October 25, 2021

To: Alex Lee

From: Divya Ramesh

Dear Alex Lee,

With reference to our recent conversation at the International Business Conference 2021, I am glad that our company's Portfolio Manager, Brenda Hagerty introduced you as our important client at Waite First Securities.

After our meeting, I took the past week to analyze three of the companies you have considered - Apple, Intel, or Kroger, and to propose a good stock for adding to your portfolio ahead of your retirement plan.

Indubitably, all three of these US based companies are best in their own terms, Apple as a high-quality Tech company, Intel as top R&D spender in Semiconductor and Kroger as the largest Consumer Retailer. To compare each of these companies quantitatively, I have performed descriptive statistics on the historical data for each stock along with the S&P 500 index as a benchmark. The data considered is between January 2015 to December 2020 for a period of 72 months.

Descriptive Statistics

Sample size -72 months (6 years)

Sample Timeframe – Jan 2015-Dec 2020

	S&P 500	Apple Inc	Intel Corp	Kroger
Arithmetic Mean	0.9%	2.7%	0.9%	0.4%
Geometric Mean	0.8%	2.3%	0.7%	0.1%
Standard Deviation	4.3%	8.4%	7.1%	7.9%
Beta	1.000	1.268	0.756	0.335
Coefficient of Determination (R^2)		0.429	0.209	0.033

- Note:S&P500 data is obtained from GSPC

Let me briefly explain each of the terms:

Arithmetic mean is a simple average-- the total monthly percent returns divided by 72-months. While Geometric mean is the time-weighted rate of stock return (only applies to positive set of numbers) and it is always lower than arithmetic mean due to compounding effect, as evident from the table above.

Standard deviation is the measure of market volatility, i.e., how widely prices are dispersed from the average. You can always remember that if prices swing wildly up and down like a seesaw, a stock is highly volatile with a high standard deviation. Then comes the most interesting term, Beta, which measures the responsiveness of a stock's price to changes in the overall market. The volatility of the stock and systematic risk can be judged by calculating beta.

As an investor, you would not only want to know how your stock is performing over time against the S&P index (measured by beta), but also know how reliable the relationship is with the market. R^2, also known as systematic risk, indicates the vertical (alpha) and horizontal (beta) variation in the returns on a stock.

From the data, positive beta values for all three stocks are observed, indicating that they move in the same direction as rest of the market. Accessing the beta value of Apple = 1.268 (highest among the rest), shows that Apple is 26.8% more volatile than the market. While Kroger has the least beta value = 0.335 showing it is the least risky stock. We can also infer that the geometric mean of stock return is the highest for apple at 0.023 compared to Intel at 0.007 and Kroger at 0.001. Overall, we can infer that high-beta stocks are riskier but yield higher returns.

Technology stocks tend to have a higher beta compared to the market (Kenton, 2021). Beta value greater than 1.0, indicates that Apple is more volatile than the market. Every year, Apple has a variety of new launches of their innovative gadgets, and they have a market capital of $2.46 Trillion which usually causes a lot of people to closely follow and invest in their stocks so there might be a lot of short-term buyers and sellers who engage in options trading, which might be a reason for their volatility. In contrast, a beta value less than 1.0 means that the stocks are less volatile than the market.

Based on the statistical observation, I would recommend investing in Intel stocks, taking into consideration your desire for low-risk stock. Intel's beta value of 0.756 is lesser than 1(unlike Apple), meaning there will be lesser risk and since it is closer to S&P500 index(unlike Kroger), it moves in tandem with the S&P 500 to a great extent. Furthermore, Intel has geometric mean return of 0.7%, unlike Kroger which has a significantly negligible (0.1%) return on investment. Even though the short-term return for Intel is not as high as that of Apple's, still there is a huge potential for growth, in 10 years, as Intel shifts from PC-centric to data-centric businesses such as AI and autonomous driving. The company is also holding its dominant share for microprocessors (Zacks, n.d.).

I would also like you to take note of a few limitations to the analysis:

- We have considered stock return to be strictly defined by volatility and the Beta coefficient assumes that stock returns are normally distributed. However, there are many surprises in the financial market such as macro-economic conditions, which affects the stock returns' distribution. Hence, Beta is not an accurate indicator.
- Analysis is based on historical data; past is not a precise measure of the future movements.
- There are other factors to consider when accessing a stock such as market capital, dividends, upcoming/future projects for the company etc.

I hope the above would be of help to decide on a stock to invest, feel free to reach out and stay safe.

Thank you.

Divya

Divya Ramesh
Portfolio Associate Manager

Encl. Technical Report

TECHNICAL REPORT

SOURCE OF DATA, VARIABLE DEFINITIONS, AND SAMPLE SIZE

The stock prices historical data used in this analysis has been extracted from Yahoo Finance (Yahoo Finance, n.d.) and the sample size(timeframe) used for statistical analysis is 72 months [Jan 2015 to Dec 2020]. A stock's returns are regressed against the returns of a broader index, S&P 500, to generate a beta for the particular stock (Beers & Schmitt, 2021). In general, Simple linear regression compares a dependent variable, y, to an independent variable, x. In investment context, y is the return on the asset of interest (Rj) and x is the return on overall stock market(Rm), refers to S&P500 index. The return of a stock can be measured using an empirical framework - Capital Asset Pricing Model(CAPM) and beta is the slope of regression line.

ESTIMATED CAPITAL ASSET PRICING(CAPM) MODEL – R OUTPUT

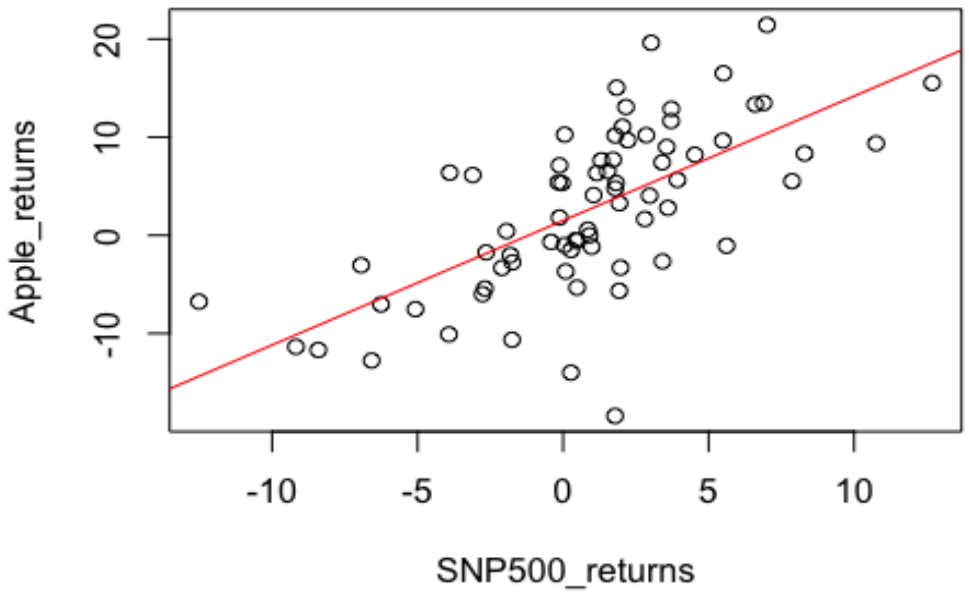
Estimated SLR Model for Apple based on Jan 2015-Dec 2020 Data:

```
Residuals:
     Min       1Q   Median       3Q      Max
-22.1677  -3.3589  -0.6433   4.1446  14.2870

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)      1.4991     0.7682   1.951    0.055 .
SNP500_returns   1.2680     0.1750   7.247 4.42e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.37 on 70 degrees of freedom
Multiple R-squared:  0.4287, Adjusted R-squared:  0.4205
F-statistic: 52.52 on 1 and 70 DF,  p-value: 4.415e-10
```

Bivariate Fit of Apple by S&P500



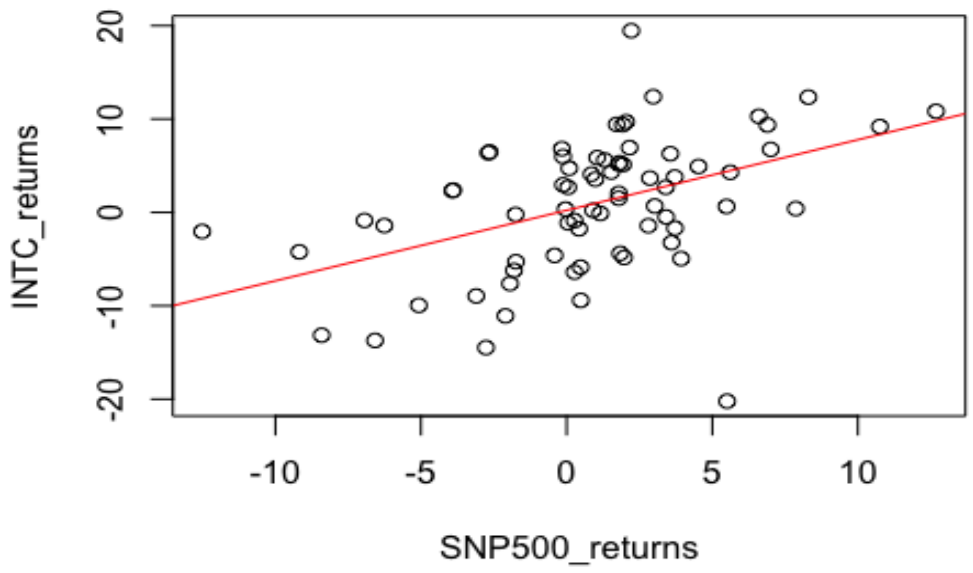
Estimated SLR Model for Intel based on Jan 2015-Dec 2020 Data:

```
Residuals:
    Min      1Q  Median      3Q     Max
-24.610  -4.570   0.861   4.211  17.559

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)      0.2230     0.7716   0.289    0.773
SNP500_returns   0.7556     0.1757   4.300 5.43e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.398 on 70 degrees of freedom
Multiple R-squared:  0.209,  Adjusted R-squared:  0.1976
F-statistic: 18.49 on 1 and 70 DF,  p-value: 5.426e-05
```

Bivariate Fit of Intel by S&P500



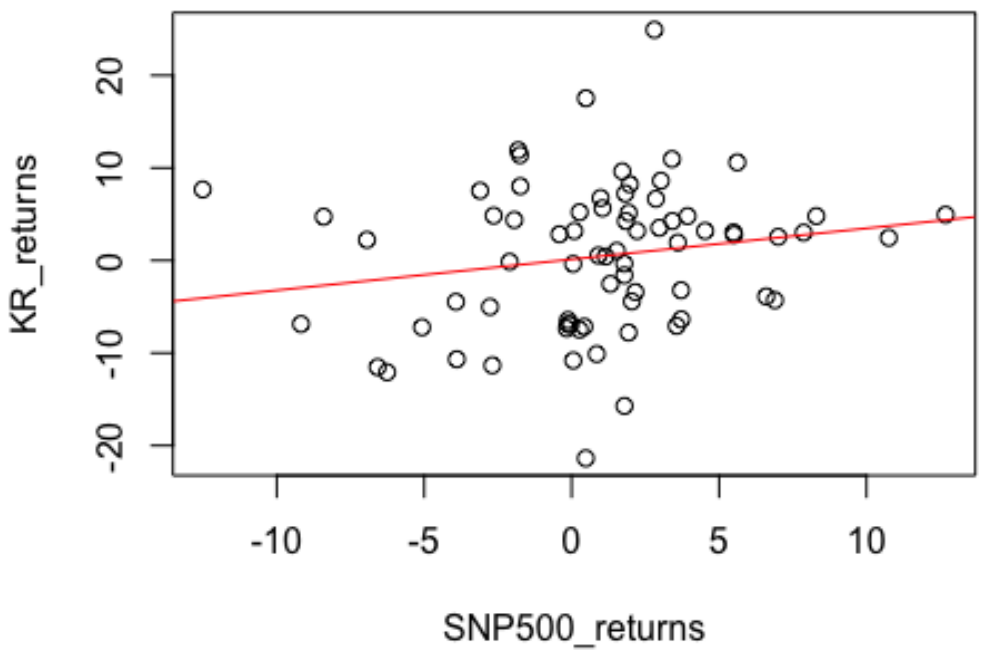
Estimated SLR Model for Kroger based on Jan 2015-Dec 2020 Data:

```
Residuals:
    Min      1Q  Median      3Q     Max
-21.670  -6.303   0.418   5.040  23.856

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)      0.1305     0.9458   0.138    0.891
SNP500_returns   0.3354     0.2154   1.557    0.124

Residual standard error: 7.843 on 70 degrees of freedom
Multiple R-squared:  0.03348,    Adjusted R-squared:  0.01968
F-statistic: 2.425 on 1 and 70 DF,  p-value: 0.1239
```

Bivariate Fit of Kroger by S&P500



CAPM for Simple Linear Regression

$R_j = \beta_0 + \beta_1 R_m + \varepsilon$

where

β_0 = y-intercept
β_1 = investment beta (slope of line of regression)
ε = error term

R_j = return on the asset of interest
R_m = return on overall stock market

CAPM for Apple based on Jan 2015-Dec 2020 Data

Apple returns = 1.499 + (1.268 * S&P500 returns)

CAPM for Intel based on Jan 2015-Dec 2020 Data

Intel returns = 0.223 + (0.756 * S&P500 returns)

CAPM for Kroger based on Jan 2015-Dec 2020 Data

Kroger returns = 0.131 + (0.335 * S&P500 returns)

LEVEL OF SIGNIFICANCE

To estimate whether beta differs from 1, p-value needs to be accessed with alpha (Levels of Significance):

H_0: $\beta_{1.} = 1$

H_a: $\beta_{1.} \neq 1$

APPLE

Calculating t-statistics:
$t = (b1 - \beta_1)/S_{b1}$

$= (1.268 - 1)/0.175 = 1.531$

Probability = 0.9349

For 2-tailed test,

p-value = (1-0.9349)*2=0.1302

Since the p-value for Apple is greater than 0.05, it is not statistically significantly different from 1 at 5% level of significance.

INTEL

Calculating t-statistics:
$t = (b1 - \beta_1)/S_{b1}$

$= (0.756 - 1)/0.176 = -1.386$

Probability = 0.0851

p-value = 0.0851*2=0.1702

Since the p-value for Intel is greater than 0.05, it is not statistically significantly different from 1 at 5% level of significance.

KROGER

Calculating t-statistics:
$t = (b1 - \beta_1)/S_{b1}$

$= (0.335 - 1)/0.215 = -3.093$

Probability = 0.0014

p-value = 0.0014*2=0.0028

Since Kroger has a p-value greater than 0.001, it is not statistically significantly different from 1 at 0.1% level of significance.

Note: Probability values are obtained from web-based calculator, Source: (Stat Trek, n.d.), and Degrees of Freedom is taken as 70.

HYPOTHESIS TESTING

Considering the t-statistics in SLR context, when beta coefficient is equated to zero,

$H_0: \beta_{1.} = 0$

Substituting $\beta_{1.} = 0$ in $t = (b_1 - \beta_1)/S_{b1}$ ➔ $t = b_1/S_{b1}$

In this case the slope becomes 0, and there will be no correlation between stock returns and overall market, which defeats the purpose of this measuring a security's return. The hypothesis testing is therefore more meaningful when beta value of S&P index is taken as 1.

COMPARITIVE DATA ANALYSIS

OLDER DATA:

Sample Timeframe – 1999-2004

	S&P 500	Apple Computer	Intel Corp
Arithmetic Mean	0.09%	3.10%	0.98%
Standard Deviation	4.59%	16.61%	14.65%
Beta	1.00	1.81	2.05

Drawing inference from the older data calculated for a Timeframe from 1999 to 2004, it is observed that the beta for Apple and Intel has significantly reduced – from 1.81 to 1.27 for apple and 2.05 to 0.76 for Intel. Previously, Intel was in top 10 of S&P500 companies but now it has only 0.5% weightage in S&P500, so this explains why Intel's beta value has reduced. Over the years, market capital of Apple increased, in 2018, it became the first publicly traded US company to be valued at $1trillion. Therefore, the volatility of the stocks have reduced causing the standard deviation to reduce by half.

REFERNCES

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(TOTAL WORD COUNT: 1194)