87	241402800	+2.01%	-1.99%	+2.18%
34	200310	0.993	36.99	224183400	+2.03%	-1.99%	-1.93%
35	200311	0.988	36.76	168216300	-1.99%	-1.99%	-1.75%
36	200312	0.987	36.84	243213700	+2.0%	-2.0%	+2.45%
37	200401	3.763	40.53	209201600	+2.1%	+4.81%	-1.86%
38	200402	0.98	41.2	222462100	+2.02%	-1.26%	+2.06%
39	200403	0.984	43.84	216650400	+2.06%	+2.0%	-1.97%
40	200404	0.992	42.57	185980900	-1.97%	+2.01%	-1.86%
41	200405	1.025	38.75	178960500	-1.91%	+2.03%	-1.96%
42	200406	1.122	38.85	225139100	+2.0%	+2.09%	+2.26%
43	200407	1.273	38.64	174976400	-1.99%	+2.13%	-1.78%
44	200408	1.409	39.8	200758000	+2.03%	+2.11%	+2.15%

4. Instructions

- Since we have constructed our code for different circumstances, you just need to press the play button until the instruction tells you to stop. (Ideally you have to press play button 22 times to fullfill the tables) Each press insert one year worth of data into all tables, 12 data per press per each table sinc each data worth 1 month of data. Our data analysis start from 2001 until 2022
 - When data base is empty: Insert 2001 data into different tables
 - When data is full: The program prints the following which indicate that the tables are at full capacity: "Unable to insert more data since we inserted all available data". And does not insert further data into tables.
- Uncomment the functions at the bottom part of the program to visualize the functions or csv files that you want to retrieve. The function options are listed in the following part.

5. Code Documentation

- Functions
 - setUp(url)

1. Input: url
2. Output: dictionary of json file in accordance with the url
3. This function takes in the url of API we selected and return the dictionary of loaded json file
- ii. `load_interest_rate_data()`
 1. Loads API of Interest Rate information and retrieves the monthly average interest rate for a year for each run
- iii. `insert_table_JPM()`
 1. Loads API of JPM's stock information and retrieves the monthly stock price and volume. Then create two different tables each having the information of stock price and stock volume for corresponding date.
- iv. `insert_table_AAPL()`
 1. Loads API of AAPL's stock information and retrieves the monthly stock price and volume. Then create two different tables each having the information of the stock price and the stock volume for its corresponding date.
- v. `AAPL_PRICE_TIMELINE()`
 1. Visualizes the changes of AAPL's stock price in the timeline by using line graph
 2. X-axis: time ,Y-axis: stock price
- vi. `AAPL_VOLUME_TIMELINE()`
 1. Visualizes the changes of AAPL's stock volume in the timeline by using line graph
 2. X-axis: time, Y-axis: stock volume
- vii. `JPM_PRICE_TIMELINE()`
 1. Visualizes the changes of JPM's stock price in the timeline by using line graph
 2. X-axis: time ,Y-axis: stock price
- viii. `JPM_VOLUME_TIMELINE()`
 1. Visualizes the changes of AAPL's stock volume in the timeline by using line graph
 2. X-axis: time, Y-axis: stock volume
- ix. `join_interest_rate_apple_price()`
 1. Join INTEREST_RATE and AAPL_PRICE tables using the dat as a key integer
- x. `join_interest_rate_apple_volume()`
 1. Join INTEREST_RATE and AAPL_VOLUME tables using the dat as a key integer
- xi. `join_interest_rate_jpm_price()`

1. Join INTEREST_RATE and JPM_PRICE tables using the dat as a key integer
- xii. `join_interest_rate_jpm_volume()`
 1. Join INTEREST_RATE and JPM_VOLUME tables using the dat as a key integer
- xiii. `AAPL_PRICE_Interest_rate_correlation()`
 1. Visualizes the correlation graph to show the correlation between AAPL's stock price and Interest rate
- xiv. `AAPL_VOLUME_Interest_rate_correlation()`
 1. Visualizes the correlation graph to show the correlation between AAPL's stock volume and Interest rate
- xv. `change_AAPL_PRICE_Interest_rate_correlation(lst, lst2)`
 1. Input: takes in two different lists that each contains the data of monthly change of stock prices of AAPL in percentage and monthly change of interest rate in percentage
 2. Visualizes the correlation graph to show the correlation between the changes in stocks prices and interest rates.
- xvi. `change_JPM_PRICE_Interest_rate_correlation(lst, lst2)`
 1. takes in two different lists that each contains the data of monthly change of stock prices of JPM in percentage and monthly change of interest rate in percentage
 2. Visualizes the correlation graph to show the correlation between the changes in stocks prices and interest rates.
- xvii. `change_AAPL_VOLUME_Interest_rate_correlation(lst, lst2)`
 1. Input: takes in two different lists that each contains the data of monthly change of stock volume of AAPL in percentage and monthly change of interest rate in percentage
 2. Visualizes the correlation graph to show the correlation between the changes in stock volumes and interest rates.
- xviii. `change_JPM_VOLUME_Interest_rate_correlation(lst, lst2)`
 1. Input: takes in two different lists that each contains the data of monthly change of stock volume of JPM in percentage and monthly change of interest rate in percentage
 2. Visualizes the correlation graph to show the correlation between the changes in stock volumes and interest rates.
- xix. `write_AAPL_data_csv()`
 1. Write information about AAPL in csv which uses columns of
 2. `"Date", "avg_interest_rate", "stock_price", "stock_volume", "Percent change of price", "Percent change of interest rate", "Percent change of Volume"`

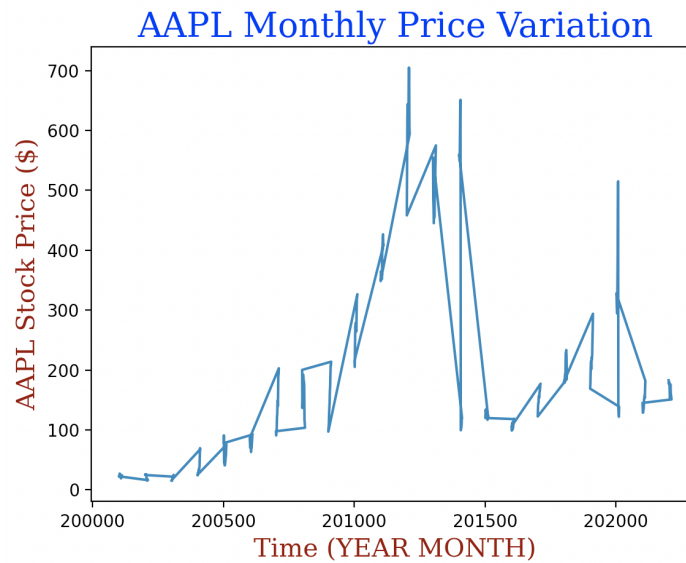
xx. write_JPM_data_csv()

1. Write information about JPM in csv which uses columns of
2. "Date", "avg_interest_rate", "stock_price", "stock_volume",
"Percent change of price", "Percent change of interest
rate", "Percent change of Volume"

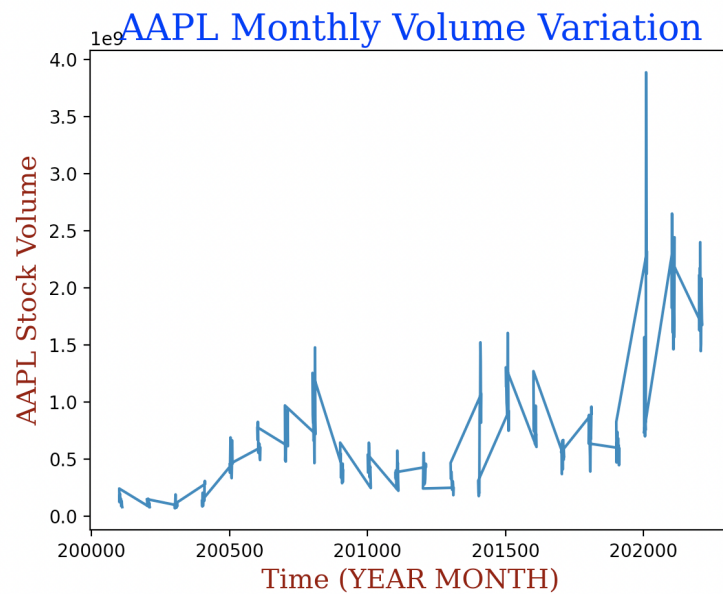
6. Visualizations

a. Input Data Visualizations

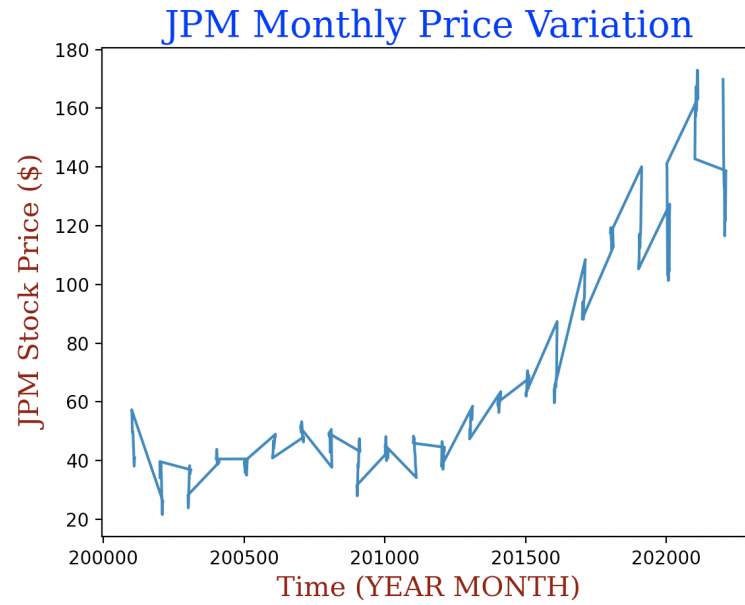
i. AAPL Monthly Price Variation



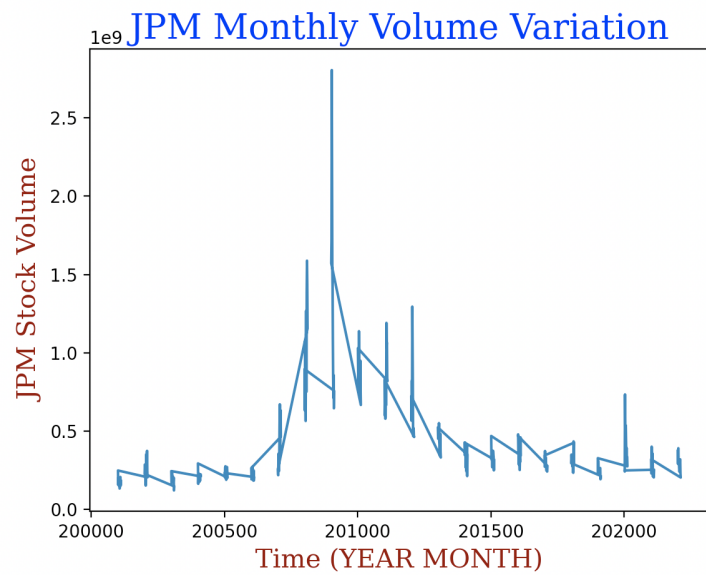
ii. AAPL Monthly Volume Variation



iii. JPM Monthly Price Variation

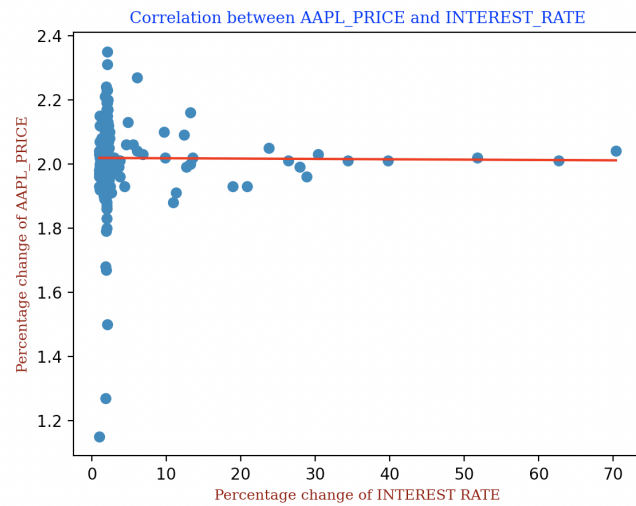


iv. JPM Monthly Volume Variation

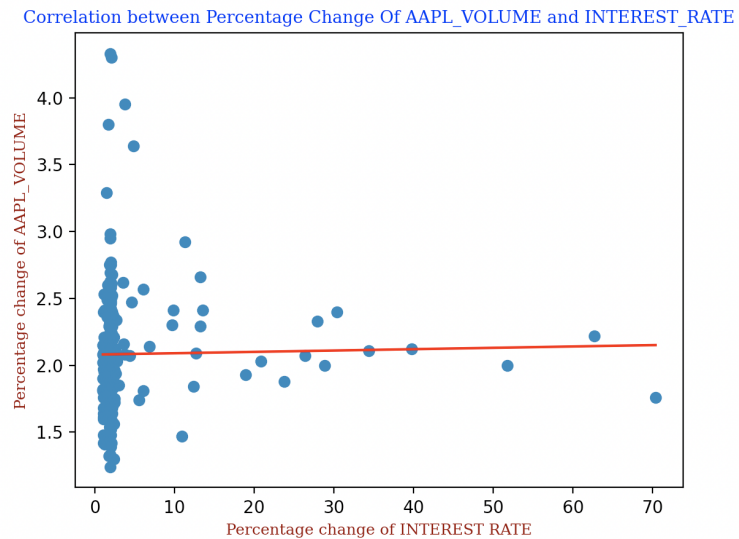


b. Processed Data Visualization

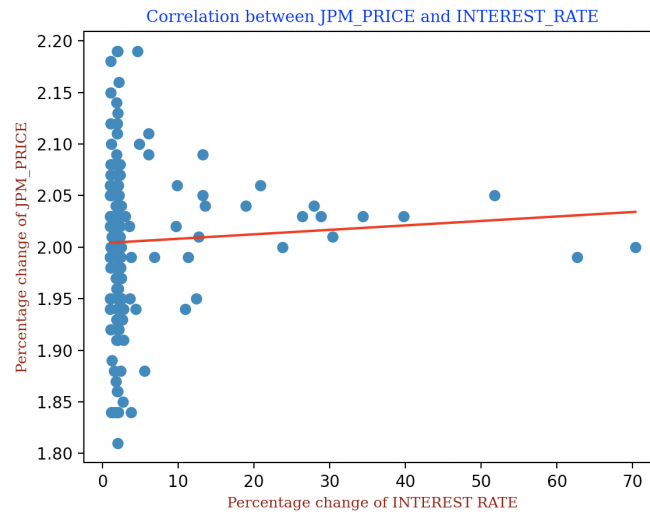
i. Correlation between AAPL_Price and Interest_rate



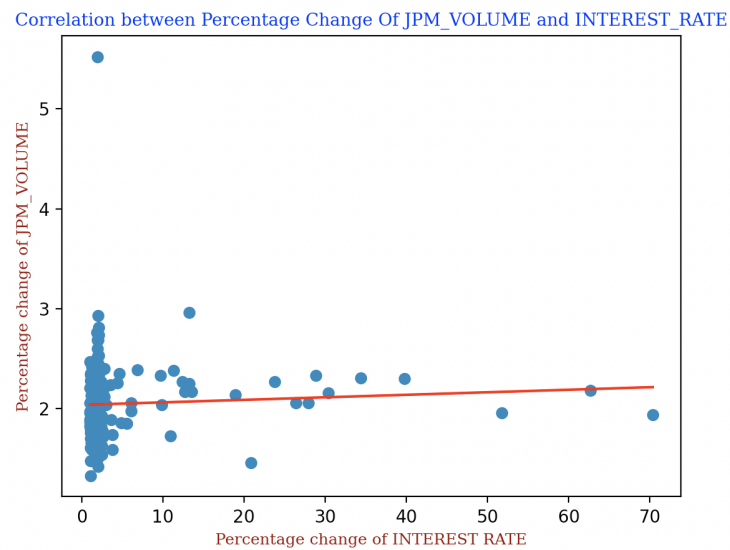
ii. Correlation between AAPL_Volume and Interest_rate



iii. Correlation between Percentage change of JPM_Price and Interest Rate



iv. Correlation between Percentage Change of JPM_Volume and Interest Rate



Resources

- API for Interest rate:
 - "https://api.fiscaldata.treasury.gov/services/api/fiscal_service/v2/accounting/od/avg_interest_rates?filter=record_date:lt:2023-03-31"
- API for AAPL Stock data:
 - "https://www.alphavantage.co/query?function=TIME_SERIES_MONTHLY&symbol=AAPL&apikey=GVVMWZMSSP5RKNCN"
- API for JPM Stock data:
 - "https://www.alphavantage.co/query?function=TIME_SERIES_MONTHLY&symbol=JPM&apikey=GVVMWZMSSP5RKNCN%22"
- Correlation graph in python
 - "<https://www.geeksforgeeks.org/plotting-correlation-matrix-using-python/>"