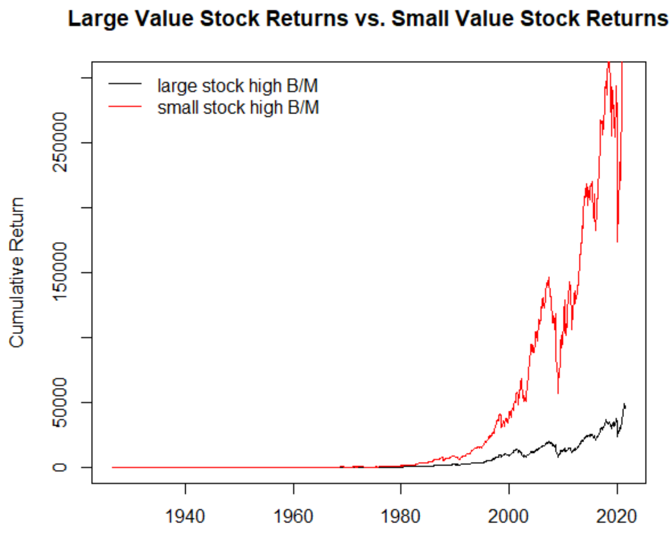
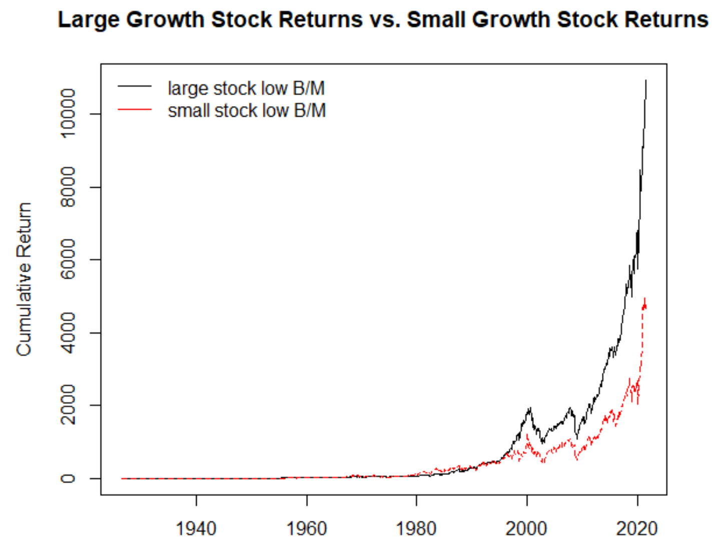
Investments Mini Project 1

QUESTION 1

Graph A shows that small value stocks outperform large value stocks in the long run in the US market. In addition, a comparison between graph A and graph B reveals that value stocks outperform growth stocks in both small and large firm capitalization-size categories. Consistent with these findings, we see that small value stocks in in US stock market have earned the highest historical returns of the four types of stock in this study.



Graph A



Graph B

Our analysis is consistent with research conducted by well respected financial analysts, dating back to the mid-to-late 1900s. Fama and French (1992) suggested that value stocks may be riskier and therefore require superior returns to compensate investors for bearing such additional risk. Other theorists, such as Kahneman and Tversky (1982) suggest that the discrepancy between value and growth stock returns is the result of forecasting error by institutional investors and security research analysts. He believes that they place too much weight on recent information relative to old data when conducting stock valuations. Growth stocks are characterized as having very high recent EPS growth rates and therefore people expect future performance of these stocks to continue in a sharp upward trajectory and therefore investment research analysts systematically overestimate the future EPS of growth stocks compared to value stocks. Thus in subsequent periods, actual EPS growth rates for growth stocks are disappointingly lower than expected and high returns associated with growth stocks tend to subsequently decline. On the contrary, their findings show that low growth rates associated with value stocks tend to increase.

Reference:

Bauman, W. S., C. Mitchell Conover, & Miller, R. E. (1998). Growth versus Value and Large-Cap versus Small-Cap Stocks in International Markets. *Financial Analysts Journal, 54*(2), 75–89. http://www.jstor.org/stable/4480069

Hypothesis testing with a significance level of 5% (95% confidence).

a) Comparison of small vs. large value stocks
- H0: on average, small value stock returns are equal to large value stock returns
- H1: on average, small value stock returns are not equal to large value stock returns.
- Because the p-value of 0.008564 for this paired t-test is much smaller than our significance threshold of 0.05, our results are statistically significant. This means that we have enough evidence against the null hypothesis to conclude the alternative hypothesis that on average, small value stock returns are not equal to large value stock returns. We can therefore say that small value stocks do in fact outperform large value stock in the US stock market.

b) Comparison of small vs. large growth stocks
   - H0: on average, small growth stock returns are equal to large growth stock returns
   - H1: on average, small growth stock returns are not equal to large growth stock returns
   - Because the p-value of 0.6150 for this paired t-test is larger than our significance threshold of 0.05, we do not have enough evidence against the null hypothesis. We therefore fail to reject the null hypothesis that small growth stock returns are equal to large growth stock returns on average.

c) Comparison of small value stocks vs. small growth stocks
   - H0: on average, small value stock returns are equal to small growth stock returns
   - H1: on average, small value stock returns are not equal to small growth stock returns
   - Because the p-value of 0.00009365 for this paired t-test is much smaller than our significance threshold of 0.05, our results are statistically significant. This means that we have enough evidence against the null hypothesis to conclude the alternative hypothesis that small value stock returns are not equal to small growth stock returns. Therefore our findings presented by the graphs that small value stocks significantly outperform small growth stocks in the long run are valuable.

d) Comparison of large value stocks vs. large growth stocks
   - H0: on average, large value stock returns are equal to large growth stock returns
   - H1: on average, large value stock returns are not equal to large growth stock returns
   - Because the p-value of 0.05105 for this paired t-test is larger than our significance threshold of 0.05, we do not have enough evidence against the null hypothesis. We therefore fail to reject the null hypothesis that large value stock returns are equal to large growth stock returns on average. It is important to note that because the p-value

is so close to the significance threshold, there is a higher change of committing a type I error in our conclusion.

QUESTION B

When the geometric mean is considered, it makes it more expensive for a portfolio's returns to have a larger standard deviation. The geometric mean describes the past performance of the returns more precisely than arithmetic means since it takes into account the effect of compounding. Geometric mean is more relevant when numbers in the series are not independent of each other or if numbers tend to make large fluctuations. Stock returns meet both of these criteria and thus geometric mean is more accurate for this study.

Geometric Mean = Arithmetic Mean- 0.5*sd^2

When looking at the approximate geometric mean formula, we notice that there is an inverse relationship between geometric returns and the standard deviation (risk) of a stock. Because the geometric mean is an inverse function of the standard deviation squared, the fluctuation in geometric returns is more pronounced for each unit change in the standard deviation of a stock return. Therefore, it is more costly to have portfolios with high standard deviations because their returns are more susceptible to greater losses as the market exhibits negative impacts. Stated differently, these portfolios experience greater losses when market conditions are poor because incremental losses accumulate more rapidly over time due to the effects of compounding. In effect, overall costs increase at a faster rate than returns (profits) since we square the standard deviation.

QUESTION C

APPENDIX: R SCRIPT

```
rm(list = ls())

## Question 1 ##
## "Adapt the code to plot large value stocks versus small value stocks (â€ œValue Stocksâ€ • )
and large growth stocks versus small growth stocks (â€ œGrowth Stocksâ€ • )"

setwd("~/Quants MSBC 5031/Data")
ff = read.table("french_6portfolios.txt")
names(ff) = c("DATE","S.L", "S.M", "S.H", "B.L", "B.M", "B.H")

ff$DATE <- as.character(ff$DATE)
ff$DATE <- paste(ff$DATE, "01", sep = "")

##this function computes gross returns, given percentage returns as an input##
gross_ret = function(vec){
  gross_ret = 1+(vec/100)
  return(gross_ret)
}
## Defining Variables for Gross Returns ##
ff$big_low = gross_ret(ff$B.L) #This is the large growth stock
ff$big_mid = gross_ret(ff$B.M)
ff$big_hi = gross_ret(ff$B.H) #This is the large value stock

ff$sm_low = gross_ret(ff$S.L) #This is the small growth stock
ff$sm_mid = gross_ret(ff$S.M)
ff$sm_hi = gross_ret(ff$S.H) #This is the small value stock
```

```
## Reformatting the DATE variable as a date object ##
ff$DATE = as.Date(ff$DATE, format="%Y%m%d")

## Plotting historical returns ##
## Note: cumulative return is (1+r1)*(1+r2)*...*(1+rt), computed using cumprod(gross_return)

## Illustrating geomean calculation ##
plot(ff$DATE, cumprod(ff$big_hi), type="l", main="Large Firm Returns", sub="Black is high B/M, Blue is low B/M", xlab="Date", ylab="Cumulative Return")

gm_mean = function(a){prod(a)^(1/length(a))}

big_hi_gm = gm_mean(ff$big_hi)
ff$big_hi_gm = big_hi_gm
lines(ff$DATE, cumprod(ff$big_hi_gm), lty="dashed")

## Contrasting the historical returns from four types of portfolios ##
par(mfrow=c(1,2))
plot(ff$DATE, cumprod(ff$big_hi), type="l", main="Large Firm Returns", sub="Black is high B/M, Blue is low B/M", xlab="Date", ylab="Cumulative Return")
lines(ff$DATE, cumprod(ff$big_low), col="blue")

plot(ff$DATE, cumprod(ff$sm_hi), type="l", main="Small Firm Returns", sub="Black is high B/M, Blue is low B/M", xlab="Date", ylab="Cumulative Return")
lines(ff$DATE, cumprod(ff$sm_low), col="blue", lty="dashed")

#Question 1

par(mfrow = c(1,2))
```

```
plot(ff$DATE, cumprod(ff$big_hi), type="l", main="Large Value Stock Returns vs. Small Value Stock Returns", ylim = range(0,300000), xlab="Date", ylab="Cumulative Return")

lines(ff$DATE, cumprod(ff$sm_hi), col="red")

legend("topleft", legend = c("large stock high B/M", "small stock high B/M"), col=c("black","red"),
    lty=c("solid","solid"), bty="n")


plot(ff$DATE, cumprod(ff$big_low), type="l", main="Large Growth Stock Returns vs. Small Growth Stock Returns", xlab="Date", ylab="Cumulative Return")

lines(ff$DATE, cumprod(ff$sm_low), col="red", lty="dashed")

legend("topleft", legend = c("large stock low B/M", "small stock low B/M"), col=c("black","red"),
    lty=c("solid","solid"), bty="n")


## Question 2 ##

## Compare Geometric Mean to Arithmetic Mean for each of the four return series


## 2a.

## Compute the arithmetic mean of the returns for each of the four portfolios (express your answer in decimal form rather than percentages).


arith_mean_Big_hi <- mean(ff$big_hi)

arith_mean_Big_low <- mean(ff$big_low)


arith_mean_Sm_hi <- mean(ff$sm_hi)

arith_mean_Sm_low <- mean(ff$sm_low)


arith_mean_Big_hi

arith_mean_Big_low
```

```
arith_mean_Sm_hi
arith_mean_Sm_low

## 2b.
## Compute the standard deviation of the returns.

sd_Big_hi <- sd(ff$big_hi)
sd_Big_low <- sd(ff$big_low)

sd_Sm_hi <- sd(ff$sm_hi)
sd_Sm_low <- sd(ff$sm_low)

sd_Big_hi
sd_Big_low
sd_Sm_hi
sd_Sm_low

## 2c.
## Compute the geometric mean of the gross returns

geomean_big_hi <- prod(ff$big_hi, na.rm = TRUE)^(1/1141)
geomean_big_low <- prod(ff$big_low, na.rm = TRUE)^(1/1141)

geomean_sm_hi <- prod(ff$sm_hi, na.rm = TRUE)^(1/1141)
geomean_sm_low <- prod(ff$sm_low, na.rm = TRUE)^(1/1141)

geomean_big_hi
geomean_big_low
```

```r
geomean_sm_hi
geomean_sm_low

## 2d.
## Compute the approximate geometric mean.

approx_geo_mean_big_hi <- (arith_mean_Big_hi- 0.5*sd_Big_hi^2)
approx_geo_mean_big_low <- (arith_mean_Big_low- 0.5*sd_Big_low^2)

approx_geo_mean_sm_hi <- (arith_mean_Sm_hi- 0.5*sd_Sm_hi^2)
approx_geo_mean_sm_low <- (arith_mean_Sm_low- 0.5*sd_Sm_low^2)

approx_geo_mean_big_hi
approx_geo_mean_big_low
approx_geo_mean_sm_hi
approx_geo_mean_sm_low

## Deliverables

#A
## In order to determine whether these differences are statistically significant, we can perform a t.test.
##Do small stocks tend to outperform large stocks
#comparison of small vs. large value stocks
t.test(ff$sm_hi,ff$big_hi, paired = TRUE)
#Comparison of small vs. large growth stocks
t.test(ff$sm_low,ff$big_low, paired = TRUE)

#comparison of small value stocks vs. small growth stocks
```

```
t.test(ff$sm_hi,ff$sm_low, paired = TRUE)

#comparison of large value stocks vs. large growth stocks
t.test(ff$big_hi,ff$big_low, paired = TRUE)
```