British American Tobacco p.l.c (BTI)

Harold Choi

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Importing data

```
BTI <- getSymbols("BTI", src="yahoo",auto.assign=FALSE)
```

```
summary(BTI)
```

```
##      Index              BTI.Open        BTI.High        BTI.Low
##  Min.   :2007-01-03   Min.   :22.27   Min.   :22.30   Min.   :21.63
##  1st Qu.:2010-06-17   1st Qu.:35.20   1st Qu.:35.49   1st Qu.:34.94
##  Median :2013-12-02   Median :45.84   Median :46.21   Median :45.52
##  Mean   :2013-12-01   Mean   :45.81   Mean   :46.11   Mean   :45.51
##  3rd Qu.:2017-05-17   3rd Qu.:55.40   3rd Qu.:55.64   3rd Qu.:55.02
##  Max.   :2020-10-30   Max.   :72.91   Max.   :73.41   Max.   :72.75
##    BTI.Close       BTI.Volume         BTI.Adjusted
##  Min.   :21.95   Min.   :    54400   Min.   : 9.106
##  1st Qu.:35.27   1st Qu.:   286700   1st Qu.:15.818
##  Median :45.87   Median :   498400   Median :32.168
##  Mean   :45.82   Mean   :  1069879   Mean   :30.295
##  3rd Qu.:55.34   3rd Qu.:  1286200   3rd Qu.:39.873
##  Max.   :73.28   Max.   :104557100   Max.   :59.586
```

```
str(BTI)
```

```
## An 'xts' object on 2007-01-03/2020-10-30 containing:
##   Data: num [1:3483, 1:6] 29 28.7 28.1 28 28.5 ...
##  - attr(*, "dimnames")=List of 2
##   ..$ : NULL
##   ..$ : chr [1:6] "BTI.Open" "BTI.High" "BTI.Low" "BTI.Close" ...
##   Indexed by objects of class: [Date] TZ: UTC
##   xts Attributes:
## List of 2
##  $ src    : chr "yahoo"
##  $ updated: POSIXct[1:1], format: "2020-11-02 01:24:34"
```

```
head(BTI)
```

```
##            BTI.Open BTI.High BTI.Low BTI.Close BTI.Volume BTI.Adjusted
```

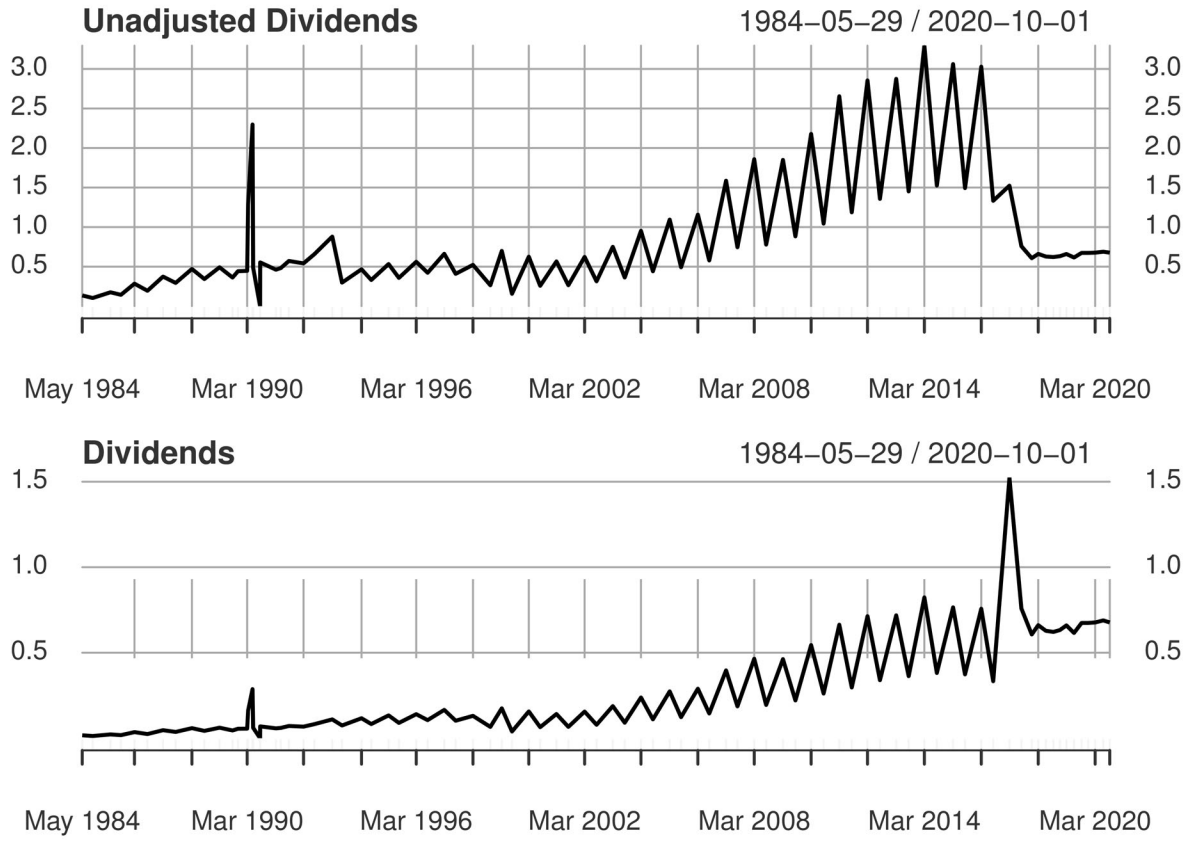
```
## 2007-01-03   29.025   29.085  28.700    28.850     157200     9.756710
## 2007-01-04   28.715   28.750  28.450    28.555     197400     9.656945
## 2007-01-05   28.075   28.145  27.900    28.075     200800     9.494616
## 2007-01-08   28.015   28.150  27.840    28.035     116600     9.481087
## 2007-01-09   28.450   28.620  28.360    28.385     131200     9.599451
## 2007-01-10   29.095   29.295  28.775    28.910     192200     9.777004
```

```
tail(BTI)
```

```
##            BTI.Open BTI.High BTI.Low BTI.Close BTI.Volume BTI.Adjusted
## 2020-10-23    33.89    33.97   33.50     33.64    1359600        33.64
## 2020-10-26    33.90    33.90   33.49     33.69    1456300        33.69
## 2020-10-27    33.25    33.28   32.69     32.69    1917600        32.69
## 2020-10-28    32.12    32.14   31.68     31.83    2941800        31.83
## 2020-10-29    31.83    32.49   31.64     32.31    4161600        32.31
## 2020-10-30    31.92    32.00   31.60     31.88    2411800        31.88
```

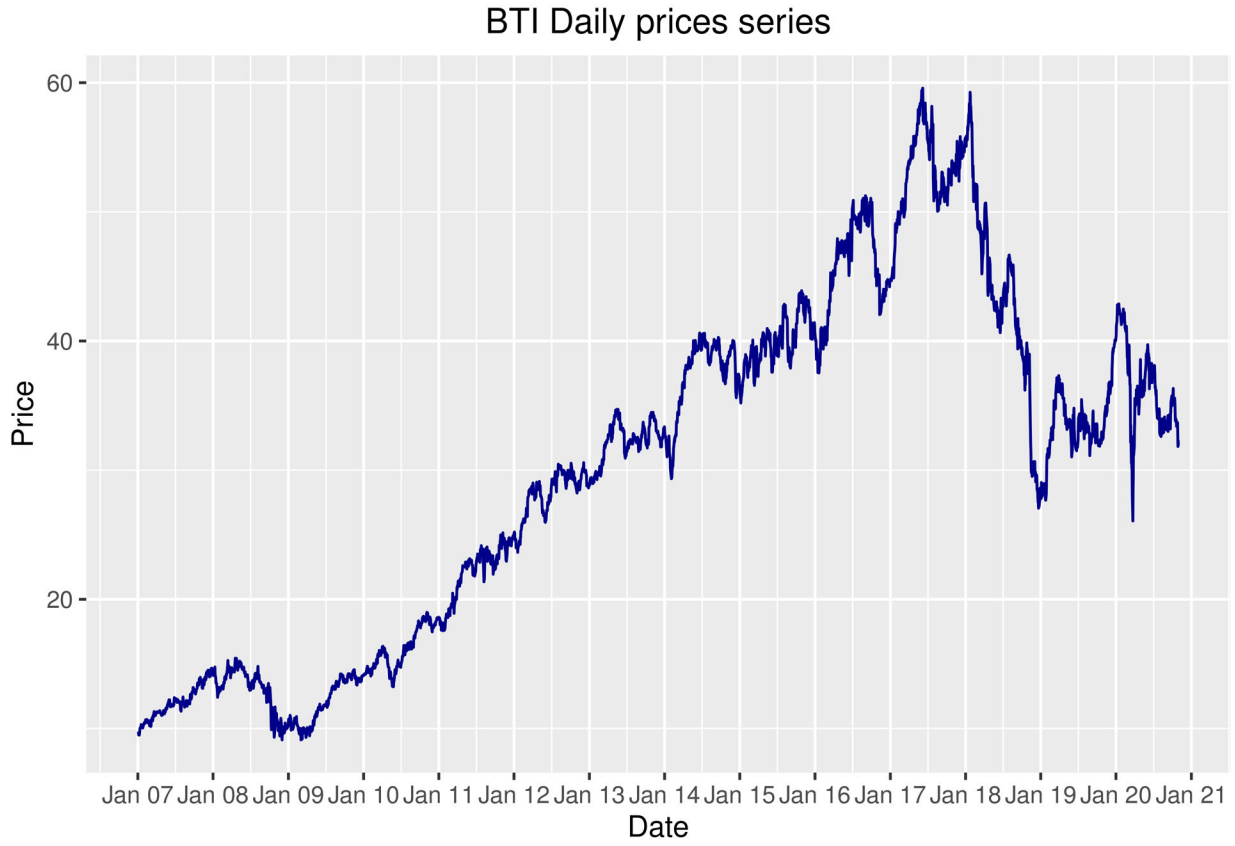
Dividends

```
par(mfrow=c(2,1))
plot(raw_dividends, main="Unadjusted Dividends")
plot(dividends, main="Dividends")
```

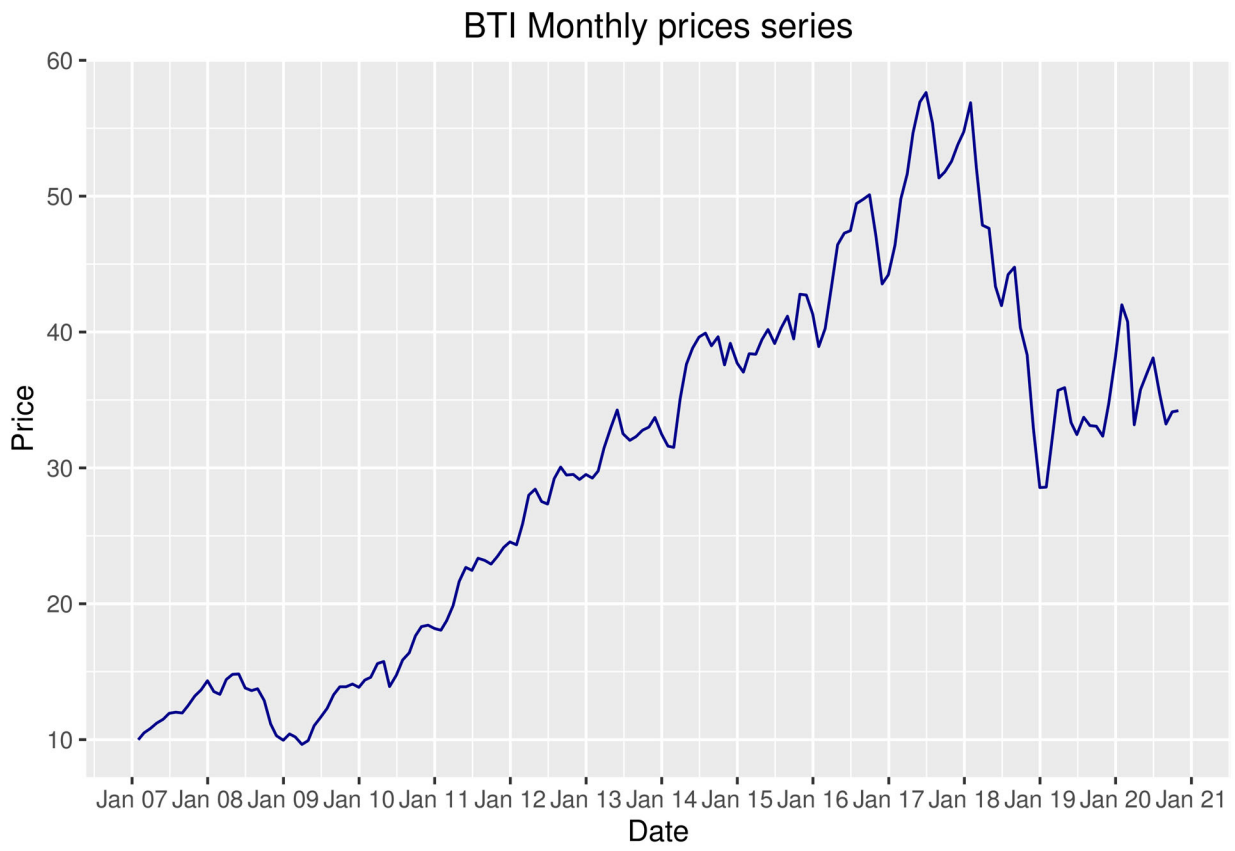


Plotting returns

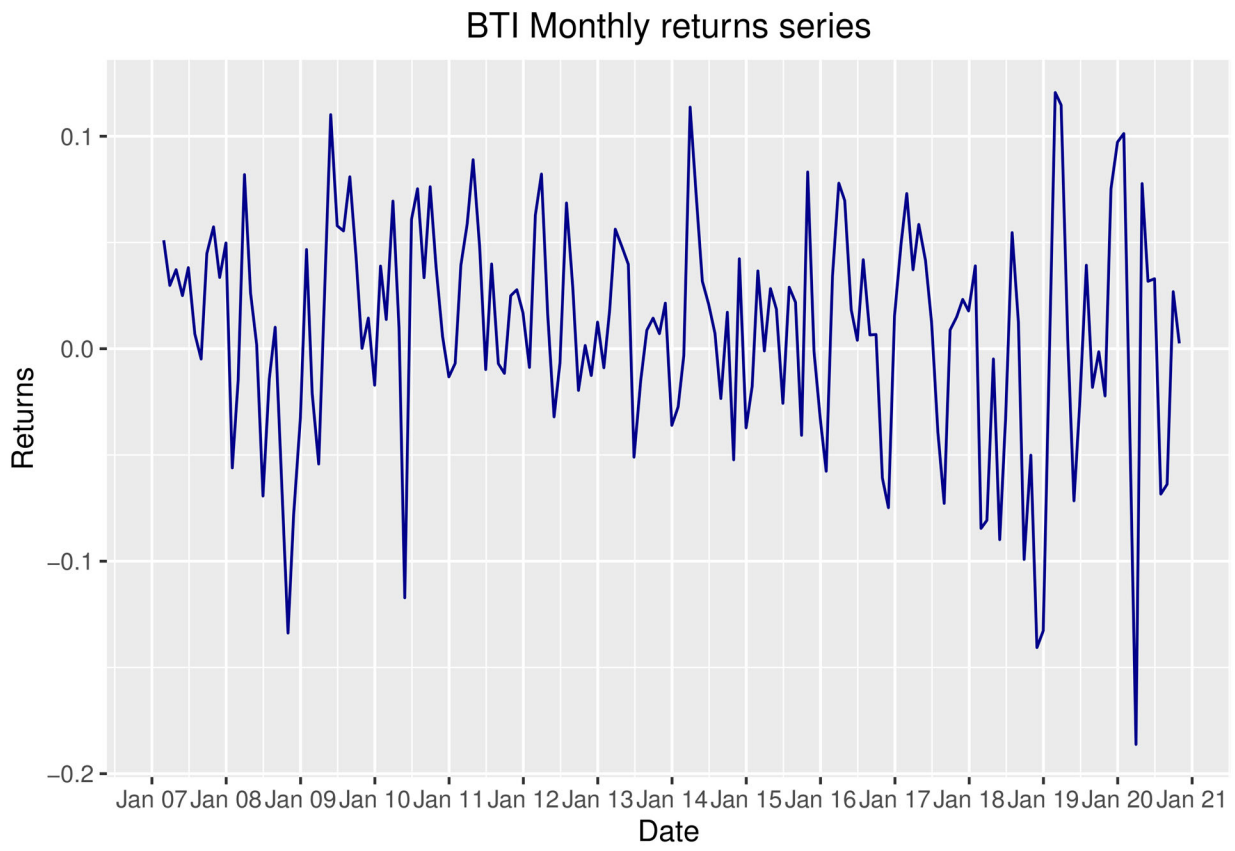
```
ggplot(BTI, aes(y = BTI$BTI.Adjusted, x = index(BTI))) +
  geom_line(color = "darkblue") +
  ggtitle("BTI Daily prices series") +
  xlab("Date") + ylab("Price") +
  theme(plot.title = element_text(hjust = 0.5)) +
  scale_x_date(date_labels = "%b %y", date_breaks = "1 year")
```



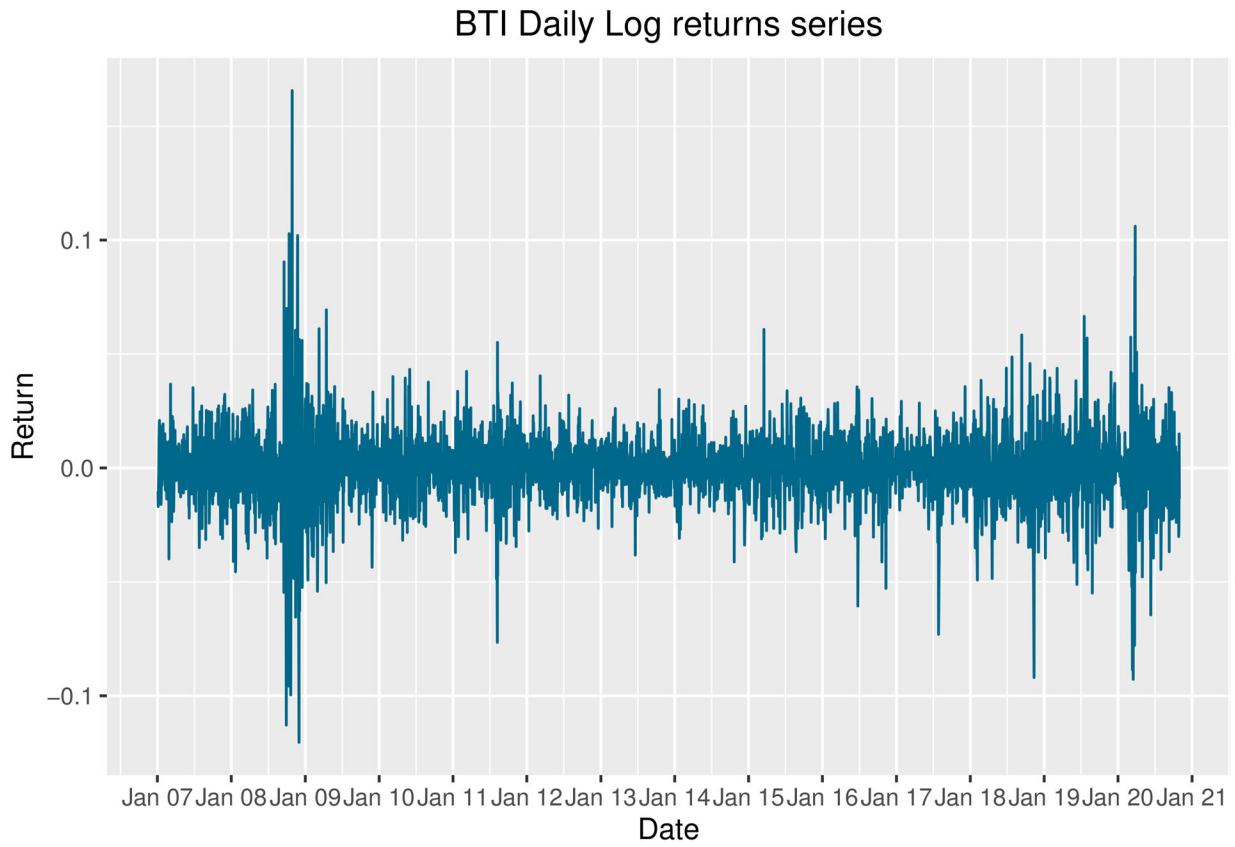

```
ggplot(BTI1, aes(y = BTI1$BTI.Adjusted, x = index(BTI1))) +
  geom_line(color = "darkblue") +
  ggtitle("BTI Monthly prices series") +
  xlab("Date") + ylab("Price") +
  theme(plot.title = element_text(hjust = 0.5)) +
  scale_x_date(date_labels = "%b %y", date_breaks = "1 year")
```




```
ggplot(BTI1_return_discrete, aes(y = BTI1_return_discrete$BTI.Adjusted, x = index(BTI1_return_discrete))
  geom_line(color = "darkblue") +
  ggtitle("BTI Monthly returns series") +
  xlab("Date") + ylab("Returns") +
  theme(plot.title = element_text(hjust = 0.5)) +
  scale_x_date(date_labels = "%b %y", date_breaks = "1 year")
```



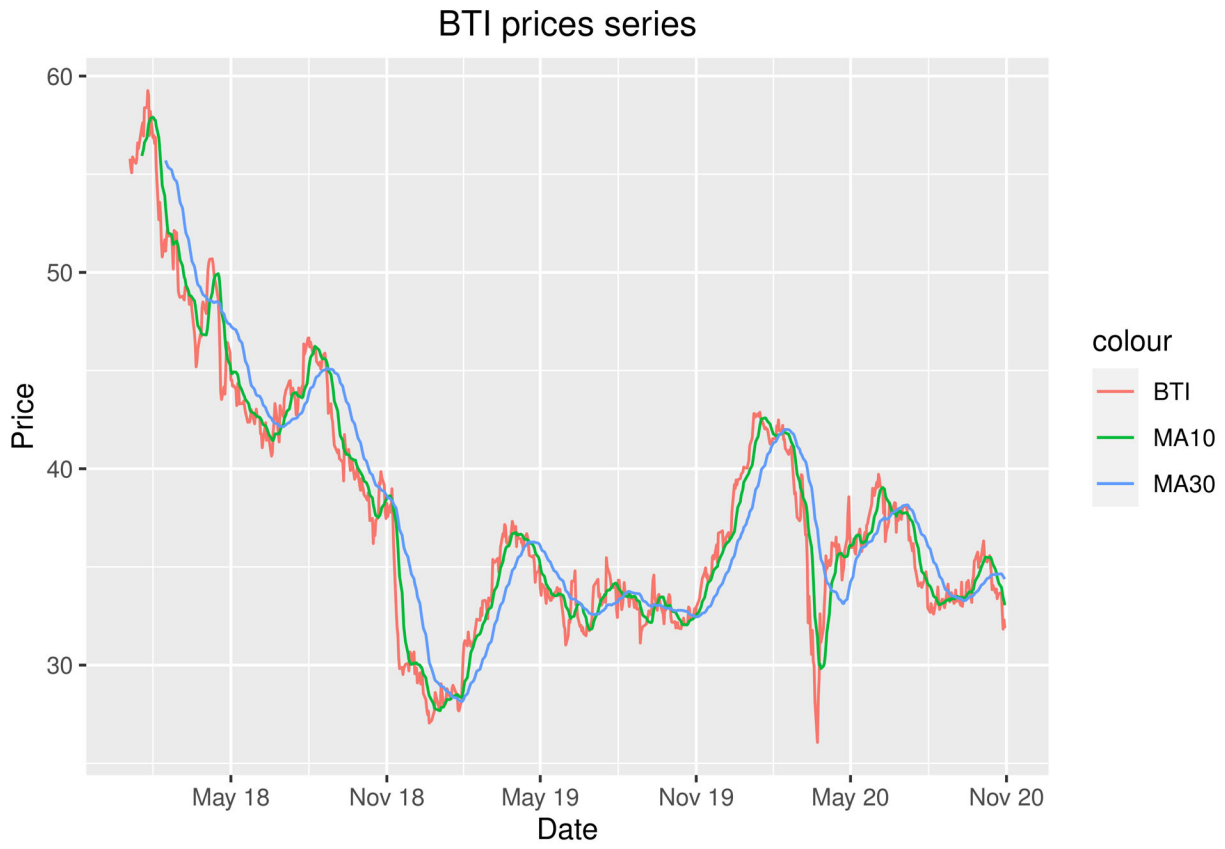

```
ggplot(BTI_adj_ret, aes(x = index(BTI_adj_ret), y = BTI_adj_ret)) +
  geom_line(color = "deepskyblue4") +
  ggtitle("BTI Daily Log returns series") +
  xlab("Date") + ylab("Return") +
  theme(plot.title = element_text(hjust = 0.5)) + scale_x_date(date_labels = "%b %y", date_breaks = "1 y
```



Moving average

- British American Tobacco stock price is extracted from 2018-01-02 and the moving average is calculated for the stock price using a 10 and 30 day moving average.
- The moving average is important to understand the BTI's stock technical charts. It smoothes out daily price fluctuations by averaging stock prices and is effective in identifying potential trends.

```
ggplot(bti_mm, aes(x = index(bti_mm))) +
  geom_line(aes(y = bti_mm[,6], color = "BTI")) + ggtitle("BTI prices series") +
  geom_line(aes(y = mm10, color = "MA10")) +
  geom_line(aes(y = mm30, color = "MA30")) + xlab("Date") + ylab("Price") +
  theme(plot.title = element_text(hjust = 0.5), panel.border = element_blank()) +
  scale_x_date(date_labels = "%b %y", date_breaks = "6 months")
```



Skewness and Kurtosis

- Skewness and kurtosis provides judgement in terms of extremes of BTI's stock price rather than focusing solely on the average.
- The adjusted price of BTI is 0.05, therefore the distribution is approximately symmetric and there is very few instances of heavy tails in gains and losses.
- However, the Open and close price are moderately skewed at 0.080 for both measures.
- Kurtosis for BTI is in the acceptable range of between -3 and 3. Therefore BTI's stock price has less outliers in the the daily movement.

```
skewness(BTI) # measure of asymmetry, normal is 0
```

```
##            BTI.Open   BTI.High    BTI.Low  BTI.Close BTI.Volume BTI.Adjusted
## Skewness 0.08041182 0.08664444 0.07538672 0.08093544   26.05146   0.04973667
```

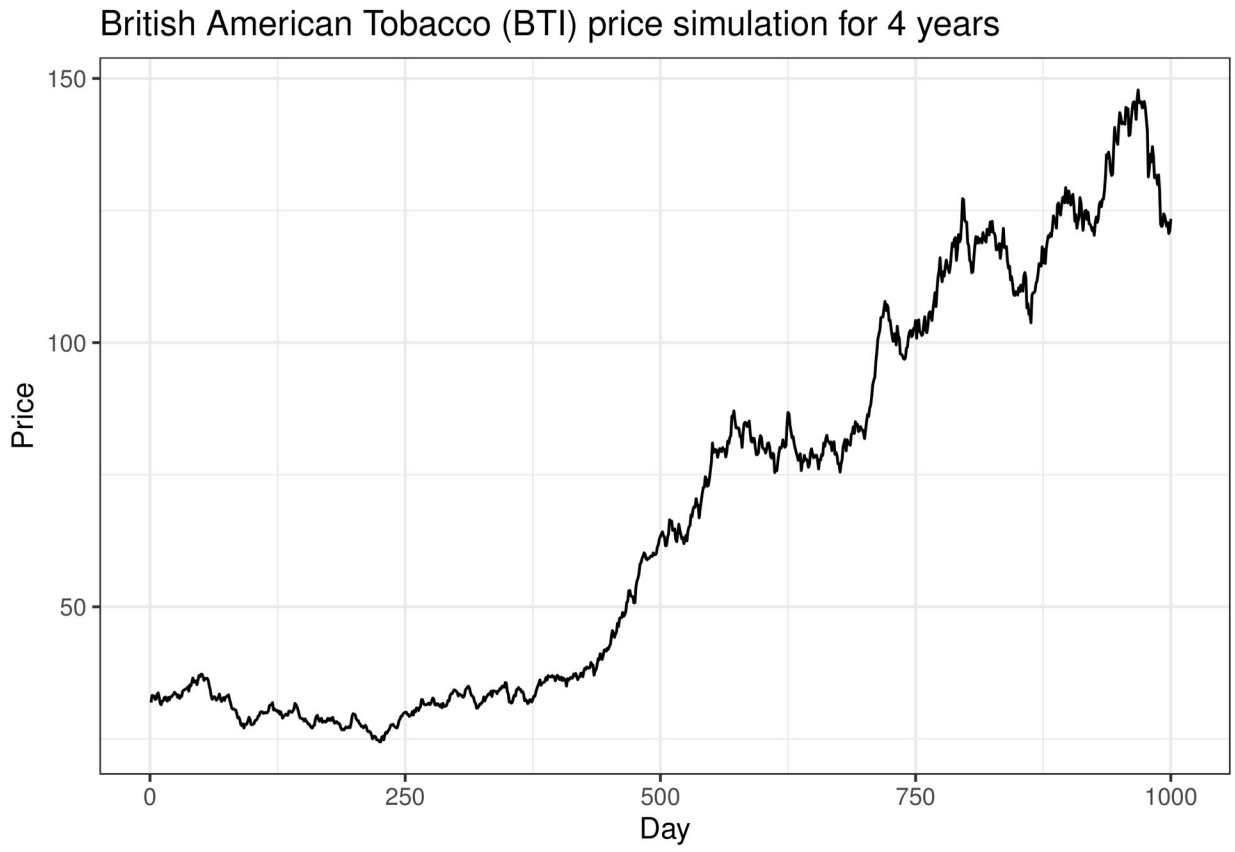
```
kurtosis(BTI) # measure of heavy tailedness, normal is 3
```

```
##                  BTI.Open  BTI.High   BTI.Low BTI.Close BTI.Volume BTI.Adjusted
## Excess Kurtosis -1.116229 -1.117913 -1.116442 -1.117803   1029.213    -1.063751
```

Random walk

- The log returns of British American Tobacco's stock is the fundamental for the random walk model.

```r
BTI_log_returns <- BTI %>% Ad() %>% dailyReturn(type='log')
BTI_mean_log <- mean(BTI_log_returns)
BTI_sd_log <- sd(BTI_log_returns)


# Random walk
mu <- BTI_mean_log
sig <- BTI_sd_log
testsim<-rep(NA,1000)

price<-rep(NA,252*4)
price[1]<-as.numeric(BTI$BTI.Adjusted[length(BTI$BTI.Adjusted),])

for(i in 2:length(testsim)){
  price[i]<-price[i-1]*exp(rnorm(1,mu,sig))
}

random_data<-cbind(price,1:(252*4))
colnames(random_data)<-c("Price","Day")
random_data<-as.data.frame(random_data)

random_data%>%ggplot(aes(Day,Price))+
  geom_line()+
  labs(title="British American Tobacco (BTI) price simulation for 4 years")+
  theme_bw()
```

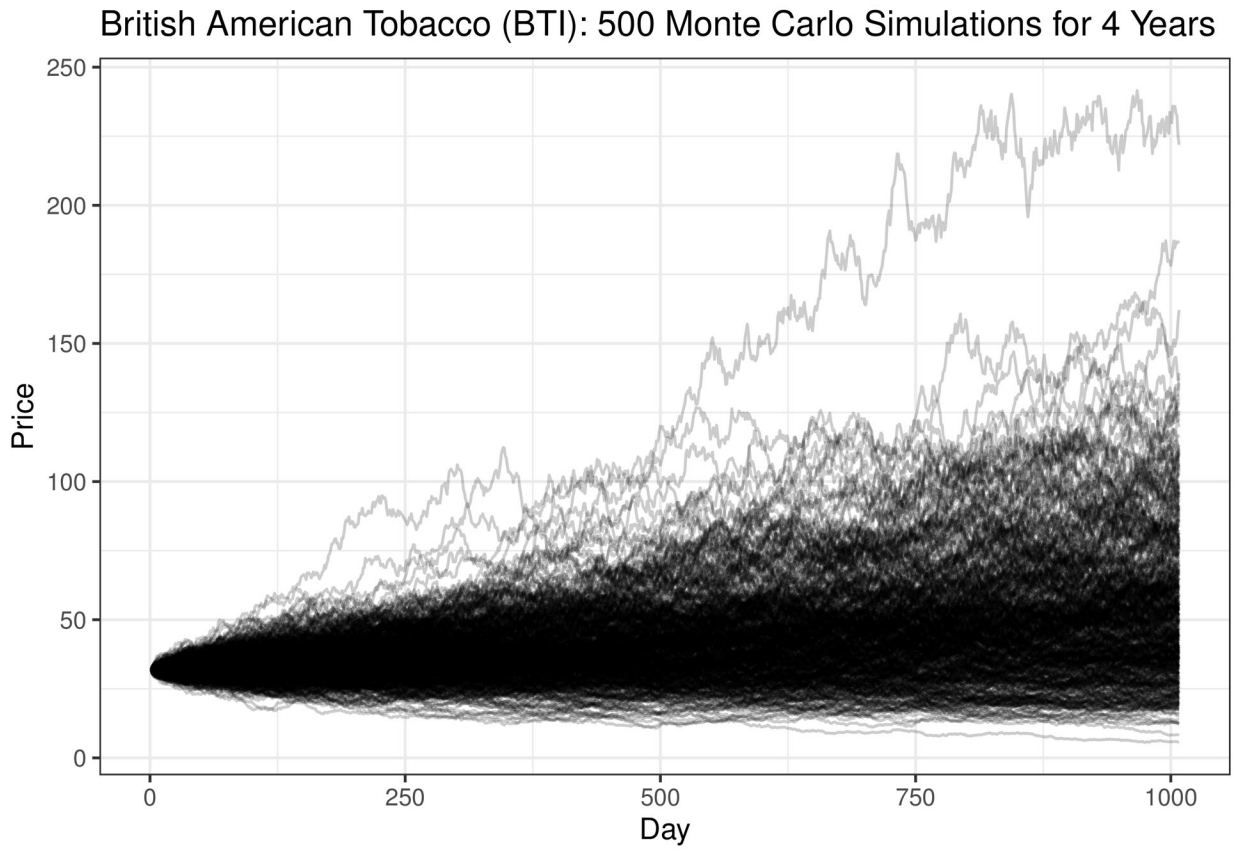


Monte Carlo Simulation

```
N<-500
mc_matrix<-matrix(nrow=252*4,ncol=N)
mc_matrix[1,1]<-as.numeric(BTI$BTI.Adjusted[length(BTI$BTI.Adjusted),])

for(j in 1:ncol(mc_matrix)){
  mc_matrix[1,j]<-as.numeric(BTI$BTI.Adjusted[length(BTI$BTI.Adjusted),])
  for(i in 2:nrow(mc_matrix)){
    mc_matrix[i,j]<-mc_matrix[i-1,j]*exp(rnorm(1,mu,sig))
  }
}

name<-str_c("Sim ",seq(1,500))
name<-c("Day",name)

final_mat<-cbind(1:(252*4),mc_matrix)
final_mat<-as.tibble(final_mat)
colnames(final_mat)<-name

dim(final_mat) #1008 501
```

```
## [1] 1008  501
```

```
final_mat%>%gather("Simulation","Price",2:501)%>%ggplot(aes(x=Day,y=Price,Group=Simulation))+geom_line(a
```



- Given the result of the simulation, British American Tobacco stock may reach the price of 93.30 in four years time or crash to a 17.02 low.

```
probs<-c(0.005,0.025,0.25,0.5,0.75,0.975,0.995)

final_mat[500,-1]%>%as.numeric()%>%quantile(probs=probs)
```

```
##     0.5%     2.5%      25%      50%      75%    97.5%    99.5%
## 13.49989 18.63160 30.65191 39.53096 49.76558 76.23621 96.95079
```