Distance to Default Analysis

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In this part, I apply Merton's technique for estimating distance-to-default (DD) as well as probability of default (using normal CDF) for a given company.

First I create a Merton function to calculate the distance-to-default.

```
warning=FALSE
library('quantmod')
```

```
## Warning: package 'quantmod' was built under R version 4.3.2

## Loading required package: xts

## Warning: package 'xts' was built under R version 4.3.3

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

## Loading required package: TTR

## Warning: package 'TTR' was built under R version 4.3.3

## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
Merton<-function(par,E0,sigmaE,r,T,D,lower,upper)
{
  #function to be minimized
  F2plusG2<-function(par,E0,sigmaE,r,T,D)
  {
    A0<-par[1]
    sigmaA<-par[2]

    d1<-(log(A0/D)+(r+sigmaA^2/2)*T)/(sigmaA*sqrt(T))
    d2<-d1-sigmaA*sqrt(T)

    return((E0-A0*pnorm(d1)+exp(-r*T)*D*pnorm(d2))^2
           +(sigmaE*E0-pnorm(d1)*sigmaA*A0)^2)
  }
  # par contains initial values
  result<-optim(par=par, fn=F2plusG2, gr = NULL,
                E0=E0, sigmaE=sigmaE, r=r, T=T, D=D,
```

```
                 method= "L-BFGS-B", lower=lower, upper=upper)
  return(result)
}
```

Then, I find the relevant data for ABDE from the Finance dataset.

```
mystart<-'2023-01-31'
myend<-'2024-02-01'#to get data that ends on the last day of January
myticker<-'ADBE'

stockdata<-getSymbols(Symbols=myticker,
                      from=mystart,to=myend,auto.assign = FALSE)

head(stockdata)
```

```
##            ADBE.Open ADBE.High ADBE.Low ADBE.Close ADBE.Volume ADBE.Adjusted
## 2023-01-31    364.71    370.70   364.01     370.34     2572400        370.34
## 2023-02-01    370.01    386.72   366.80     383.92     3362000        383.92
## 2023-02-02    393.28    402.49   388.88     392.23     4020000        392.23
## 2023-02-03    384.29    386.72   377.92     379.33     2695400        379.33
## 2023-02-06    376.21    379.29   373.39     375.23     2369600        375.23
## 2023-02-07    373.43    384.94   372.76     383.82     2476200        383.82
```

Here I find out the annual stock volatility.

```
sigmaE<-sd(diff(log(stockdata[,6])),na.rm=TRUE)*sqrt(252)
sigmaE<-round(x=sigmaE,digits=2)
sigmaE
```

```
## [1] 0.32
```

Relevant data extracted from WRDS.

```
shortterm<-314+73

longterm<-4007

D<-shortterm+0.5*longterm
D
```

```
## [1] 2390.5
```

```
shares<-455

P0<-as.numeric(tail(stockdata[,6],1))
E0<-round(P0*shares,2)
P0
```

```
## [1] 617.78
```

I get the risk free rate from FRED's pre-installed library.

```
T<-1
myrate<-getSymbols(Symbols='DGS3MO',src='FRED',auto.assign = FALSE)
myrate[time(myrate) =='2024-01-31']
```

```
##            DGS3MO
## 2024-01-31   5.42
```

```
rfree<-5.42*0.01
rfree
```

```
## [1] 0.0542
```

Now, I estimate the initial value of Assets and initial asset volatility.

```
A0ini<-E0+D; sigmaAini<-0.1
myresult<-Merton(par=c(A0ini,sigmaAini),E0=E0,sigmaE=sigmaE,
                 r=rfree,T=T,D=D,
                 lower=c(A0ini*0.001,0.001),
                 upper=c(A0ini*10,4))
myresult
```

```
## $par
## [1] 2.833543e+05 3.174428e-01
##
## $value
## [1] 1.101143e-20
##
## $counts
## function gradient
##       20       20
##
## $convergence
## [1] 0
##
## $message
## [1] "CONVERGENCE: REL_REDUCTION_OF_F <= FACTR*EPSMCH"
```

```
A0<-round(x=myresult$par[1],digits=2)
sigmaA<-round(x=myresult$par[2],digits=2)
A0
```

```
## [1] 283354.3
```

```
sigmaA
```

```
## [1] 0.32
```

Now, I calculate the distance to default and the probability of distance to default.

```
d1<-(log(A0/D)+(rfree+sigmaA^2/2)*T)/(sigmaA*sqrt(T))
d2<-round(d1-sigmaA*sqrt(T),2)
prob<-pnorm(-d2)
d2
```

```
## [1] 14.93
```

```
prob
```

```
## [1] 1.051331e-50
```

Hence, I conclude that this company is safe with a negligible distance to default.