HW 5

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Monte Carlo Simulation

Parameters set-up

```
t<-0.5
mu_a<-0.15
sigma_a<-0.20
mu_b<-0.12
sigma_b<-0.18
S_a_0<-100
S_b_0<-75
n_a<-100
n_b<-100
```

functions set-up

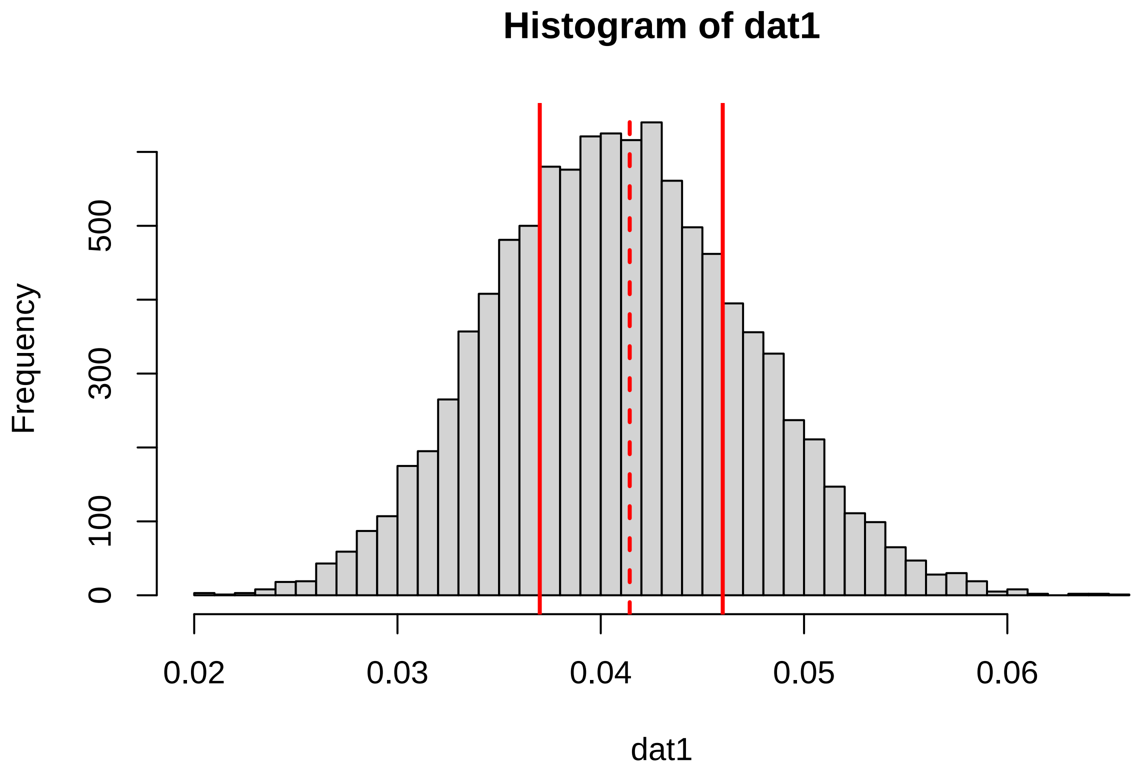
```
##stock prices function under Geometric Brownian Motion
S_t_GBM<- function(s_0, mu, sigma ,t){
  s_t<-s_0*exp((mu-sigma**2/2)*t+sigma*rnorm(1, 0, sqrt(t)))

  return(s_t)
}

##wealth function
wealth_f<-function(n_a, mu_a, sigma_a, S_a_0, n_b, mu_b, sigma_b, S_b_0, t){
  wealth_t<-n_a*S_t_GBM(S_a_0, mu_a, sigma_a,t)+n_b*S_t_GBM(S_b_0, mu_b, sigma_b,t)

  return(wealth_t)
}

##characteristic function
Il<-function(w0, wt){
  if(wt/w0<=0.9){
    return (1)
  }
  else{
    return (0)
  }
}

##single probability generation function
Pf<-function(w0, N, t=0.5){
```

```
  Il_v<-rep(NA, N)
  wt<-rep(NA, N)
  for(i in 1:N){
    wt[i]<-wealth_f(n_a, mu_a, sigma_a, S_a_0, n_b, mu_b, sigma_b, S_b_0, t)
    Il_v[i]<-Il(w0, wt[i])

  }

  Prob<-sum(Il_v)/N
  return(Prob)
}

##simulation generation
mymc1<-function(n, w0, N, t=0.5){
  mc_ps<-rep(NA, n)
  for(i in 1:n){
    mc_ps[i]<-Pf(w0, N, t)
  }
  return(mc_ps)
}
```

Simulations

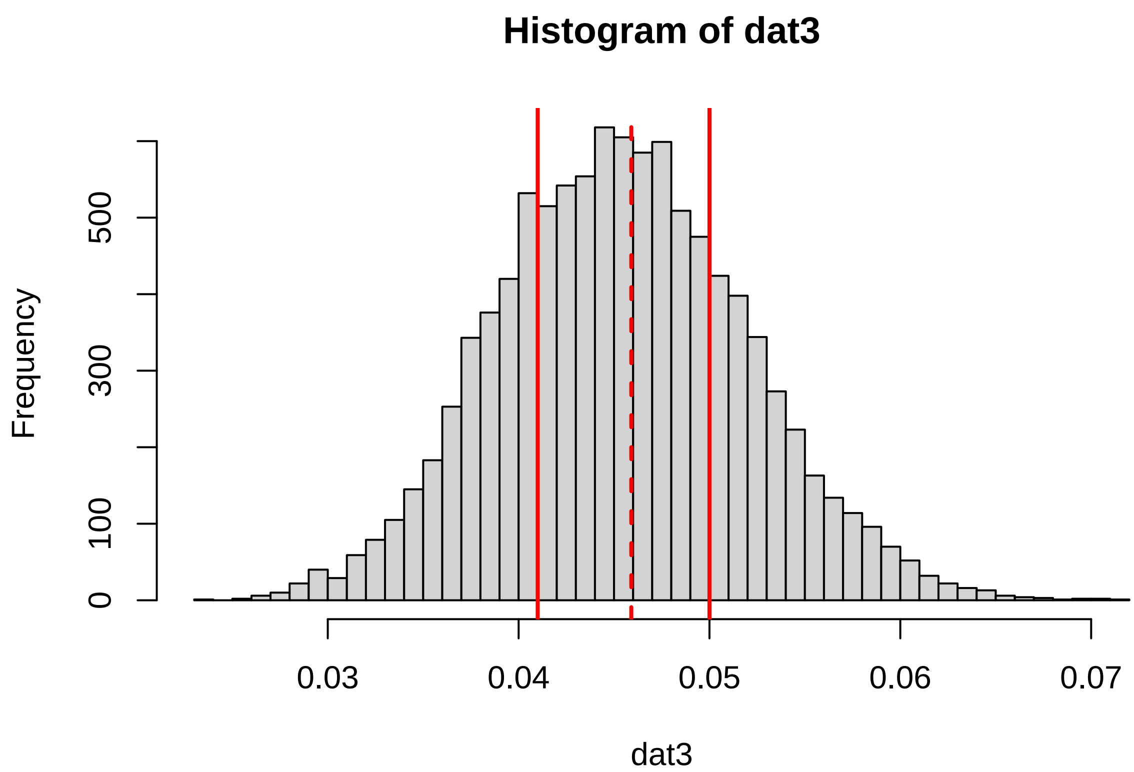
n=10000(number of iterations), N=1000, t=0.5(default)

```
W_0<-17500

set.seed(021031)
dat1<-mymc1(10000, W_0, 1000)
hist(dat1, breaks = "fd")
abline(v=mean(dat1), col="red", lty=2, lwd=2)
abline(v=quantile(dat1, 0.25), col="red", lwd=2)
abline(v=quantile(dat1, 0.75), col="red", lwd=2)
```



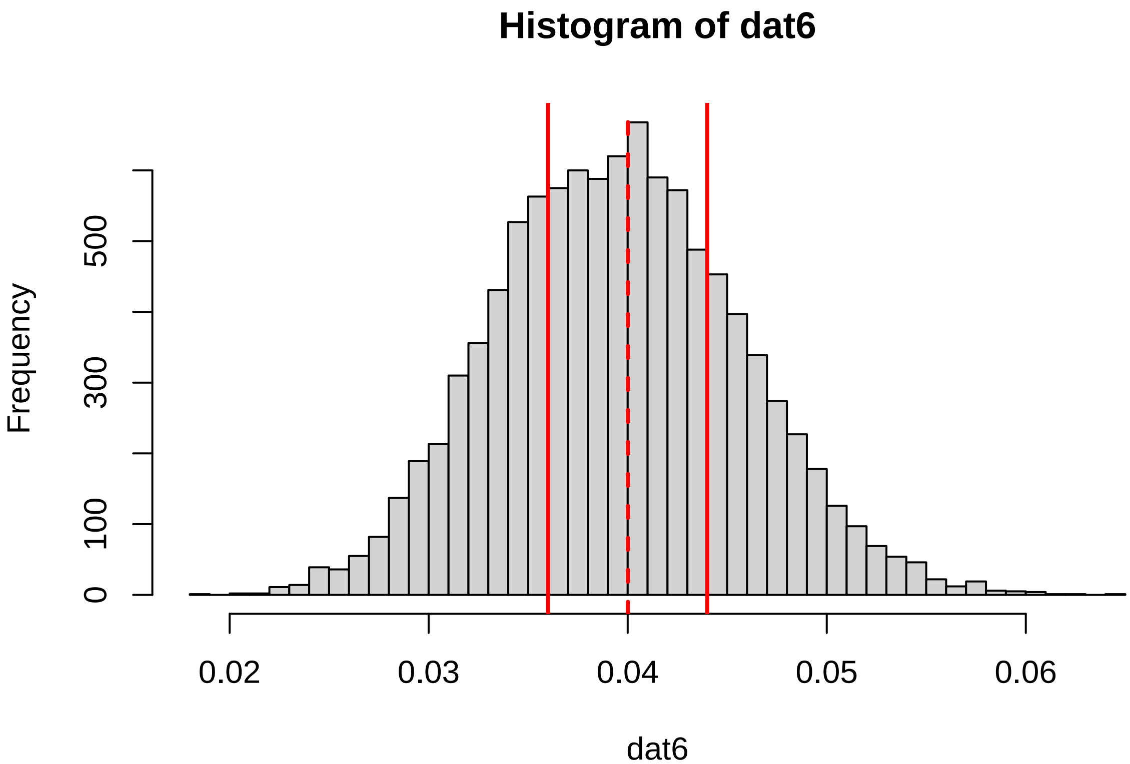
n=10000, N=1000, t=1

```
set.seed(021031)
dat3<-mymc1(10000, W_0, 1000, 1)
hist(dat3, breaks = "fd")
abline(v=mean(dat3), col="red", lty=2, lwd=2)
abline(v=quantile(dat3, 0.25), col="red", lwd=2)
abline(v=quantile(dat3, 0.75), col="red", lwd=2)
```



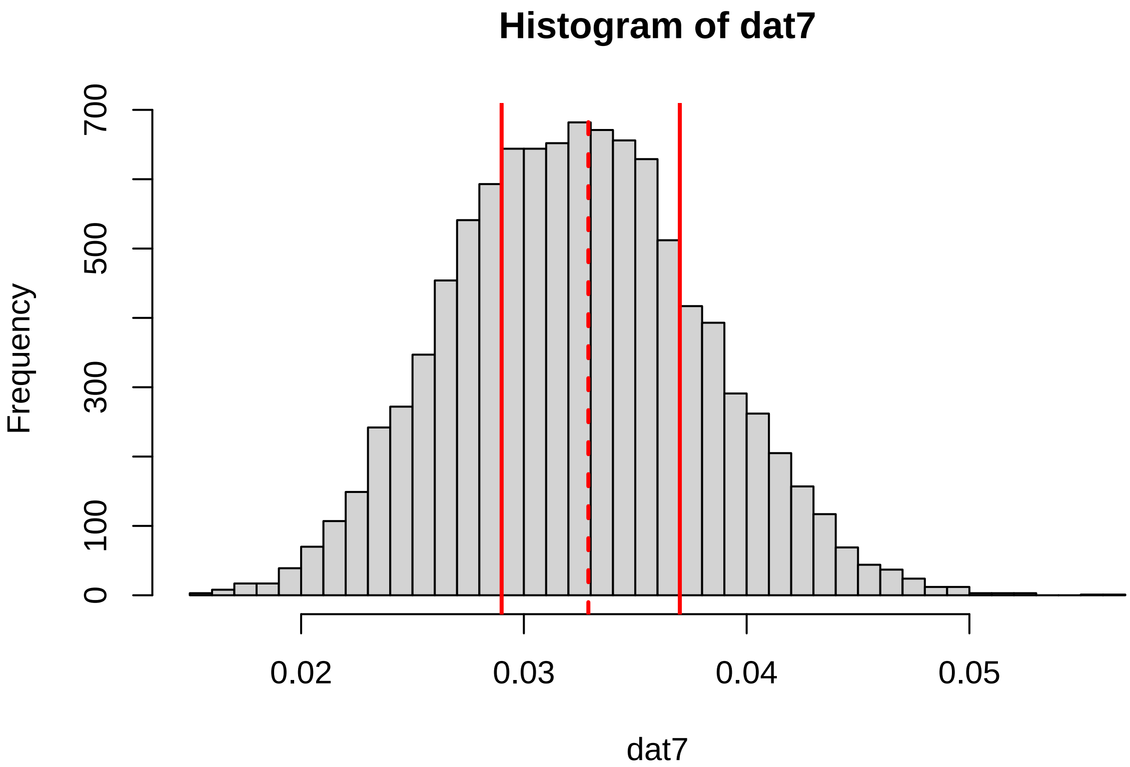
n=10000, N=1000, t=1.5

```
set.seed(021031)
dat6<-mymc1(10000, W_0, 1000, 1.5)
hist(dat6, breaks = "fd")
abline(v=mean(dat6), col="red", lty=2, lwd=2)
abline(v=quantile(dat6, 0.25), col="red", lwd=2)
abline(v=quantile(dat6, 0.75), col="red", lwd=2)
```



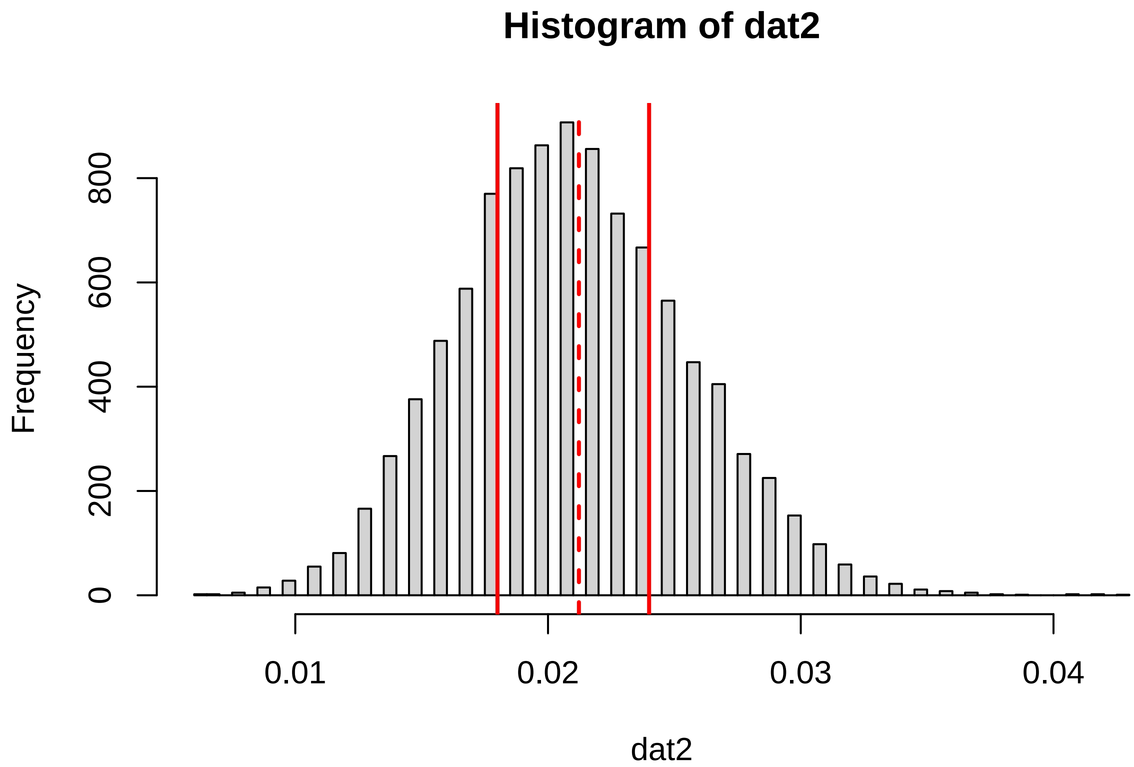
n=10000, N=1000, t=2

```
set.seed(021031)
dat7<-mymc1(10000, W_0, 1000, 2)
hist(dat7, breaks = "fd")
abline(v=mean(dat7), col="red", lty=2, lwd=2)
abline(v=quantile(dat7, 0.25), col="red", lwd=2)
abline(v=quantile(dat7, 0.75), col="red", lwd=2)
```



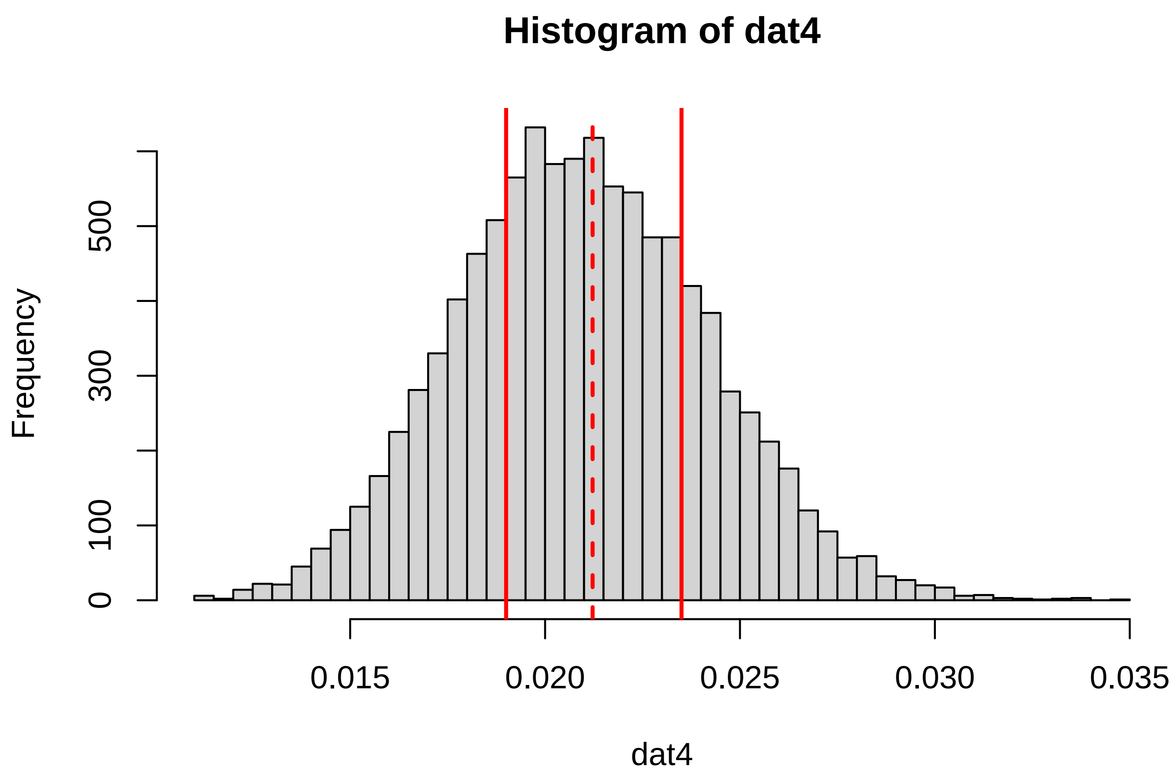
n=10000, N=1000, t=3

```
set.seed(021031)
dat2<-mymc1(10000, W_0, 1000, 3)
hist(dat2, breaks = "fd")
abline(v=mean(dat2), col="red", lty=2, lwd=2)
abline(v=quantile(dat2, 0.25), col="red", lwd=2)
abline(v=quantile(dat2, 0.75), col="red", lwd=2)
```



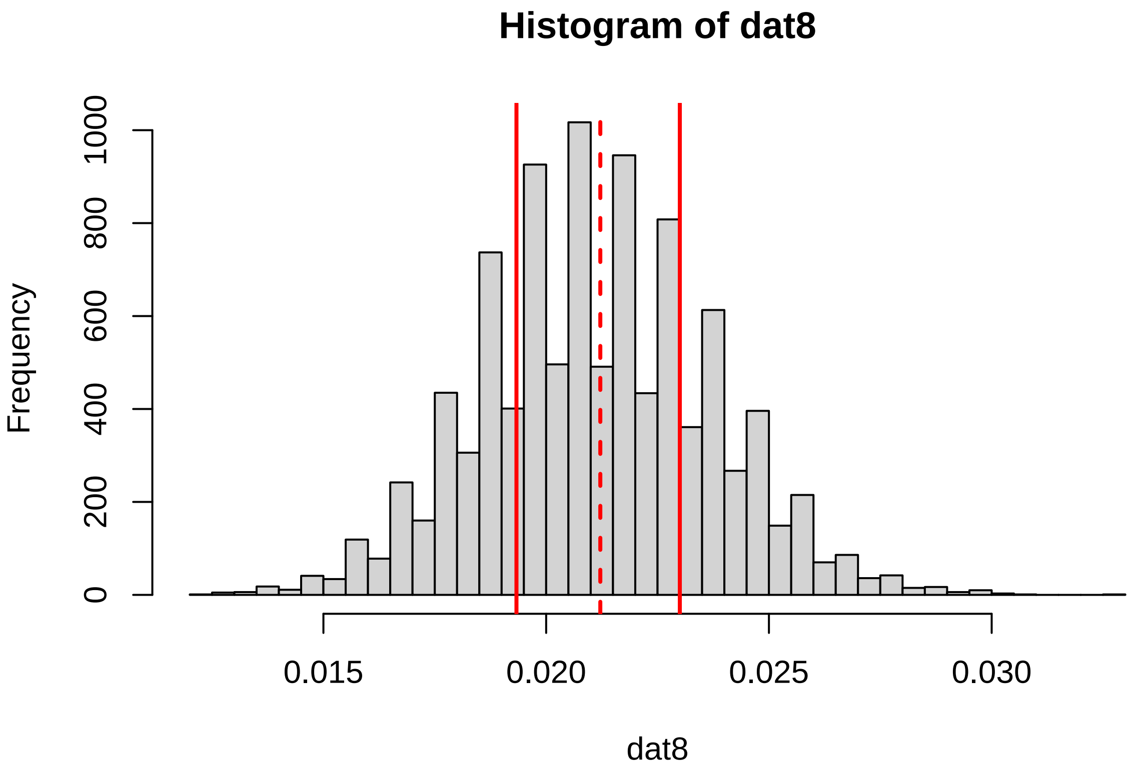
n=10000, N=2000, t=3

```
set.seed(021031)
dat4<-mymc1(10000, W_0, 2000, 3)
hist(dat4, breaks = "fd")
abline(v=mean(dat4), col="red", lty=2, lwd=2)
abline(v=quantile(dat4, 0.25), col="red", lwd=2)
abline(v=quantile(dat4, 0.75), col="red", lwd=2)
```



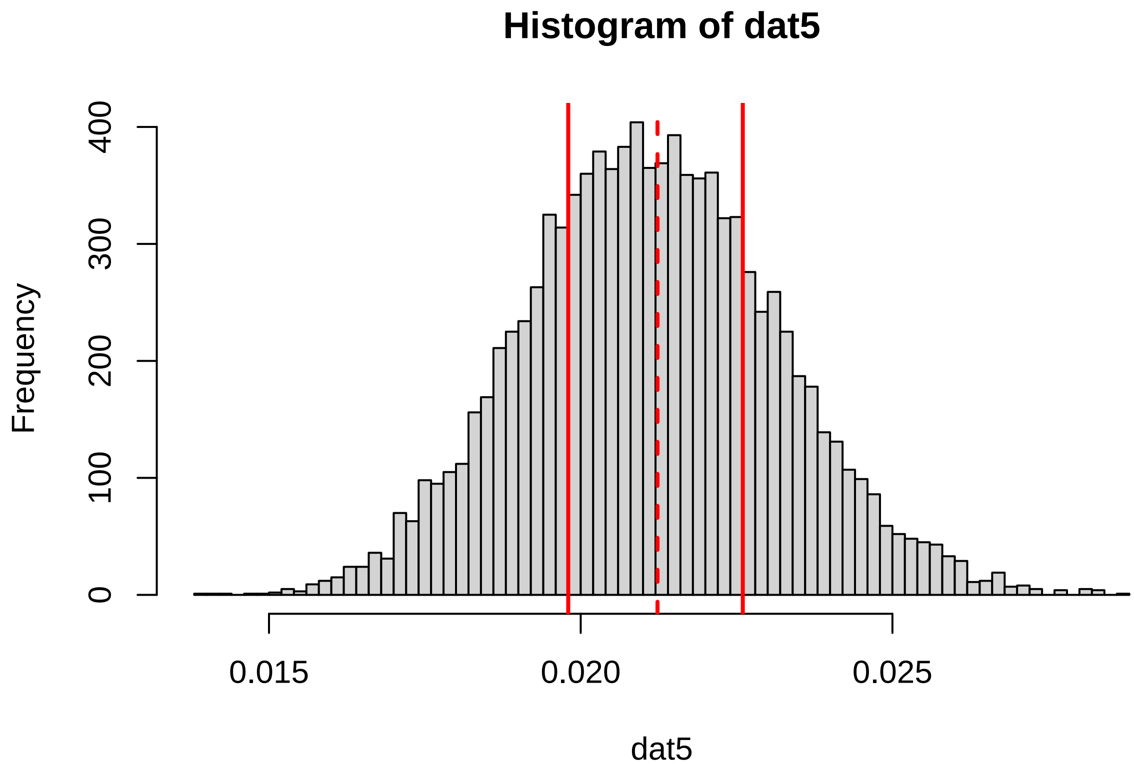
n=10000, N=3000, t=3

```
set.seed(021031)
dat8<-mymc1(10000, W_0, 3000, 3)
hist(dat8, breaks = "fd")
abline(v=mean(dat8), col="red", lty=2, lwd=2)
abline(v=quantile(dat8, 0.25), col="red", lwd=2)
abline(v=quantile(dat8, 0.75), col="red", lwd=2)
```



n=10000, N=5000, t=3

```
set.seed(021031)
dat5<-mymc1(10000, W_0, 5000, 3)
hist(dat5, breaks = "fd")
abline(v=mean(dat5), col="red", lty=2, lwd=2)
abline(v=quantile(dat5, 0.25), col="red", lwd=2)
abline(v=quantile(dat5, 0.75), col="red", lwd=2)
```



Discussion

For this Monte Carlos simulation on stock portfolio, we first experiment with the T–terminal time in years. Our default time is 0.5 year and I test T=1, 1.5, 2, 3 years. We found that the mean probability that the value of your portfolio drops by more than 10% is gradually decreasing as T increases. After that, we keep T constant and test with various values for N(=1000, 2000, 3000, 5000) and we found that sample variance get much smaller since the 25% quantile and 75% quantile results in narrower range as the N get larger.

Thus, I would suggest to keep this stock portfolio since its performance is good and robust especially in longer period of time. The chance of stock value dropping more than 10% is only about 0.02.