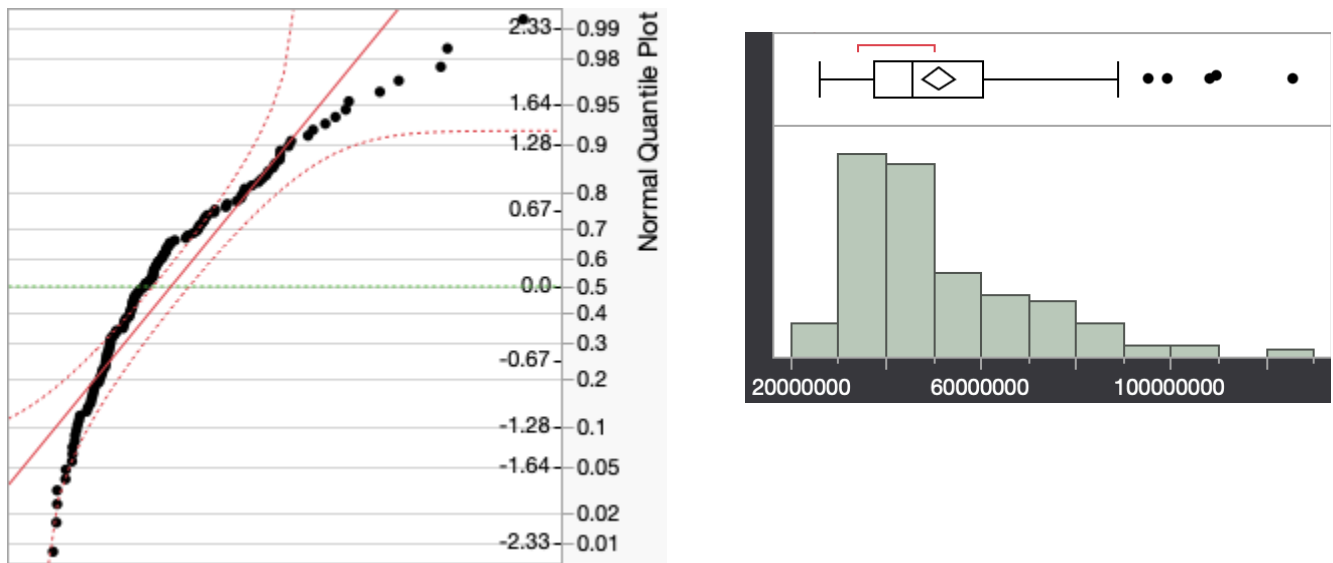


IEE474 Project

Data Description:

This project evaluates the stability of the trading volume for the SPDR S&P 500 ETF Trust. The variable studied is daily trading volume (shares traded) for SPY from October 1, 2024 to April 8, 2025. A total of 130 observations were collected using the Python yfinance library, and was analyzed using JMP Pro 18. The special cause event was the U.S. announcement of new tariffs on China on April 2, 2025, called *Liberation Day*. This event was expected to increase trading volume.

Data:

This data does not follow a normal distribution. We observe multiple data points outside the 95% confidence bands. According to JMP, this data more closely aligns with the lognormal distribution, which is supported by the histogram. See page 4 for raw data.

Initial Control Chart Parameters:

An \bar{X} and R chart was selected because the data is continuous (daily volume of shares traded) and grouped into subgroups of 5, making it suitable for this chart type. The following formulas were used to calculate the control limits:

$$\text{X Bar Chart Formulas: } LCL = \bar{\bar{x}} - A_2 \bar{R}; CL = \bar{\bar{x}}; UCL = \bar{\bar{x}} + A_2 \bar{R}$$

$$\text{R- Bar Chart Formulas: } LCL = D_3 \bar{R}; CL = \bar{R}; UCL = D_4 \bar{R}$$

For the Pre-Event Charts:

$$\text{X Bar: } LCL = 32702991; CL = 50847016; UCL = 68991041$$

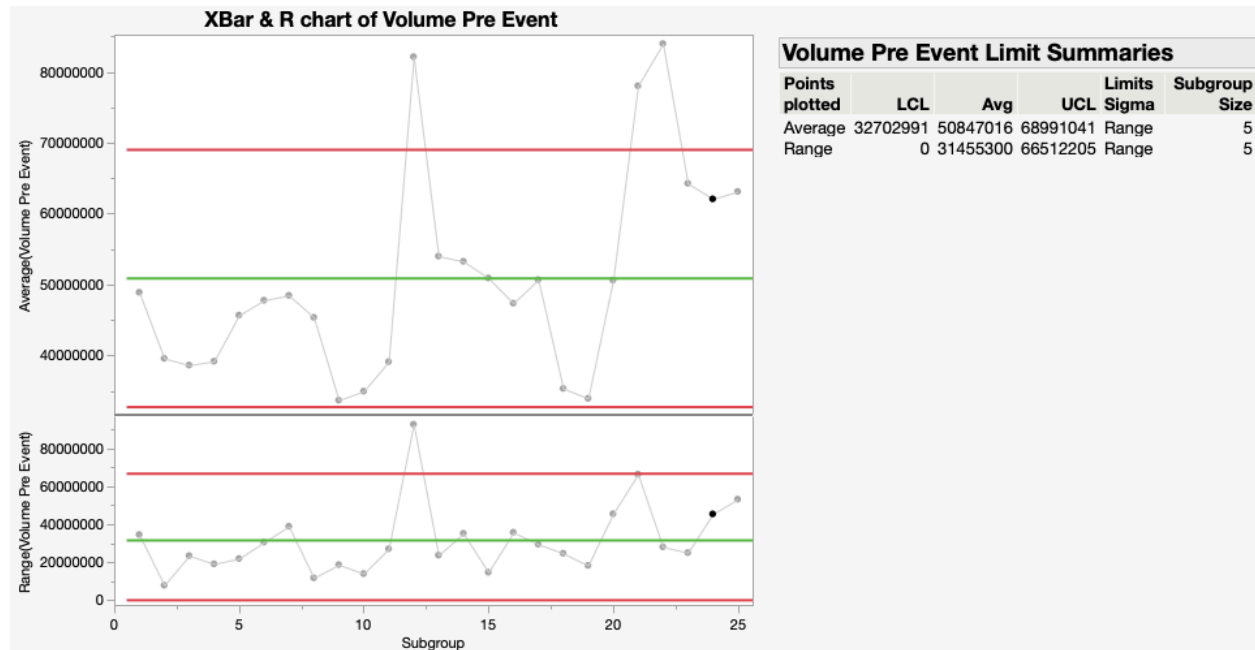
$$\text{R Chart: } LCL = 0; CL = 31455300; UCL = 66512205$$

For the Charts Containing all Data Points Including the Event:

$$\text{X Bar: } LCL = 33918527; CL = 55371312; UCL = 76824097$$

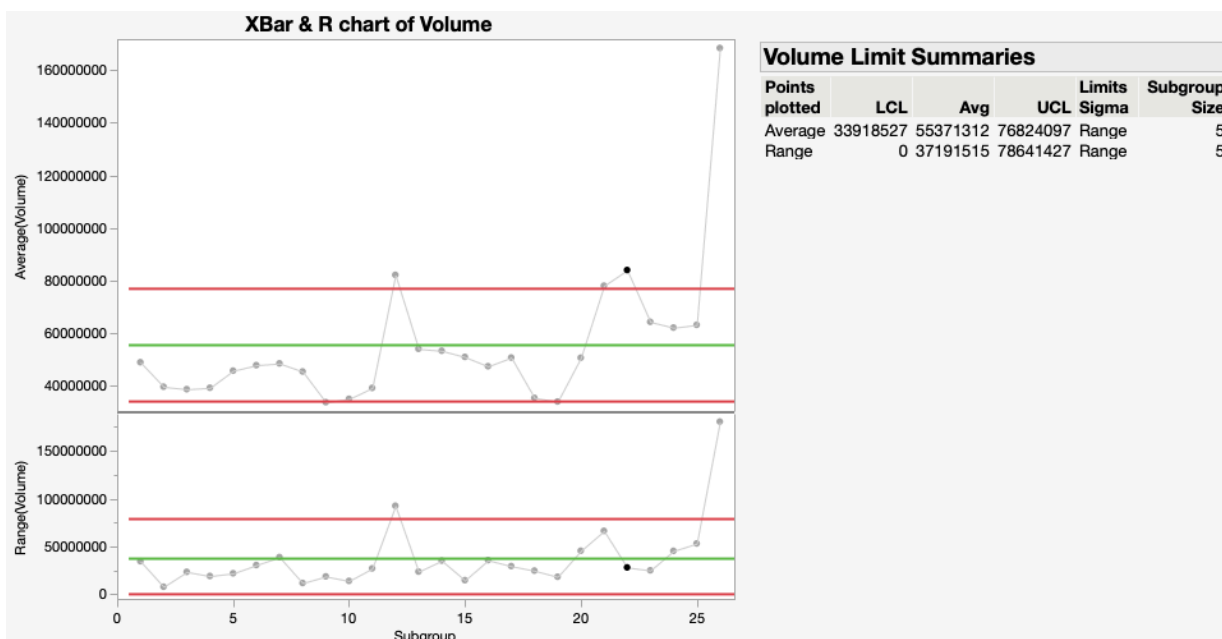
$$\text{R Chart: } LCL = 0; CL = 37191515; UCL = 78641427$$

Initial Control Chart Stability:



The control charts for the pre-event data shows several points outside control limits, indicating the system was not in statistical control before the event. Common cause variation is present as SPY volume is continuous and follows a stochastic process called Brownian motion; which explains the common cause variation around the CL. Assignable cause variation is also present in subgroups 12, 21, and 22 as they exhibited elevated trading volumes. Subgroup 12 aligned with early December 2024, a period known for increased trading activity due to expiration of various financial contracts on December 19, 2024, known as a Quadruple Witching Day. Subgroups 21 and 22, mid-January 2025, aligned with the lead-up to President Trump's second inauguration on January 20, 2025, a time of heightened market anticipation and activity. These events likely contributed to the observed spikes in trading volume, representing special cause variations that disrupted the statistical control of the process during the pre-event period.

Effect of the Event on the Control Chart:



The post-event data shows a large spike in volume, triggering points above the UCL on both the X bar and R charts, confirming that the Liberation Day event introduced assignable cause variation. The control chart triggered immediately after the announcement of the tariffs. This supports the conclusion that the event did not follow statistical control and is the clear assignable cause for the increase in volume above the UCL of both the X bar and R charts.

Resources

- S&P Global. (2025, February). *Market Attributes: U.S. Equities January 2025*. S&P Dow Jones Indices.
<https://www.spglobal.com/spdji/en/documents/commentary/market-attributes-us-equities-202501.pdf>
- TradeStation. (2024, November 15). *Quadruple Witching Dates 2025: What Stock and Futures Traders Should Know*.
<https://www.tradestation.com/insights/2025/02/11/quadruple-witching-dates-2025-stock-futures-trading/>
- Yahoo Finance. (2024). *SPY Historical Data*. <https://finance.yahoo.com/quote/SPY/history/>

Raw Data

Date	Volume	Date	Volume	Date	Volatility	Date	Volatility
10/1/24	72,668,800	11/26/24	45,621,300	1/28/25	44,433,300	3/26/25	51,848,300
10/2/24	38,097,800	11/27/24	34,000,200	1/29/25	37,177,400	3/27/25	42,164,200
10/3/24	40,846,500	11/29/24	30,177,400	1/30/25	39,281,300	3/28/25	71,662,700
10/4/24	42,939,100	12/2/24	31,746,000	1/31/25	66,671,500	3/31/25	95,328,200
10/7/24	49,964,700	12/3/24	26,906,600	2/3/25	65,857,200	4/1/25	54,609,600
10/8/24	37,398,700	12/4/24	42,787,600	2/4/25	33,457,800	4/2/25	76,014,500
10/9/24	37,912,200	12/5/24	28,762,200	2/5/25	30,653,100	4/3/25	125,986,000
10/10/24	44,138,100	12/6/24	31,241,500	2/6/25	35,771,500	4/4/25	217,965,100
10/11/24	42,268,000	12/9/24	34,742,700	2/7/25	50,788,500	4/7/25	256,611,400
10/14/24	36,217,200	12/10/24	37,234,500	2/10/25	26,048,700	4/8/25	165,816,600
10/15/24	54,203,600	12/11/24	28,677,700	2/11/25	30,056,700	4/9/25	241,867,300
10/16/24	30,725,400	12/12/24	31,543,800	2/12/25	45,076,100	4/10/25	162,331,200
10/17/24	34,393,700	12/13/24	35,904,700	2/13/25	40,921,300	4/11/25	97,741,700
10/18/24	37,416,800	12/16/24	43,695,200	2/14/25	26,910,400		
10/21/24	36,439,000	12/17/24	55,773,500	2/18/25	26,749,000		
10/22/24	34,183,800	12/18/24	108,248,700	2/19/25	31,011,100		
10/23/24	49,314,600	12/19/24	85,919,500	2/20/25	36,554,000		
10/24/24	34,979,900	12/20/24	125,716,700	2/21/25	76,519,800		
10/25/24	47,268,200	12/23/24	57,635,800	2/24/25	50,737,200		
10/28/24	30,174,700	12/24/24	33,160,100	2/25/25	58,266,500		
10/29/24	42,899,700	12/26/24	41,219,100	2/26/25	43,321,600		
10/30/24	41,435,800	12/27/24	64,969,300	2/27/25	74,196,700		
10/31/24	60,182,500	12/30/24	56,578,800	2/28/25	88,744,100		
11/1/24	45,667,500	12/31/24	57,052,700	3/3/25	74,249,200		
11/4/24	38,217,000	1/2/25	50,204,000	3/4/25	109,648,200		
11/5/24	39,478,300	1/3/25	37,888,500	3/5/25	71,230,500		
11/6/24	68,182,000	1/6/25	47,679,400	3/6/25	80,094,900		
11/7/24	47,233,200	1/7/25	60,393,100	3/7/25	81,158,800		
11/8/24	46,444,900	1/8/25	47,304,700	3/10/25	99,326,600		
11/11/24	37,586,800	1/10/25	73,105,000	3/11/25	88,102,100		
11/12/24	43,006,100	1/13/25	47,910,100	3/12/25	69,588,200		
11/13/24	47,388,600	1/14/25	48,420,600	3/13/25	74,079,400		
11/14/24	38,904,100	1/15/25	56,900,200	3/14/25	62,660,300		
11/15/24	75,988,800	1/16/25	43,319,700	3/17/25	49,008,700		
11/18/24	37,084,100	1/17/25	58,070,600	3/18/25	66,041,400		
11/19/24	49,412,000	1/21/25	42,532,900	3/19/25	66,556,000		
11/20/24	50,032,600	1/22/25	48,196,000	3/20/25	62,958,200		
11/21/24	46,750,300	1/23/25	41,152,100	3/21/25	83,763,000		
11/22/24	38,226,400	1/24/25	34,604,700	3/24/25	58,766,800		
11/25/24	42,441,400	1/27/25	70,361,100	3/25/25	38,355,700		