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Code : https://colab.research.google.com/drive/1YSJ8y9eIAguj4Aq_GSHRCvedN_K0T-i4?usp=sharing

1. Introduction

Stock market analysis is a crucial component in financial decision-making, providing insights into price behaviour, risk, and return. With the increasing availability of historical market data and powerful analytical tools, data-driven methods enable investors, analysts, and businesses to identify market trends, compute risk metrics, quantify volatility, and compare performance across assets.

This study focuses on four major technology stocks—AAPL, GOOG, MSFT, and NFLX—using Python-based data analysis to compute daily returns, moving averages, volatility indicators, normalized prices, and cumulative returns. The objective of this analysis is to understand comparative stock behaviour, identify performance patterns, and derive preliminary insights that support investment evaluation and risk assessment.

2. Dataset

2.1 Dataset Description

The dataset contains 248 rows and 7 base columns, extracted for four technology stocks - AAPL, GOOG, MSFT, NFLX- with 62 observations per ticker.

Column	Description	Type
Ticker	Stock Identifier	object
Date	Daily trading date	datetime64[ns]
Open	Opening price	float64
High	Highest intraday price	float64
Low	Lowest intraday price	float64
Close	Closing price	float64
Volume	Shares traded	int64

2.2 Feature Engineering

To strengthen the analysis, several financial indicators were engineered:

- Daily Returns : Measures percentage change from one day's close to the next, indicating price momentum and volatility.
- Moving Averages (Trend Indicators) : These help identify bullish/bearish trends.
    - 7-day MA: Short-term trend
    - 30-day MA: Long-term trend
- Volatility (Risk Indicators): Standard deviation of returns; higher values indicate higher risk.

- Normalized Price (Base = 100): Allows cross-ticker comparison regardless of price differences.
- Cumulative Returns (Growth Indicator): Shows how $1 invested in each stock would grow over time.

2.3 Tools Used

2.3.1 Programming Environment

Google Colab (Python - cloud based notebook environment)

2.3.2 Python Libraries

Library	Purpose
Pandas	Data cleaning, transformation, feature creation
Seaborn	Visualizations (line plots, distribution plots)
Matplotlib.pyplot	Custom charts, trend plots

3. Exploratory Data Analysis

3.1 Summary Statistics

3.1.1 Price Level Comparison and Market Positioning

- NFLX exhibits the highest overall price range, with mean opening and closing values of approximately 328 USD and 327 USD, respectively. This reinforces Netflix's position as a high-priced equity among modern tech firms.
- MSFT follows as the second-highest priced stock, with average Open and Close prices around 274–275 USD, reflecting Microsoft's stable market valuation.
- AAPL trades in the mid-range category, averaging around 157–158 USD, consistent with long-term patterns of stable growth and moderate volatility.
- GOOG demonstrates the lowest average price (≈ 100–102 USD), reflecting Alphabet's stock split mechanics rather than weak performance.

This stratification suggests that while NFLX and MSFT operate in higher valuation bands, GOOG and AAPL offer comparatively affordable entry points for investors seeking lower capital requirements.

3.1.2 Volatility and Risk Assessment

- NFLX displays the highest price variability, with std values exceeding 18 USD, signalling pronounced intraday and interday price fluctuations. This aligns with Netflix's historical sensitivity to subscriber trends, earnings announcements, and sector competition.
- MSFT shows moderate volatility (std ≈ 17 USD), consistent with a mature, diversified technology conglomerate.
- AAPL and GOOG exhibit the lowest volatility levels (std ≈ 7 USD and 6 USD), underscoring their stability and resilience in the broader technology market.

These findings indicate that NFLX represents the highest-risk, highest-variance asset in the group, while AAPL and GOOG offer more predictable short-term behaviour suitable for conservative investment approaches.

3.1.3 Price Dispersion and Range Dynamics

- NFLX shows a wide trading band, with Low prices dipping to ~292 USD and High prices extending to ~373 USD. This 80+ USD spread is significantly larger than that of the other stocks.
- MSFT exhibits a trading range between ~246 USD and ~311 USD, indicating consistent price appreciation with moderate fluctuations.
- AAPL maintains a narrow band (≈ 144–174 USD), reinforcing its classification as a lower-volatility asset.
- GOOG has the tightest range (≈ 89–109 USD), supporting its identification as the most stable security in this dataset.

The compression of the interquartile range (25%–75%) for GOOG and AAPL signals strong internal consistency, whereas the expanded range for NFLX highlights market dynamism and possible susceptibility to external shocks.

3.1.4 Volume-Based Market sentiment and liquidity behaviour

- AAPL demonstrates the highest average trading volume (~60 million shares), indicating exceptional liquidity and strong investor participation. AAPL exhibits high variability in trading volume (~14M), similar to GOOG. This indicates that both stocks experience periodic surges in trading activity, typically around earnings releases or major announcements.
- GOOG and MSFT exhibit nearly identical volume levels (~30 million), reflecting healthy yet stable trading cycles. Their slightly lower variability relative to AAPL indicates consistent investor interest without extreme spikes.
- NFLX shows a comparatively low mean volume (~6.4 million shares), implying lower liquidity and potentially higher price sensitivity to trade imbalances.

This liquidity structure suggests AAPL is the most institutionally favoured stock, while NFLX's thinner trading book may contribute to its heightened volatility.

3.2 Distribution Analysis

3.2.1 Price Distribution behaviour across ticker

- AAPL exhibits a narrow and compact distribution across all price metrics. This indicates high internal price consistency and lower day-to-day volatility. The absence of extreme outliers in the price variables suggests predictable trading behaviour and strong market stability.
- MSFT shows moderate dispersion, with a wider IQR than AAPL but still within a stable band. The medians across Open, High, Low, and Close remain centrally positioned within the box, signalling balanced upward and downward pressures. The upward stretching whiskers suggest periods of positive price excursions, consistent with a growth-driven security.
- NFLX displays the widest box and the most extended whiskers across all price metrics. This confirms Netflix as the most volatile price-wise among the four stocks. The price distribution shows higher upper whiskers, indicating frequent intraday peaks and strong upward bursts. Lower whiskers widen the range further, demonstrating sensitivity to market corrections and external shocks. The overall structure indicates a high-risk, high-return profile.
- GOOG maintains the tightest spread among all the stocks. Its distributions for Open, High, Low, and Close sit within a narrow price band, reflecting very stable trading patterns. The boxplots exhibit minimal vertical expansion, and whiskers remain short, indicating controlled volatility and consistent investor confidence.

3.2.2 Analysis of Volume Distribution and Market Participation

- AAPL demonstrates the highest median volume with numerous high-value outliers. These outliers correspond to heavy trading days, often triggered by earnings calls, product releases, or market-wide news. The consistently high volume suggests strong institutional participation and exceptional liquidity.
- MSFT shows moderate and controlled volume distribution. The IQR is reasonably compact, indicating stable investor engagement. A few upward outliers highlight occasional demand surges, consistent with news cycles or technological developments.
- NFLX has the lowest overall trading volume and the smallest IQR among the tickers. Several upward outliers indicate episodic trading spikes, often associated with quarterly subscriber reports or competitive streaming events. The low baseline volume contributes to the high price volatility observed in the price boxplots.
- GOOG maintains a stable mid-range volume distribution with several high-value outliers. While the IQR is moderate rather than tight, the pattern suggests steady investor participation with periodic spikes likely driven by institutional adjustments or major news events.

3.2.3 Volatility and Risk Implications Based on Distributional Spread

- NFLX - Highest volatility
    - Exhibits the widest box and largest whisker extensions across price variables.
    - Low liquidity amplifies price swings.
- AAPL - Lowest volatility
    - Tight price clusters and minimal whisker variations.
    - Strong liquidity safeguards against sharp price corrections.
- MSFT - Moderate volatility
    - Balanced distribution with healthy growth potential.
    - Consistent with its diversified product ecosystem and market positioning.
- GOOG - Stability-oriented
    - Narrowest distributions and controlled volume variations.
    - Indicates pricing behaviour that aligns with a low-risk investment profile.

3.3 Normalised Price Trends (Start Index = 100)

The normalized price graph reveals the relative performance of all four stocks over time, eliminating differences in nominal pricing and enabling direct comparison.

- MSFT exhibits the strongest upward momentum, rising above 115 by the end of the observation window. This indicates consistent capital appreciation and strong bullish sentiment.
- AAPL shows a stable, moderate upward trend, closing slightly above 110, reflecting resilient long-term performance with controlled volatility.
- GOOG demonstrates a mid-range recovery, ending near the 98–100 level, which reflects moderate growth following an early decline.
- NFLX shows the weakest performance, trending persistently downward and stabilizing near 88–90 toward the end, confirming earlier evidence of high volatility and downward pressure.

The normalized trends illustrate that MSFT and AAPL are the best-performing assets during the studied period, while NFLX underperforms substantially, indicating potential structural or sentiment-driven challenges.

3.4 Moving Average Analysis (7-day vs. 30-day)

- AAPL 7-day MA consistently leads the 30-day MA, indicating sustained short-term momentum. Crossovers occur in early March and mid-April, signalling temporary correction phases followed by recovery. Overall slope suggests progressive strengthening in investor confidence.
- GOOG stock begins with a sharp decline, with both moving averages trending downward. Mid-March signals a structural reversal as both MAs start rising. The 7-day MA remains above the 30-day MA toward the end, confirming regained upward momentum.
- NFLX MA patterns reveal prolonged bearish sentiment, with the 7-day MA remaining below the 30-day MA for much of the timeline. A brief upward crossover in early April is not sustained, indicating unstable recovery attempts. This aligns with Netflix's historically volatile behaviour.
- MSFT exhibits a distinct long-term increasing track. In late March, there is a strong bullish performance when the 7-day MA crosses above the 30-day MA. The growing difference between the two moving averages attests to the market's continued strength and optimistic outlook.

The moving average indicators highlight MSFT and AAPL as strong momentum-driven assets, GOOG as moderately improving, and NFLX as struggling to maintain consistent upward momentum.

3.5 Rolling Volatility (7-day and 30-day)

- Short-Term Volatility (7-day)
    - NFLX consistently exhibits the highest volatility, with spikes above 0.04, reflecting significant short-term risk.
    - GOOG shows moderate volatility with episodic surges (0.025–0.030), signalling irregular trading behaviour.
    - MSFT has periodic increases but remains within a controlled volatility band.
    - AAPL displays the lowest and most stable volatility, rarely exceeding 0.02, confirming its defensive stock characteristics.
- Long-Term Volatility (30-day)
    - NFLX again leads with the highest stable volatility (~0.025 to 0.028), reinforcing its risk profile.
    - GOOG remains moderate (~0.018 to 0.020).
    - MSFT maintains a mid-range band (~0.016–0.018).
    - AAPL holds the lowest long-term volatility (~0.012–0.014).

NFLX is the riskiest asset from both short-term and long-term perspectives. AAPL remains the lowest-risk asset with exceptional stability. GOOG and MSFT occupy intermediate risk categories.

3.6 Return Distribution Analysis

- NFLX exhibits the widest return distribution, with multiple extreme positive and negative outliers, confirming heavy price fluctuations.
- MSFT shows moderate spread with positive skew, consistent with strong upward performance.
- AAPL and GOOG show tighter distributions and fewer extreme values, reinforcing their classification as relatively stable assets.
- Negative return outliers in GOOG and NFLX reflect susceptibility to downside shocks.

NFLX has the highest return volatility, while AAPL and GOOG maintain stable return ranges suitable for conservative strategies.

3.7 Correlation of Daily Returns

- AAPL and GOOG share the highest return correlation (0.64), indicating similar market sensitivity and shared macroeconomic drivers.
- AAPL and MSFT exhibit moderately high correlation (0.57), reflecting their similar tech-sector behaviour.
- NFLX has the lowest correlations with all others (~0.40–0.51), confirming its idiosyncratic risk profile and relative independence from broader market patterns.

Diversification benefits exist when combining NFLX with any of the other three stocks, while AAPL, MSFT, and GOOG behave more cohesively.

3.8 Cumulative return Analysis

- MSFT delivers the strongest overall performance, surpassing 1.15 in cumulative growth.
- AAPL follows, ending near 1.10, confirming stable and consistent appreciation.
- GOOG shows moderate cumulative recovery, ending slightly below 1.00–1.02, indicating mild growth.
- NFLX declines persistently and stabilizes below 0.90, reinforcing significant underperformance relative to peers.

Cumulative return behaviour highlights MSFT and AAPL as the dominant growth performers, GOOG as a moderate performer, and NFLX as the weakest asset over the observed period.

3.9 Daily Returns Over Time

- All four stocks exhibit frequent, rapid oscillations around the zero-return line, reflecting sensitivity to daily market events.
- NFLX and GOOG display the largest negative spikes (≈ –7% to –8%), confirming heightened downside susceptibility.
- MSFT shows rare but meaningful upside shocks exceeding +7%, signalling strong positive catalysts.
- AAPL maintains the most stable return band, with fewer extreme swings and tighter clustering around zero.

NFLX and GOOG are more prone to high-amplitude shocks. AAPL and MSFT maintain controlled daily variability.

3.10 Maximum Drawdown Analysis

- NFLX shows the deepest and most persistent drawdowns, reaching close to –20%, indicating prolonged vulnerability and slow recovery cycles.
- GOOG and MSFT exhibit moderate drawdowns (≈ –10% to –12%), aligning with temporary corrections rather than structural declines.
- AAPL demonstrates the shallowest drawdowns, rarely exceeding –8%, reinforcing its defensive risk profile.

Drawdown behaviour confirms that AAPL is structurally more resilient, MSFT and GOOG remain moderately stable, while NFLX carries significant downside risk that may be unacceptable for conservative investors.

3.11 Rolling 20-Day Sharpe Ratio (Risk-Adjusted Returns)

- MSFT achieves the highest Sharpe ratios, frequently touching 0.45–0.50, demonstrating superior risk-adjusted returns.

- AAPL maintains consistently positive Sharpe values after the mid-period, reaching up to 0.35–0.40, signalling stable risk efficiency.
- GOOG displays positive Sharpe performance early on but deteriorates toward the end, reflecting weakening return-to-risk efficiency.
- NFLX spends substantial periods with negative Sharpe ratios, indicating poor compensation for the volatility investors endure.

3.12 Volume vs. Daily Returns (Market Activity Correlation)

- AAPL: Higher trading volumes correlate with moderate and stable return fluctuations, indicating strong liquidity and resistance to volume-driven price shocks.
- GOOG: Displays moderate sensitivity, with occasional sharp negative returns even at higher volume levels, suggesting episodic negative sentiment triggers.
- MSFT: Shows balanced return dispersion, with volume clustering around moderate levels and occasional large positive returns.
- NFLX: Exhibits high return dispersion at relatively low volumes. This combination demonstrates that low liquidity amplifies price impact, creating outsized return spikes both upward and downward.

NFLX shows signs of liquidity-driven volatility, whereas AAPL demonstrates highly liquid, stable-volume behaviour that mitigates extreme returns. MSFT and GOOG occupy intermediate liquidity–volatility profiles.

4. Business Insights

4.1 Behavioural Insights from Price Trends and Performance Indicators
4.1.1 Comparative Price Behaviour and Market Dynamics

- NFLX, with its consistently highest price range, represents a premium-priced asset with heightened market expectations.
- MSFT, occupying the second-highest tier, reflects sustained investor confidence backed by diversified business units.
- AAPL, priced in the mid-range, maintains its reputation for long-term stable growth.
- GOOG, despite its technological dominance, appears lower-priced due to stock-split dynamics rather than diminished fundamentals.

These behaviours indicate that price alone is not a measure of performance, and investors must rely on volatility, momentum, and risk-adjusted metrics to judge overall attractiveness.

4.2 Risk and Volatility-Based Insights
4.2.1 Volatility Patterns from Summary Statistics and Rolling Windows

- NFLX consistently shows the highest volatility, with spikes exceeding 0.04 in the short term and maintaining elevated long-term risk (~0.027).
- AAPL shows the lowest volatility across all periods (mostly below 0.015 on long-term windows), confirming its reputation as a defensive stock.
- MSFT and GOOG fluctuate between moderate-risk bands, often showing elevated volatility during periods of macroeconomic uncertainty.

Risk-averse investors benefit from AAPL; MSFT provides balanced risk-adjusted growth; NFLX should only be considered by high-risk, opportunistic investors.

4.3 Return Behaviour, Market Response, and Drawdown Patterns

4.3.1 Daily Return Behaviour

- NFLX and GOOG register the largest downside spikes (–7% to –8%).
- MSFT experiences occasional large positive return shocks, indicating strong responsiveness to positive catalysts.
- AAPL retains a narrow and stable daily return band.

AAPL is the steadiest, MSFT is the most catalyst-responsive, and NFLX/GOOG carry substantial short-term risk.

4.3.2 Maximum Drawdown Analysis (Downside Risk)

- NFLX reaches peak drawdowns nearing –20%, the largest and most persistent, highlighting vulnerability to price collapses.
- MSFT and GOOG experience drawdowns around –10% to –12%, reflecting moderate resilience and steady recovery.
- AAPL posts the smallest drawdowns (~ –8%), confirming strong structural stability.

AAPL demonstrates superior downside protection; NFLX suffers severe drawdowns that would be unsuitable for conservative portfolios.

4.4 Momentum Insights from Moving Averages

4.4.1 Trend Identification via 7-Day and 30-Day Moving Averages

- AAPL 7-day MA consistently leads the 30-day MA, confirming sustained bullish sentiment. Trend reversals are brief and quickly corrected.
- GOOG early decline is followed by a mid-March trend reversal. Positive momentum is restored as the 7-day MA overtakes the 30-day MA.
- MSFT clear, consistent uptrend with a strongly widening gap between short- and long-term averages. Indicates a robust, sustained momentum pattern and investor confidence.
- NFLX shows a prolonged bearish trend, with only a short-lived reversal. Momentum stability remains weak.

MSFT and AAPL demonstrate the strongest upward momentum; GOOG recovers moderately; NFLX struggles to maintain upward trends.

4.5 Performance Efficiency: Rolling Sharpe Ratio

- MSFT achieves the highest Sharpe values (0.45–0.50), reflecting excellent risk-adjusted returns.
- AAPL remains consistently positive, reaching up to 0.40, signalling strong efficiency and stability.
- GOOG shows early strength but weakens towards the end of the period.
- NFLX spends extensive periods below zero, indicating the market does not compensate investors adequately for its high volatility.

On a risk-adjusted basis, MSFT is the strongest performer, followed by AAPL. GOOG is inconsistent, while NFLX underperforms significantly.

4.6 Cross-Asset Relationships and Diversification Benefits

4.6.1 Correlation of Returns

- Strongest correlation: AAPL–GOOG (0.64)
- Moderate correlation: AAPL–MSFT (0.57)
- Lowest correlations: NFLX with all assets (0.40–0.51)

NFLX offers the best diversification benefits due to its independence from broader market cycles, despite its high volatility.

4.7 Liquidity and Market Activity Insights (Volume–Return Relationships)

- AAPL: High volume, stable returns; strong institutional participation.
- MSFT: Moderate volume but balanced return distribution; healthy liquidity.
- GOOG: Shows occasional sharp negative returns even at higher volume levels, suggesting sentiment-driven swings.
- NFLX: Low volume and high return dispersion indicate liquidity-driven volatility.

Liquidity is a major stabilising factor for AAPL and MSFT; NFLX's low liquidity contributes directly to its instability.

5. Business Recommendations

Based on the overall analysis of price behaviour, volatility, liquidity, risk-adjusted performance, and drawdown characteristics, AAPL and MSFT emerge as the strongest investment candidates. AAPL is recommended as a core portfolio holding, offering exceptional stability, the lowest volatility, shallow drawdowns, consistently positive Sharpe ratios, and high institutional liquidity. It is ideal for conservative and long-term investors seeking dependable appreciation with minimal downside risk. MSFT is recommended as a growth-oriented investment, delivering the highest cumulative returns and superior Sharpe ratio performance, supported by strong momentum patterns and moderate volatility. This makes MSFT suitable for investors seeking higher returns without taking excessive risk. GOOG, despite strong fundamentals, shows inconsistent momentum and occasional sentiment-driven negative swings. It is best suited as a tactical "hold" position, contributing moderately to portfolio growth while offering stable liquidity but less consistent risk-adjusted performance. In contrast, NFLX carries the highest volatility, deepest drawdowns, negative Sharpe periods, and low liquidity, making it appropriate only for aggressive, high-risk investors with short-term or speculative strategies. For most investors, NFLX should be avoided or kept as a very small satellite allocation. From a diversification perspective, the lower correlation of NFLX with other assets may offer diversification benefits, but its elevated volatility often outweighs these advantages. Overall, a balanced and efficient portfolio would prioritise AAPL and MSFT as core holdings, include GOOG selectively, and treat NFLX strictly as a speculative asset.