Descriptive Statistics (Stock data from 2015-2020)

	S&P 500	Apple (AAPL)	Intel (INTC)	Kroger (KR)
Arithmetic Mean (%)	0.9	2.7	0.9	0.4
Geometric Mean (%)	0.8	2.3	0.7	0.1
Coefficient of Variation	4.6	3.1	7.7	17.9
Standard Deviation (%)	4.3	8.4	7.1	7.9
Investment Beta	1.0	1.3	0.8	0.3
Coefficient of Determination R^2 (%)	100.0	42.9	20.9	3.3

Explanation:

- **Arithmetic Mean**: This metrics measures the average of a stock's returns over a specific period, showing the typical return you might expect.
- **Geometric Mean**: This represents the average annual growth rate of an investment, taking compounding into account. It reflects what your returns would look like if they grew steadily over year.
- **Coefficient of Variation**: This shows how much risk you're taking for each unit of return. A higher value means the investment returns are more uncertain compared to the expected return.
- **Standard Deviation**: This indicates the level of risk or volatility of a stock's return. A higher standard deviation means more variability in returns, which implies greater risk.
- **Investment Beta**: Beta measures how much a stock's returns tend to move with the market. A beta above 1 means the stock is more responsive to market changes, while a beta below 1 indicates less sensitivity.
- **Coefficient of Determination**: This shows the percentage of a stock's movement that can be explained by market movements. A higher R-squared means the stock's performance is closely tied to the overall market.

Key Findings:

Apple achieved the highest geometric mean for monthly compounded returns at 2.3% and an average return of 2.7%. However, this strong performance also came with the highest standard deviation of 8.4%, highlighting a mix of high returns and increased volatility.

Intel, by contrast, offers a steadier return pattern with a lower standard deviation of 7.1% than Apple, positioning it as a less volatile choice and an appealing option for investors prioritizing risk reduction.

Kroger stands out for its reduced volatility, featuring both a low standard deviation and beta, suggesting minimal sensitivity to market swings. This stability makes Kroger a potentially lower-risk investment option.

In conclusion, Apple shows the highest returns but comes with greater volatility. Intel, with a moderate beta, strikes a balance between market alignment and variability. Kroger stands out for its low beta, suggesting resilience in market downturns but with modest returns.

Relative Magnitudes Intuition:

Apple shows the highest returns with the highest volatility and market sensitivity (beta of 1.3), typical for a tech company where growth potential comes with risk. Intel, with moderate returns and lower volatility (beta of 0.8), reflects the stability of a mature semiconductor company. Kroger, operating in the stable consumer sector, has the lowest returns and market sensitivity (beta of 0.3), yet still faces unique industry pressures, which add some volatility. These differences highlight how each stock's performance aligns with its industry's risk-return profile.

Appropriate Recommendations:

Given your goal of selecting a stock that performs well in both up and down markets, **Kroger** might be the most suitable choice. Its low beta indicates that it is less affected by market shifts, which aligns with your objective of maintaining stability. While Apple offers higher potential returns, its higher beta and volatility may not align with your current preference for risk mitigation.

Caveats or Limitations:

While these statistics are useful for understanding historical performance, they rely on past data and cannot guarantee future results. Financial markets are dynamic and influenced by numerous variables, meaning past trends may not reliably predict future outcomes.

Technical Report

Data Source:

The monthly closing stock prices at the end of each month, from **January 31st, 2015, to December 31st, 2020**, totaling **72 observations**. These summary statistics are for the S&P 500, Apple, Intel, and Kroger stocks obtained from **Yahoo Finance**.

Estimated CAPM model (R Output):

Apple (AAPL)

```
Residuals:
          Min            1Q        Median            3Q           Max
-22.167958956  -3.358629804  -0.643150784   4.144691561  14.286392560

Coefficients:
             Estimate       Std. Error     t value        Pr(>|t|)
(Intercept)  1.498982906    0.768210944    1.95126        0.055028 .
sp500        1.267978113    0.174962774    7.24713        4.4172e-10 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.37030188 on 70 degrees of freedom
Multiple R-squared:  0.42866893,       Adjusted R-squared:  0.420507057
F-statistic: 52.5209054 on 1 and 70 DF,  p-value: 4.41719451e-10
```

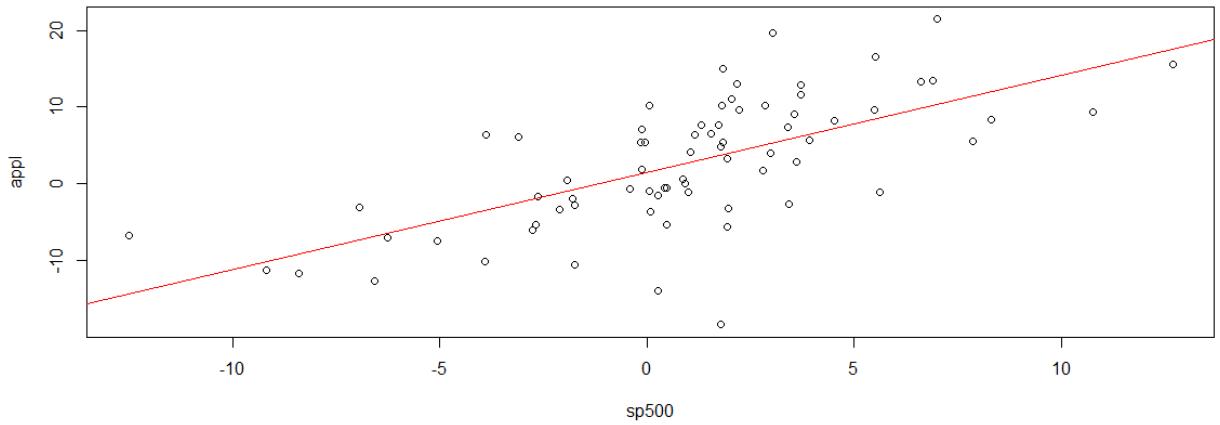

Estimated CAPM equations: (rounded to two decimal places)

- AAPL Return Percentage = **1.50** + **1.27** * S&P 500 Return Percentage
- Unit of Measurement: Percentage (%)

Intel (INTC)

```
Residuals:
          Min            1Q        Median            3Q           Max
-24.610377134  -4.570054990   0.860829194   4.211582541  17.559585348

Coefficients:
             Estimate       Std. Error     t value        Pr(>|t|)
(Intercept)  0.222927036    0.771579609    0.28892        0.77349
sp500        0.755605008    0.175729999    4.29981        5.4298e-05 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.39823615 on 70 degrees of freedom
Multiple R-squared:  0.208935295,      Adjusted R-squared:  0.19763437
F-statistic: 18.4883367 on 1 and 70 DF,  p-value: 5.42982221e-05
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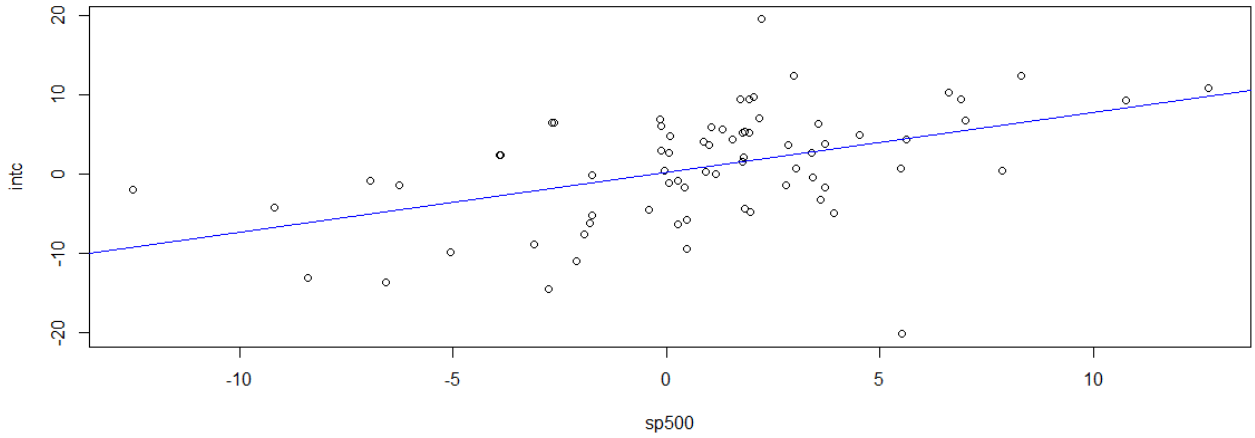

Estimated CAPM equations: (rounded to two decimal places)

- INTC Return Percentage = **0.22** + **0.76** * S&P 500 Return Percentage
- Unit of Measurement: Percentage (%)

Kroger (KR)

```
Residuals:
          Min            1Q        Median            3Q           Max
-21.670096583  -6.302491218   0.418183346   5.040647439  23.855137105

Coefficients:
               Estimate       Std. Error     t value        Pr(>|t|)
(Intercept)    0.130250964    0.945763820    0.13772        0.89086
sp500          0.335475810    0.215401072    1.55745        0.12387

Residual standard error: 7.84263891 on 70 degrees of freedom
Multiple R-squared:  0.0334914803,     Adjusted R-squared:  0.0196842158
F-statistic: 2.42564196 on 1 and 70 DF,  p-value: 0.123874305
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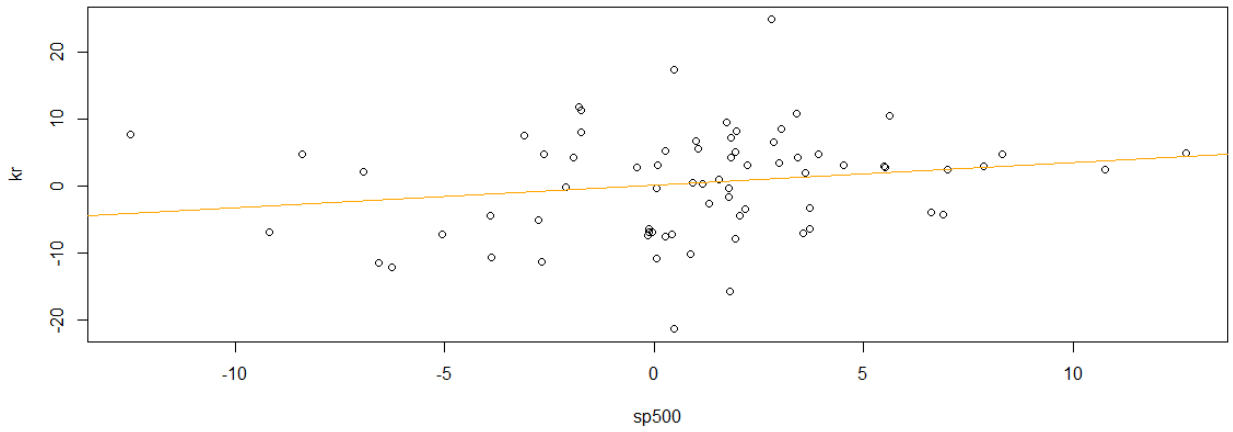

Estimated CAPM equations: (rounded to two decimal places)

- KR Return Percentage = **0.13** + **0.34** * S&P 500 Return Percentage
- Unit of Measurement: Percentage (%)

Hypothesis Testing on Beta Coefficient:

n = 72

degree of freedom (*df*) = n – 2 = 72 – 2 = 70

Apple (AAPL)

H_o: $\beta_1 = 1$
H_a: $\beta_1 \neq 1$

$$t = \frac{(\beta 1 - 1)}{s} = \frac{(1.267978113 - 1)}{0.174962774} = 1.53162931104$$

p-value ≈ 0.13

With a p-value of **0.13**, which is greater than **0.05 (5% significance level)**, we do not reject the null hypothesis.

Intel (INTC)

H_o: $\beta_1 = 1$
H_a: $\beta_1 \neq 1$

$$t = \frac{(\beta 1 - 1)}{s} = \frac{(0.755605008 - 1)}{0.175729999} = -1.39074144079$$

p-value ≈ 0.168

With a p-value of **0.168**, which is greater than **0.05 (5% significance level)**, we do n ot reject the null hypothesis.

Kroger (KR)

H_o: $\beta_1 = 1$
H_a: $\beta_1 \neq 1$

$$t = \frac{(\beta 1 - 1)}{s} = \frac{(0.335475810 - 1)}{0.215401072} = -3.0850551663$$

p-value ≈ 0.002

Since the p-value (**0.002**) is less than **0.01 (1% significance level)**, we reject the null hypothesis. Kroger's beta is significant **at a 1% significance level**.

Why this Hypothesis is more meaningful:

A beta of 0 suggests no linear relationship between a stock's returns and the markets. Analyzing if beta significantly differs from 1 allows us to understand how closely a stock tracks the market. A beta of 1 implies the investment's returns are likely to follow the market, while deviations from 1 indicate higher or lower market sensitivity, thus impacting the investment's risk level relative to market fluctuations. These insights guide investors in making more informed decisions.

Key Differences:

- **Returns**: Apple's returns declined slightly from 3.1% (1999-2004) to 2.7% (2015-2020), suggesting slower growth as it matured. Intel's returns remain steady, with the arithmetic mean being close to 1% in both. This stability might indicate less growth compared to Apple but steadier performance.
- **Standard Deviation**: Standard deviations dropped across the board, with Apple's falling from 16.6% to 8.4% (Intel: 14.6% to 7.1%). This decline reflects market stabilization and the maturation of these companies.
- **Beta**: Apple's and Intel's betas fell significantly (closer to 1), indicating less sensitivity to the market. This shift suggests that both companies became more stable as they grew.
- **Geometric Mean**: A higher geometric mean relative to the arithmetic mean for Apple and Intel in the more recent period (2015-2020) suggests that these stocks experienced steadier, compounded growth.

Intuition for Differences:

- **Company Maturity**: Established companies like Apple and Intel saw reduced volatility and beta over time.
- **Sector and Economic Trends**: Tech stocks became more stable, while grocery demand grew, as seen for example, in Kroger's positive returns.
- **Market Conditions**: Overall, decreased volatility and beta suggest more market stability and investor confidence in these large companies.