Letter to Mr. Alex Lee

Dear Mr. Alex Lee,

This letter is an investment opinion recommending one of the three stock investment opportunities to your portfolio for Apple, Intel, Kroger, taking your investment objectives into account.

The below is a summary table with expected returns (both the arithmetic and geometric means), standard deviations, and coefficients of variation along with S&P 500, estimated investment betas, coefficients of determination (R2s) for all three individual stocks

	S&P 500	Apple	Intel	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%
Coefficient of Variation	4.6	3.1	7.7	17.9
Investment Beta	1.00	1.26	0.76	0.33
R Squared		42.9%	20.9%	3.3%

Definitions:

Arithmetic Mean: It involves taking the sum of a group of numbers, then dividing that sum by the count of the numbers used in the series. Arithmetic mean is usually not accurate over successive holding periods, because it does not account for compounding.

Geometric Mean: It is the average rate of return of a set of values calculated using the products of the terms. It is the most appropriate for series that exhibit serial correlation because it accounts for compounding, and this is especially true for investment portfolios.

Standard Deviation: It measures volatility in the market or the average amount by which individual data points differ from the mean. Standard deviation helps determine the spread of asset prices from their average price.

Coefficients of Variation: It is the sample SD relative to the sample mean and can also be explained as the risk per return. A lower ratio suggests a more favorable tradeoff between risk and return. The higher the CV, the greater the dispersion.

Investment Beta(β): Beta of an investment security (i.e., a stock) is a measurement of its volatility of returns relative to the entire market. It is used as a measure of risk and is an integral part of the Capital Asset Pricing Model (CAPM). A company with a higher beta has greater risk and greater expected returns.

R-Squared: It indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model. In investing, R-squared is the percentage of a fund or security's movements that can be explained by movements in a benchmark index.

Key Findings:

When comparing various attributes of these three stocks, we can see that Kroger has a high coefficient of variation which indicates highest risk per return. It is also the least sensitive to the overall market, which makes it less favorable than Apple and Intel stocks. Also, if we compare the stock price of Apple from 2015 through 2020, there has been a significant increment in the stock price from $25.02 to $132.07 whereas Kroger's share price hasn't changed much in the last five years.

Intuitions:

Apple has the highest rate of return compared to other stocks. Apple is most sensitive to changes in the market due to its high investment beta, meaning that it will perform very well in a good market, but it will also garner high losses in a bad market. Intel and Kroger have lower investment betas than Apple, so they are less sensitive to changes in the overall market. Also, the coefficient of variation is higher for Intel in comparison to Apple; this makes Apple desirable. Kroger has the lowest overall return, but has the highest CV. At the same time, its low investment beta makes it a safe choice. Such a low investment beta might prove disappointing if the market enters a period of substantial growth, as the other stocks will significantly outperform Kroger in this case.

Recommendation:

The overall risk associated with Apple's stock is the highest, however, it is negligibly higher than the other two stocks; overall risk measures for each stock are within two percentage points of one another. Apple has the lowest CV makes us recommend Apple as our most desirable option. Furthermore, Apple has the highest average return, both before and after being adjusted for compounding. With these factors in mind, we recommend investing in Apple.

Limitation:

One caveat to our recommendation is that Apple's high investment beta makes it risky in the event of a market crash. Depending on how cautious you would prefer to be with your investment, it may be desirable for you to invest in Intel instead. The tradeoff would be that Intel has a lower average return than Apple, so if the market trends positively, you will not receive as high of a return with Intel as you would with Apple. Furthermore, it is worth nothing that Kroger would be the safest investment due to its low investment beta. While you would not see immense returns from Kroger in a strong market, it would also weather a poor market better than Apple or Intel. For this reason, it may be the most appropriate investment choice for you, given your upcoming retirement.

Technical Analysis:

The data referenced in this report is monthly stock returns for the S&P 500 and three major companies: Apple, Intel, and Kroger. The dataset spans 72 months, from January 2015 to December 2020, and the source of the data is Yahoo Finance. Previous data from 1999-2004 is also referenced for the purpose of making comparisons.

Below are the Estimated Simple Linear Regression (SLR) Capital Asset Pricing Models for Apple, Intel, and Kroger respectively:

Estimated SLR Model for Apple:

```
Call:
lm(formula = PR_AAPL ~ PR_SP500, data = newas)

Residuals:
          Min            1Q        Median            3Q           Max
-22.167958989  -3.358629850  -0.643150848   4.144691515  14.286392504

Coefficients:
              Estimate  Std. Error t value   Pr(>|t|)
(Intercept) 1.498982949 0.768210941 1.95126   0.055028 .
PR_SP500    1.267978117 0.174962773 7.24713 4.4172e-10 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.37030185 on 70 degrees of freedom
Multiple R-squared:  0.428668933,       Adjusted R-squared:  0.420507061
F-statistic: 52.5209062 on 1 and 70 DF,  p-value: 4.41719355e-10
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Estimated SLR Model for Intel:

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Call:
lm(formula = PR_INTC ~ PR_SP500, data = newas)

Residuals:
          Min            1Q        Median            3Q           Max
-24.610377181  -4.570054936   0.860829207   4.211582565  17.559585323

Coefficients:
             Estimate  Std. Error t value   Pr(>|t|)
(Intercept) 0.222927032 0.771579610 0.28892    0.77349
PR_SP500    0.755605010 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: 6.39823616 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: 5.42982214e-05
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Estimated SLR Model for Kroger:

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Call:
lm(formula = PR_KR ~ PR_SP500, data = newas)

Residuals:
          Min            1Q        Median            3Q           Max
-21.670096555  -6.302491175   0.418183296   5.040647461  23.855137132

Coefficients:
              Estimate  Std. Error t value Pr(>|t|)
(Intercept) 0.130250970 0.945763820 0.13772  0.89086
PR_SP500    0.335475808 0.215401072 1.55745  0.12387

Residual standard error: 7.84263891 on 70 degrees of freedom
Multiple R-squared:  0.0334914801,      Adjusted R-squared:  0.0196842155
F-statistic: 2.42564194 on 1 and 70 DF,  p-value: 0.123874307
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Level of Significance (α) is the maximum probability of making a type I error; typical levels of significance are 0.1%, 1%, or 5%. For Apple computers and Intel, estimated beta is not statistically significantly different from 1. For Kroger, it differs from 1 at 0.1% level of significance.

Here we are calculating the T statistics and finding the p value for Investment Beta which is given as 1.

p value for Apple = 0.13012
p value for Intel = 0.1687
p value for Kroger = 0.00292

Hypothesis:

Because the overall stock market's beta is 1, testing whether each stock's estimated beta differs from 1 allows us to understand the relative sensitivity of each stock in comparison to the overall market. If we were to test whether each stock's investment beta differs from 0, we would simply be testing whether there is a linear relationship between the return of the overall market and the return on each stock. So, as we mentioned earlier stock returns for Apple Computer and Intel are not statistically significantly differing from 1, so we cannot reject the null hypothesis. And for Kroger, it differs from 1 at 0.1% level of significance, which means that we can reject the null hypothesis.

Findings based on the older data in comparison to the new data:

One notable difference between current data and that of 1999-2004 is that Apple and Intel were both very sensitive to overall market changes, with investment betas of 1.81 and 2.05, respectively. This is compared to 1.27 and 0.76, respectively, in our more recent data. This may have been partially due to the dotcom bubble around that period, where emergent technology companies were very interesting to investors due to their role in internet-related activities. Relatedly, the risk associated with each stock in the 1999-2004 period was higher than in the current period. This might be explained by a more volatile market during that time.

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