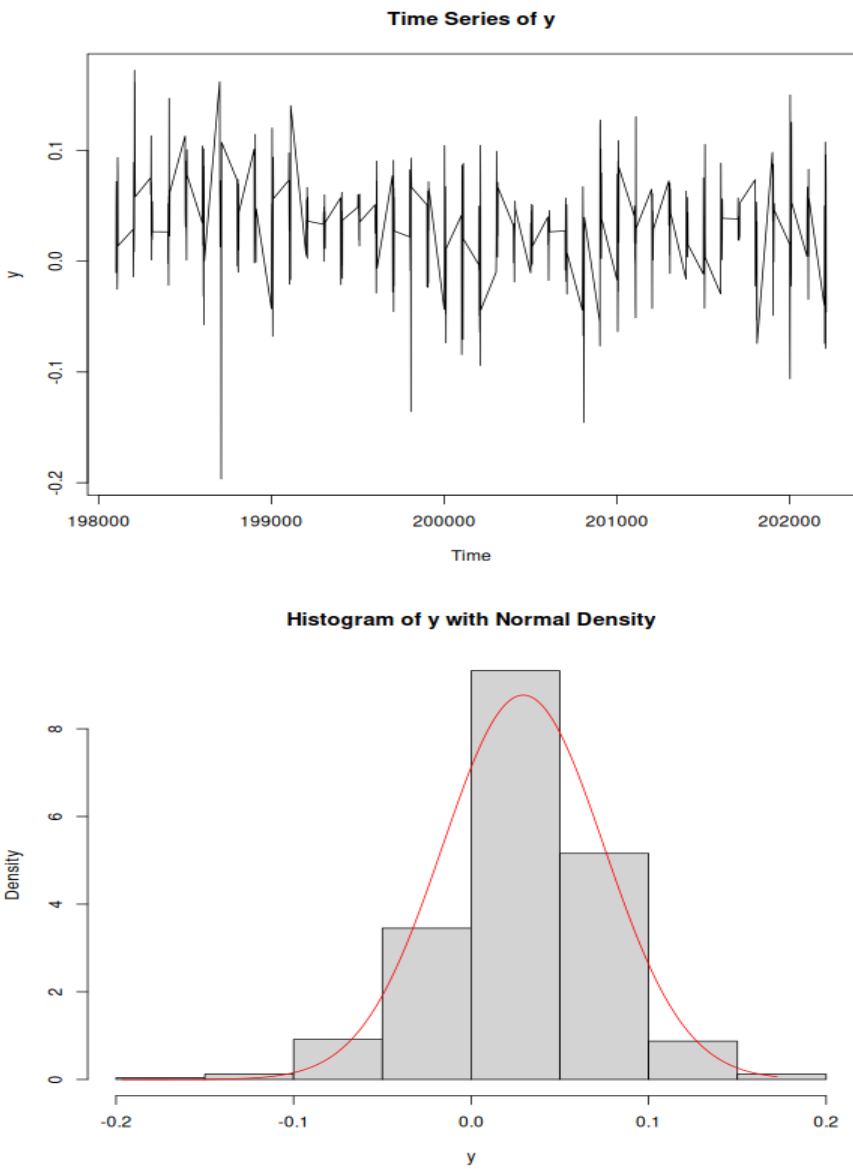
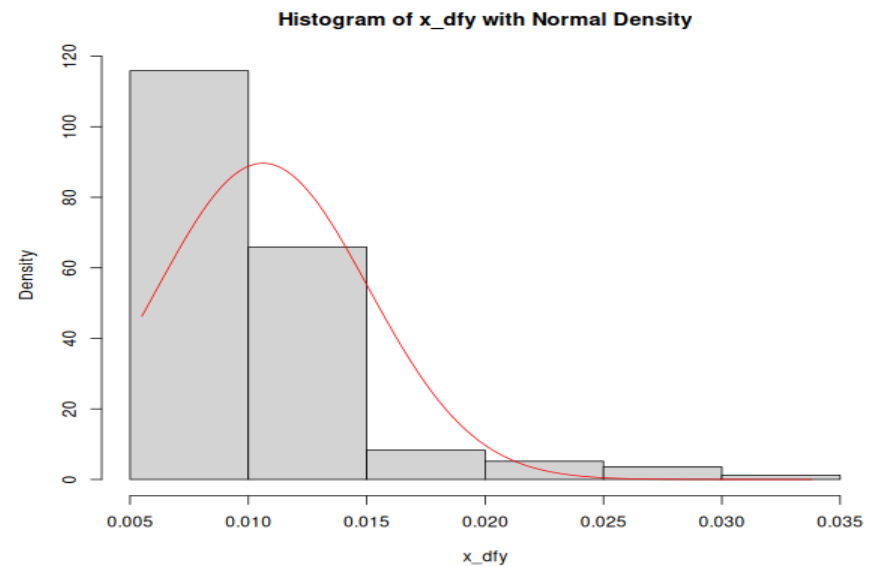
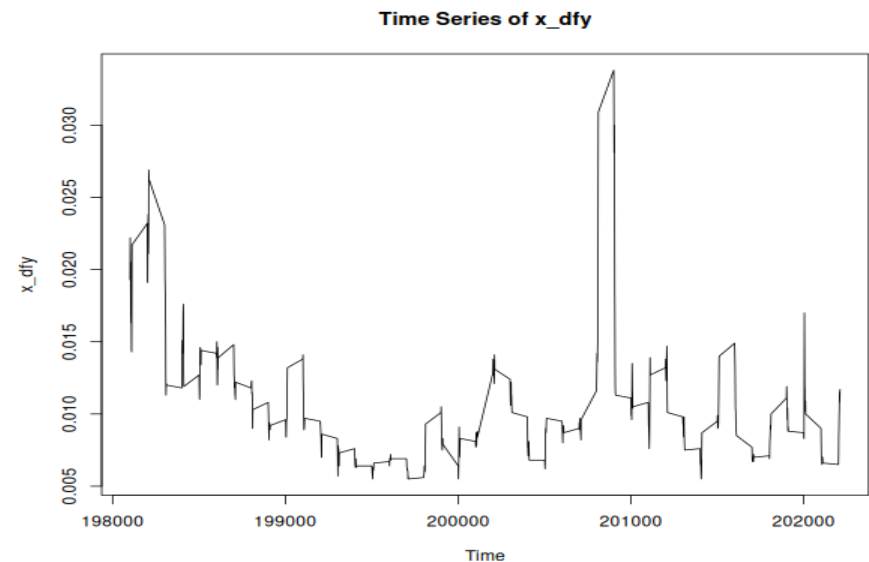
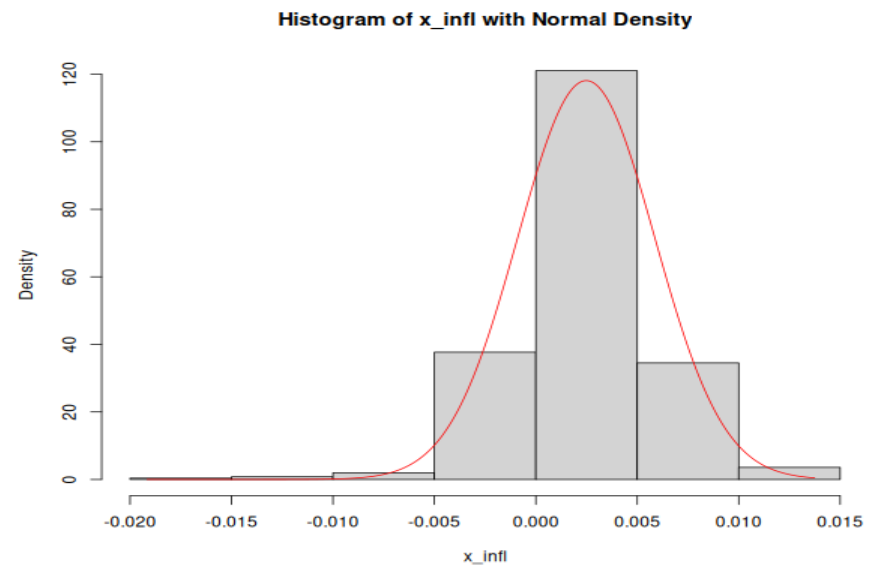
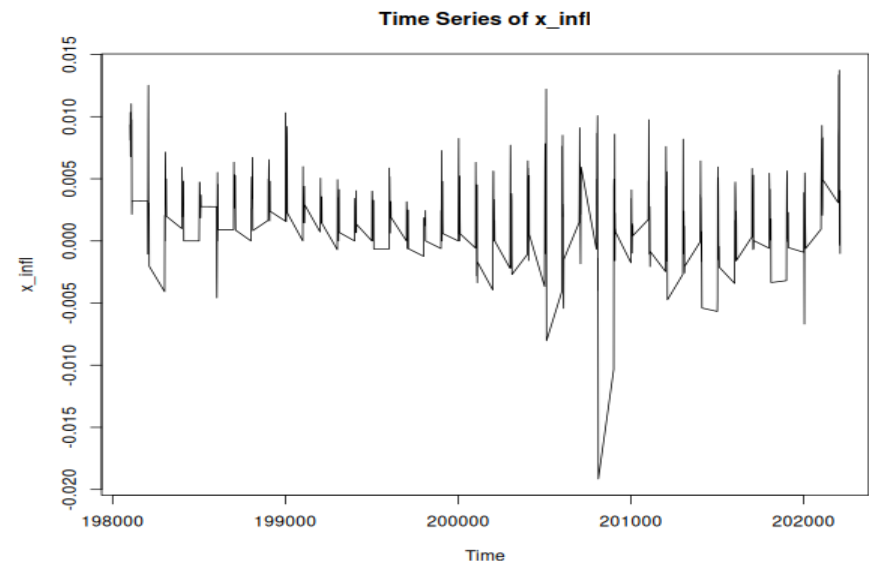


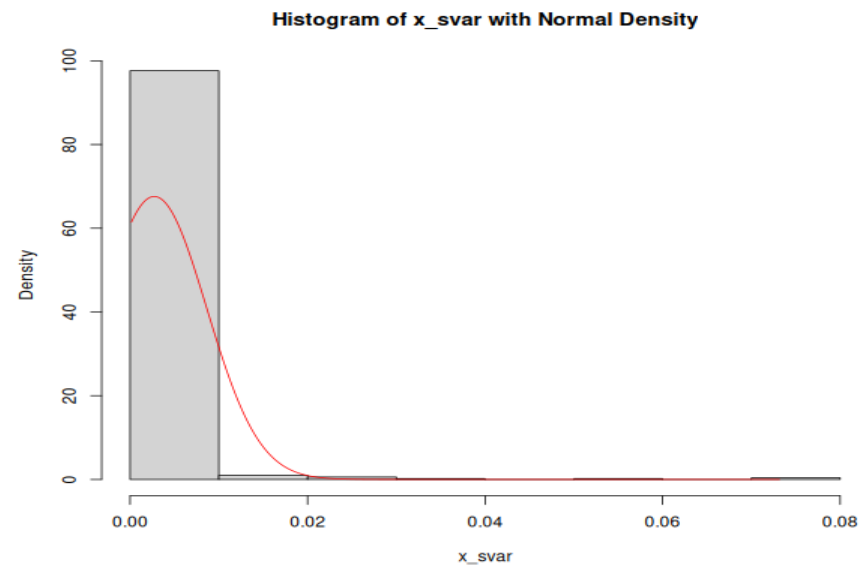
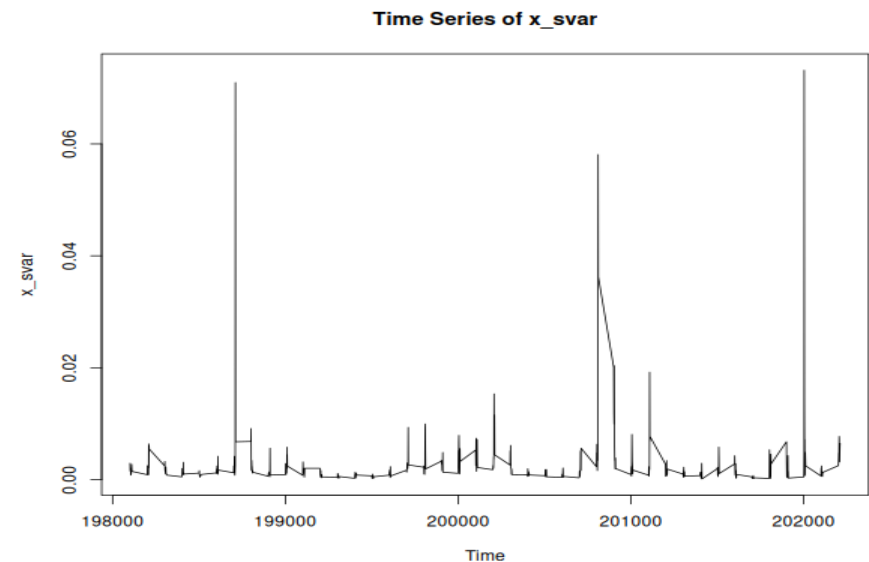
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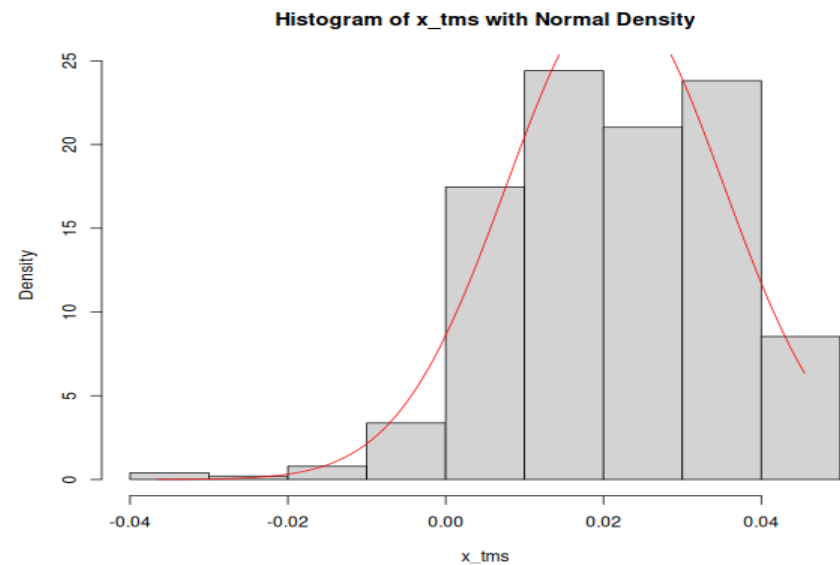
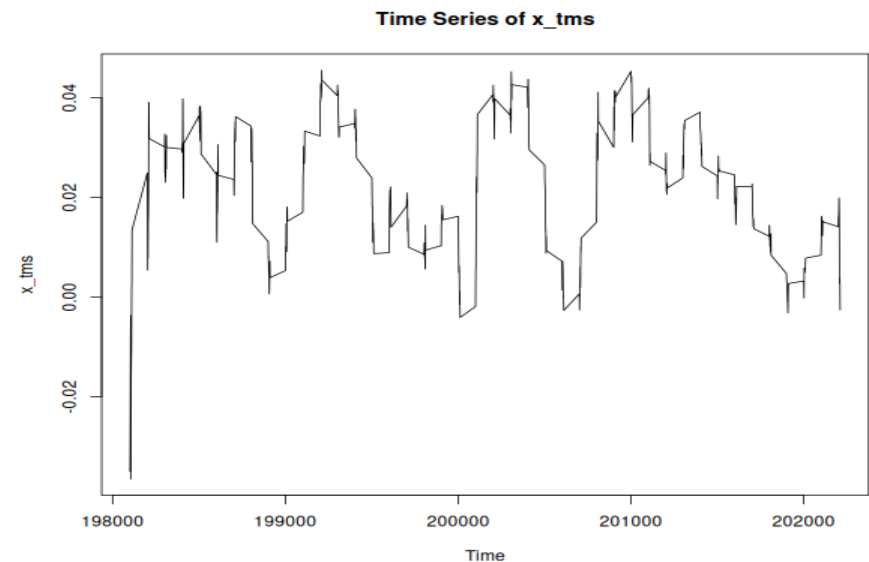
1. Data Visualization

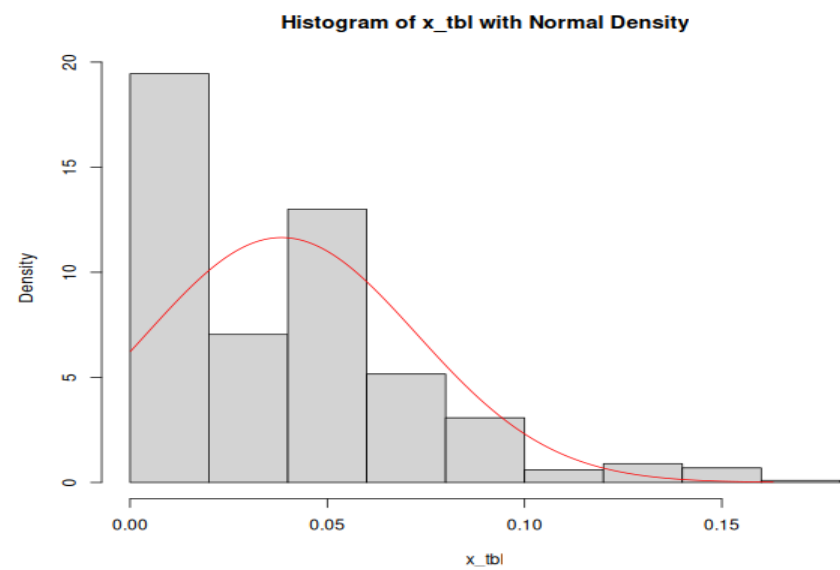
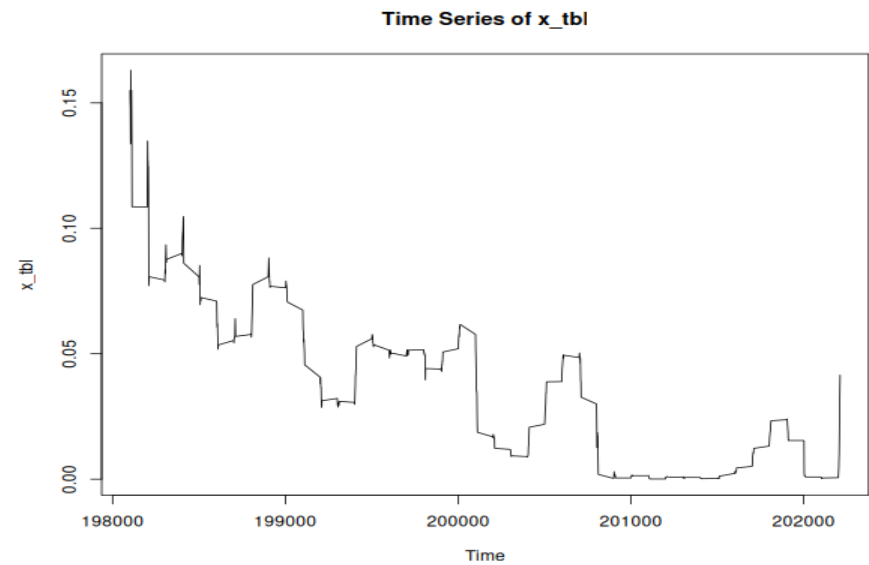


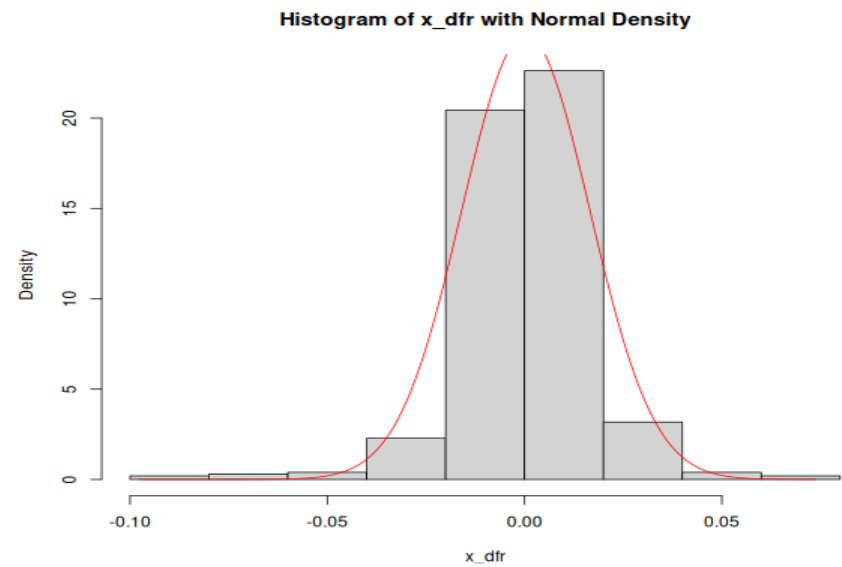
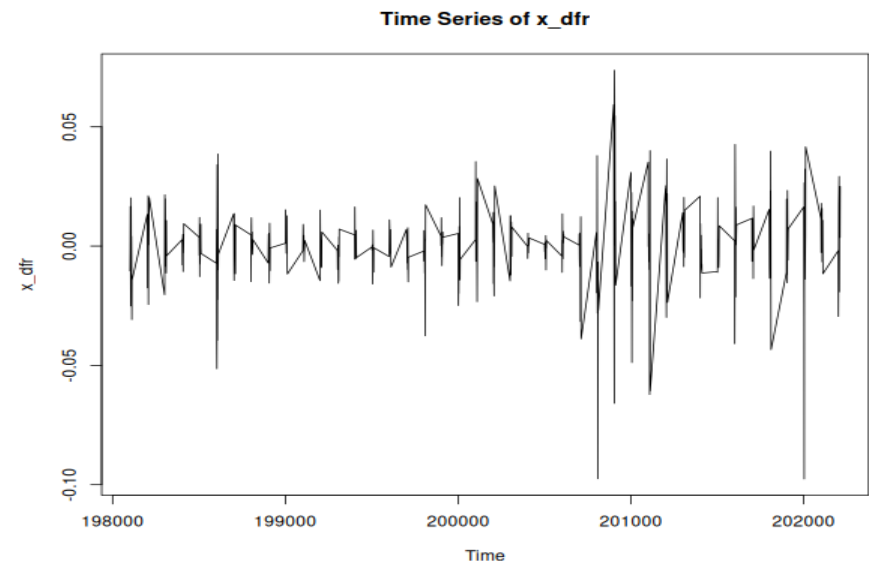


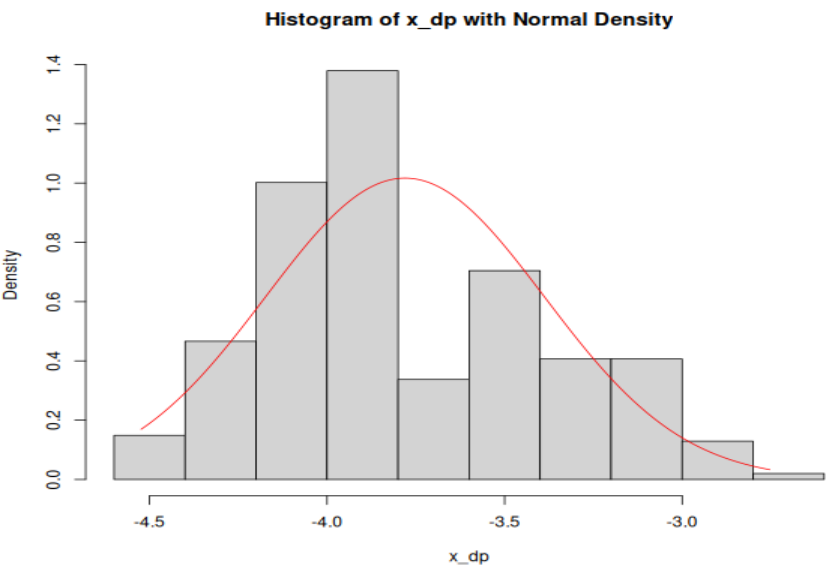
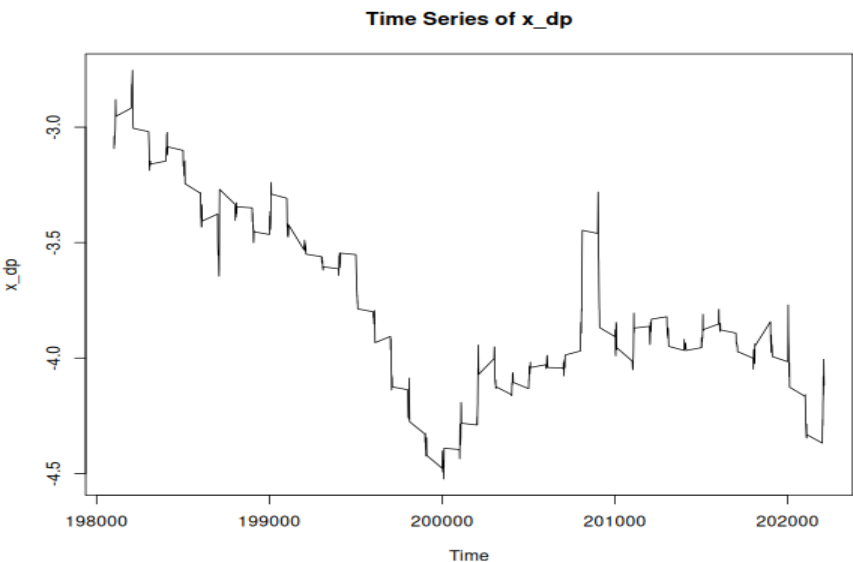


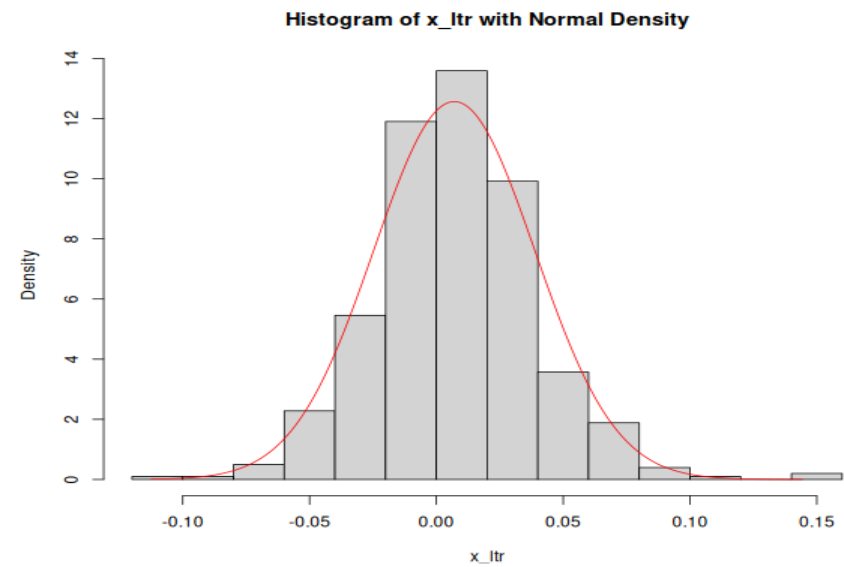
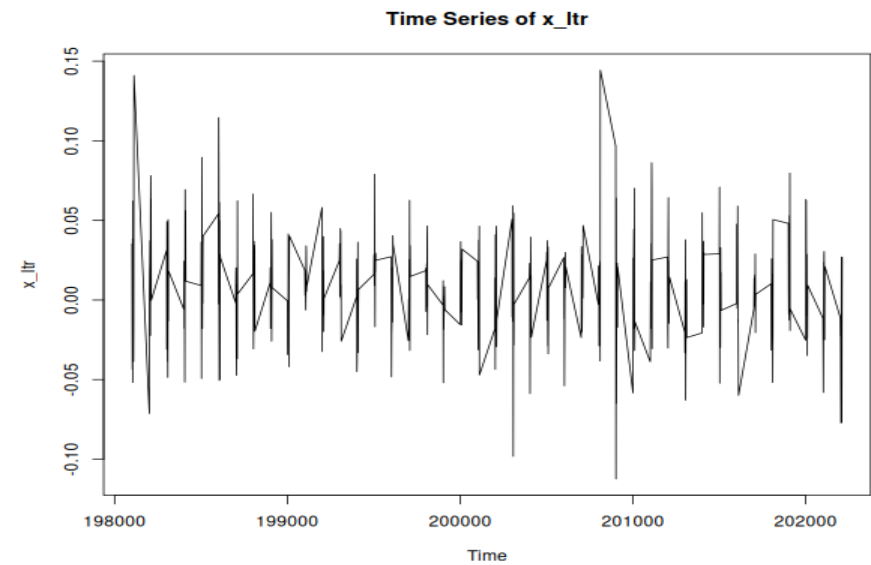


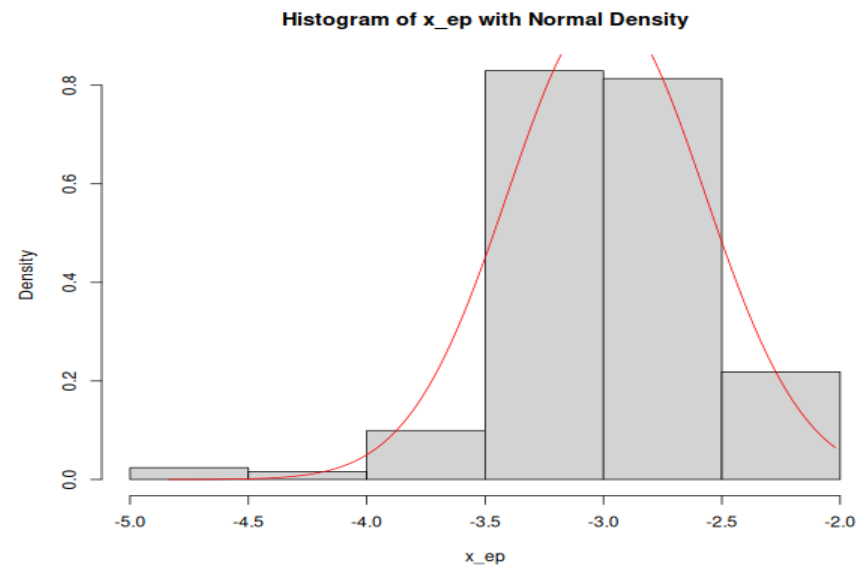
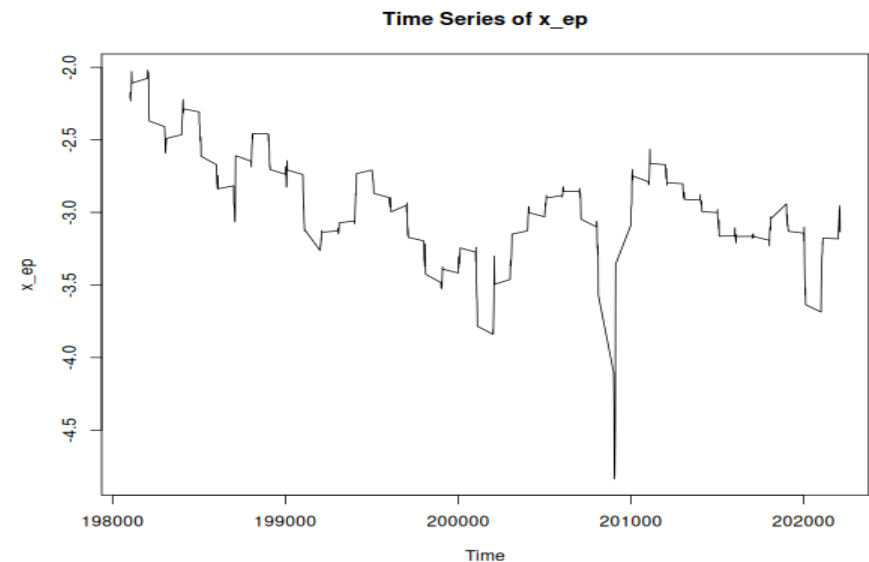


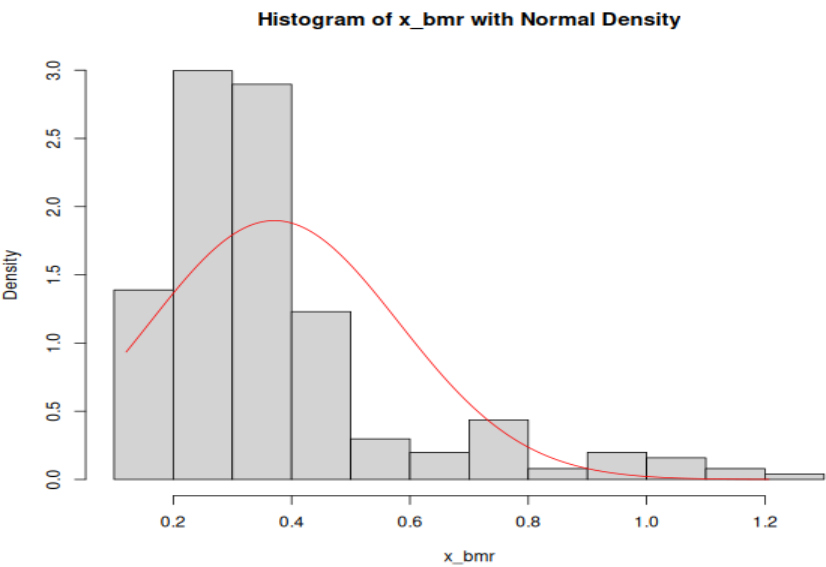
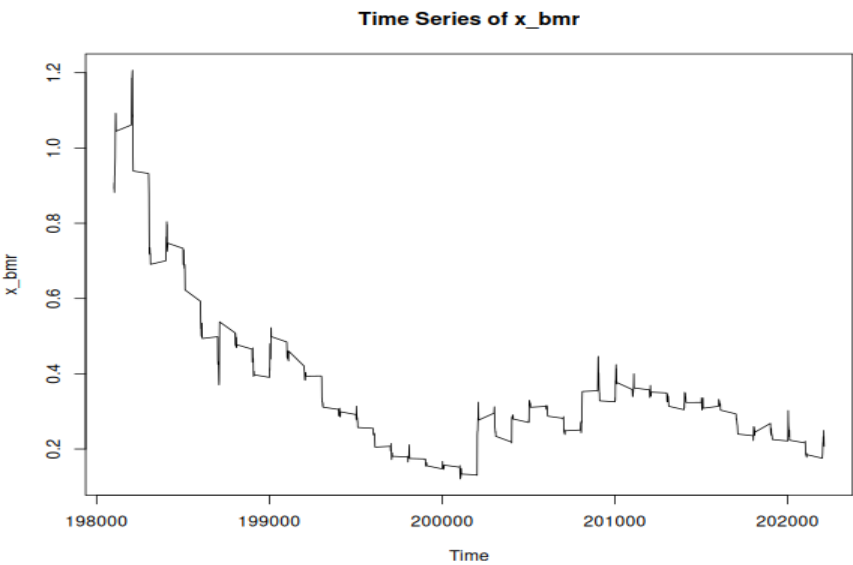


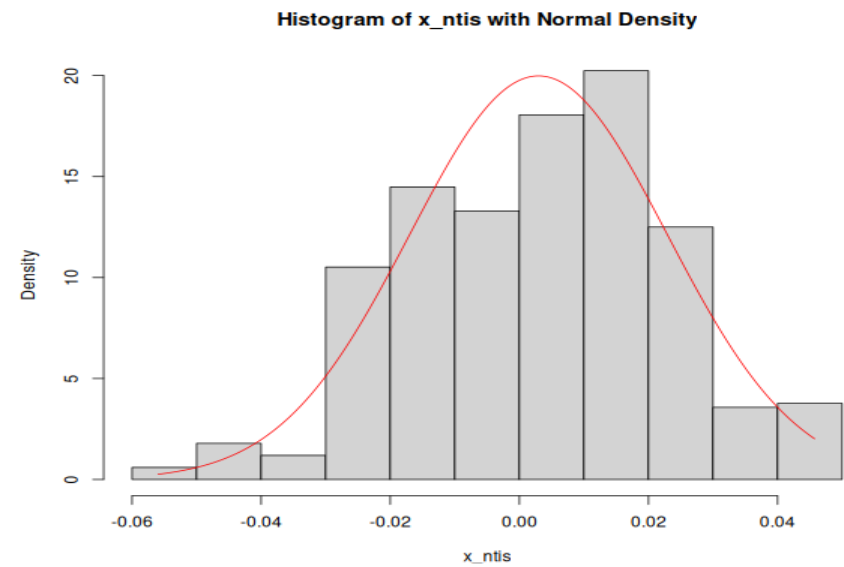
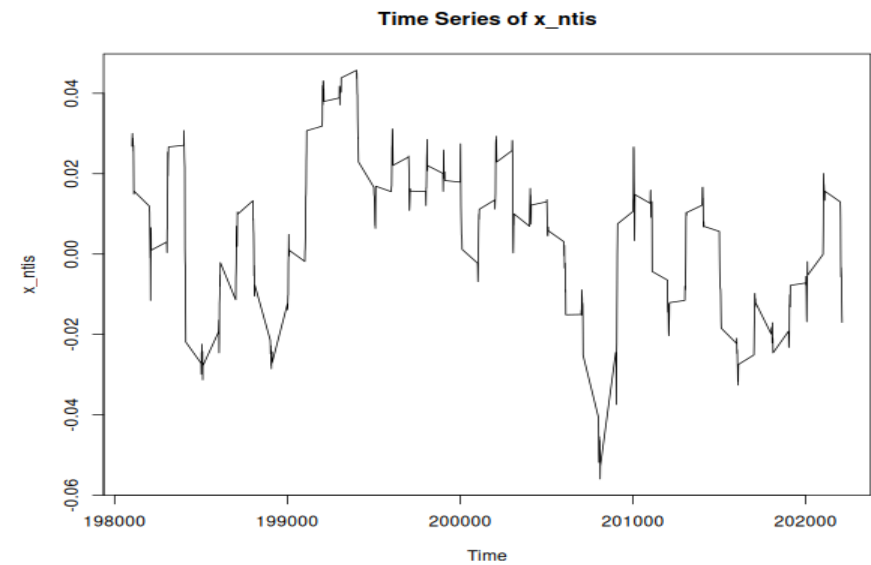












2.

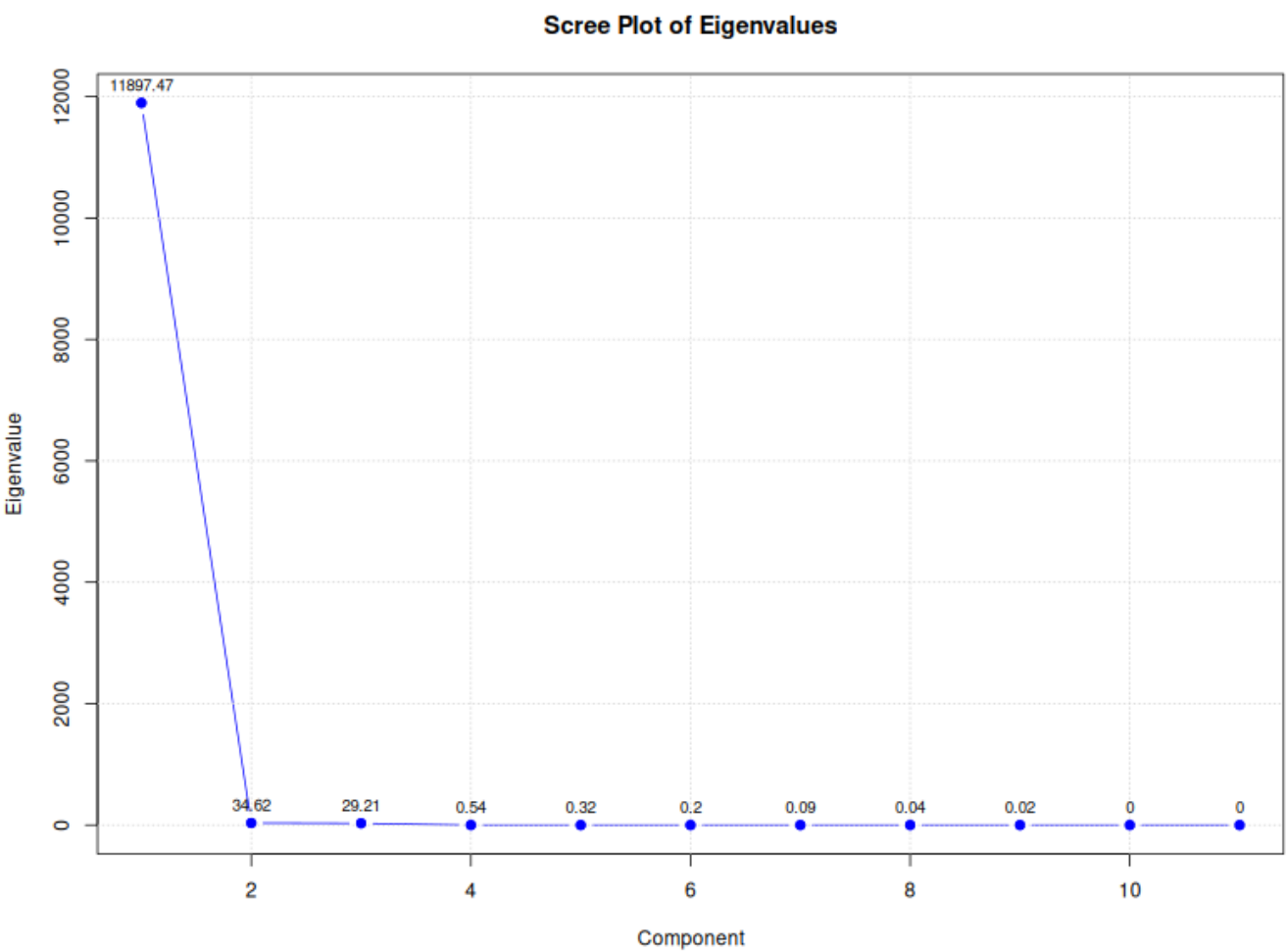
2.1. $trace(X(X'X)^{-1}X') = 11$ (calculated by R)

2.2. $trace(I_n - X(X'X)^{-1}X') = 493$ (calculated by R)

Question 2-1:
The sum of the diagonal elements of the result matrix is: 11
Question 2-2:
The sum of the diagonal elements of the final matrix is: 493

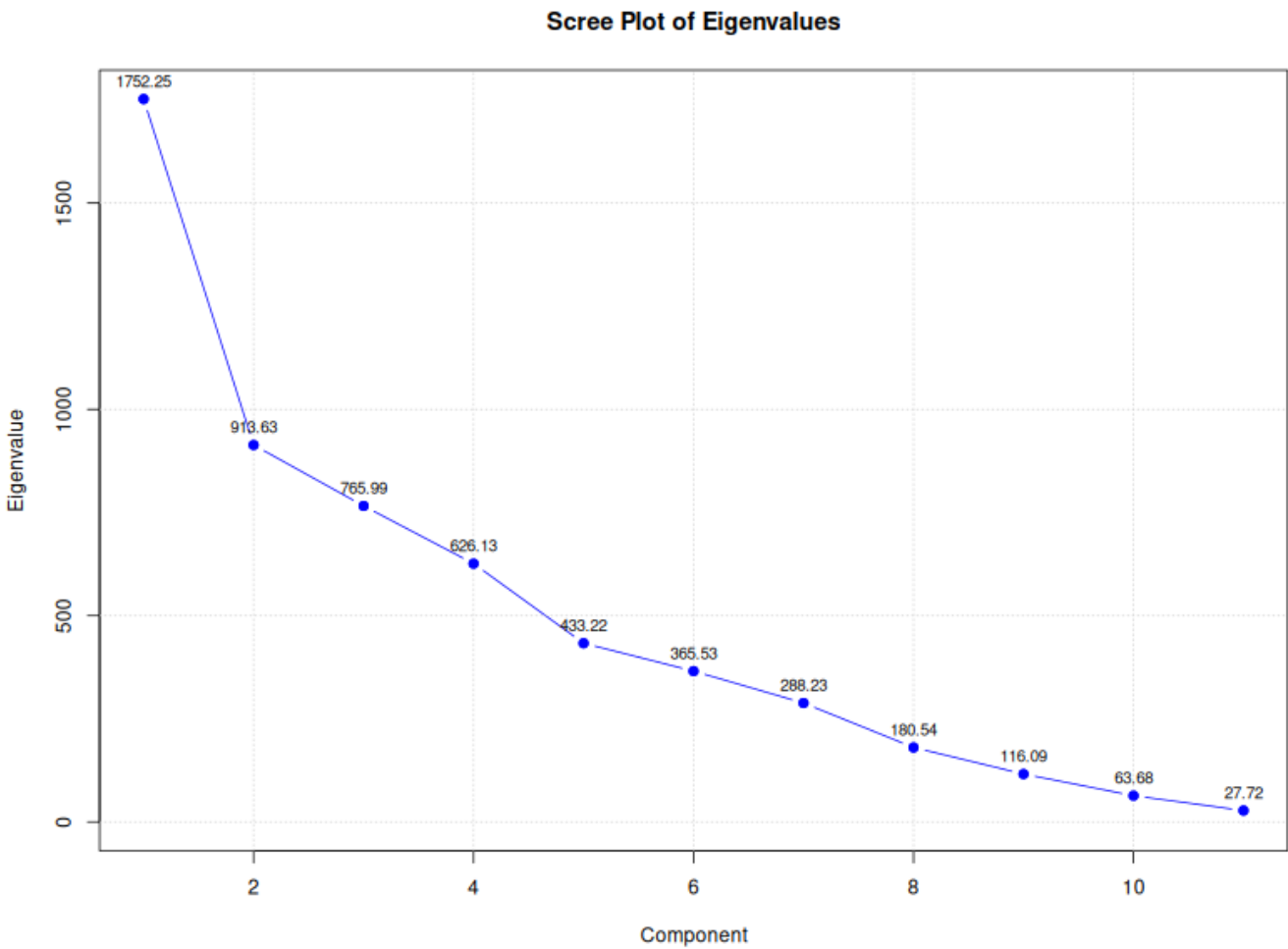
3. Eigenvalue Scree Plot

eigenvalues scree plot (sorted)

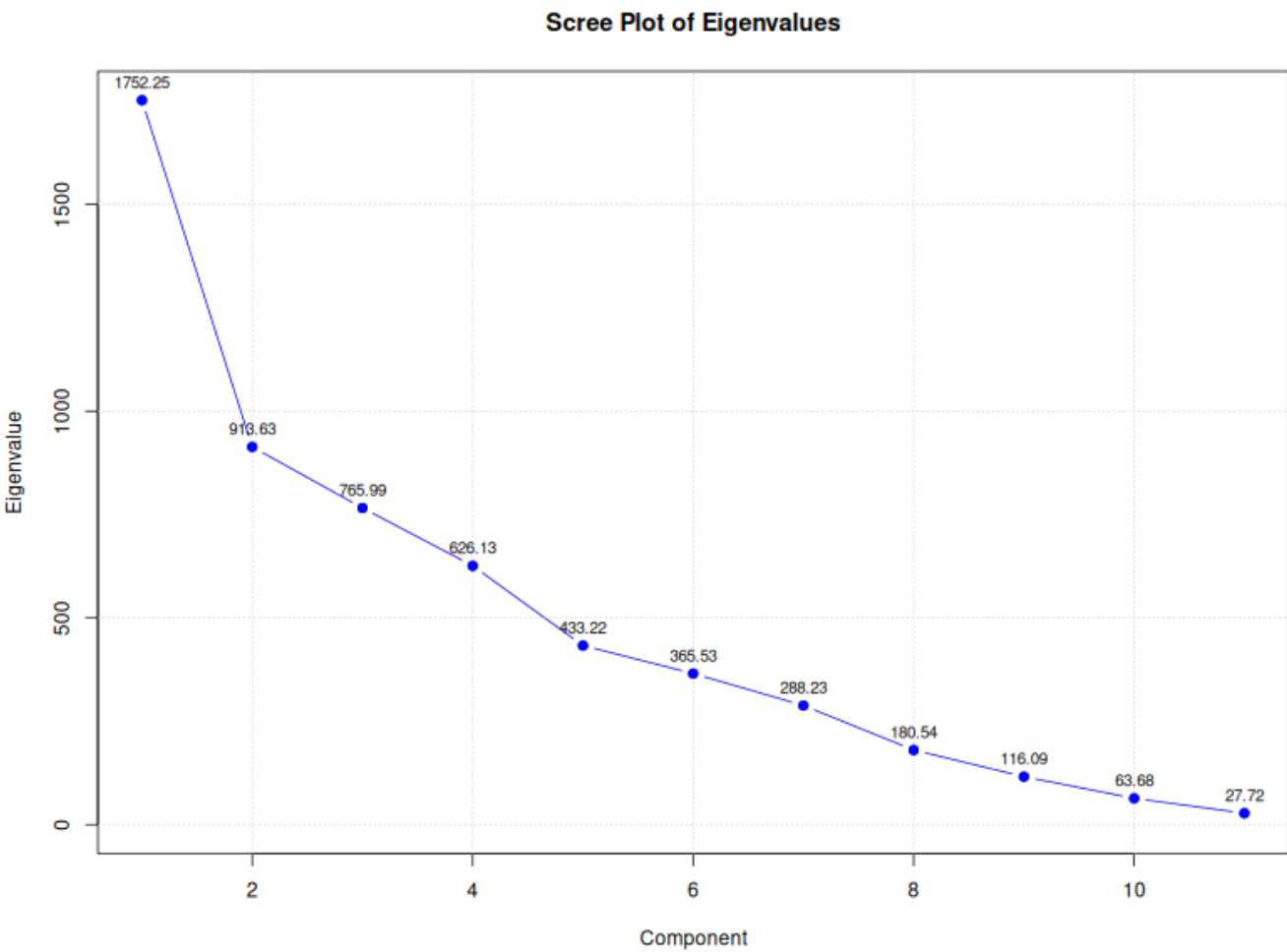


4. Standardized Matrix Comparison

scree plot of the eigenvalues of $\bar{X}'\bar{X}$



scree plot of the eigenvalues of $\tilde{X}\tilde{X}'$



The results imply that the eigenvalues of the two matrix are the same.

```
check inverse result:  TRUE
check identity matrix:  TRUE
```

5. Spectral Decomposition and Matrix Inversion

Apply the equation

$$H = \widetilde{X}' \widetilde{X}$$

$$A = H \Lambda^{-1} H'$$

The result turns out $AA^{-1} = I_k$ (verified by R)

6. Linear Equation Solution

Since X isn't a symmetric matrix, we must apply another method to calculate b. By using the below equation, we can figure out b.

$$b = \left(\widetilde{X}' \widetilde{X} \right)^{-1} \widetilde{X}' Y$$

The result of b

```
[1] "Result of b:"  
      [,1]  
[1,] -0.0051961288  
[2,] -0.0012814334  
[3,] -0.0005996872  
[4,] -0.0045372084  
[5,] -0.0108741731  
[6,]  0.0044648300  
[7,]  0.0177837102  
[8,]  0.0040115413  
[9,] -0.0008651173  
[10,] 0.0060527912  
[11,] 0.0013990910
```

7. Source Code

[Source Code](#)