Johnathan Ferdinand, Devina Gera, Archimedes Li, Henry Liu,
Katherine Shi, Sam Stevens

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1 Analysis

We can see that the price increases over time despite showing volitility. The mean and variance change over time so the stock price is not stationary. (Figure 5).

We then ran the Augmented Dickey-Fuller test on the data and got the following output:

```
Dickey-Fuller = -3.1858, Lag order = 19, p-value = 0.09026
alternative hypothesis: stationary
```

We get a P value of 0.09, thus we fail to reject the null hypothesis, and the Price of the stock is non-stationary.

Figure 4 gives that the average return on CAT is 0. At a quick glance, we can see that the mean is approximately 0 (fig 4b). The histogram showing a normal distribution with mean 0 confirms our suspicions (fig 4a).

We ran the same test again for the return of the stock and got the following output:

```
Dickey-Fuller = -20.102, Lag order = 19, p-value = 0.01
alternative hypothesis: stationary
```

This time, we reject the null hypothesis, so the return on the stocks is non-stationary.

The ACF shows that the return series is not dependent on the previous day's error. The PACF shows that the return series autocorrelates with lags. Thus, the Return series are influenced by previous days Return.(Figure 3)

The absence of autocorrelation is confirmed by the Box-Ljung test, which gives an output of

```
X-squared = 7.3365, df = 1, p-value = 0.006757
```

We reject the null hypothesis, thus the return series is not independent.

The plot of ACF of square return values (Fig 2) shows a clear but slow decay of auto correlation.

The rolling performance chart points to GARMA being able to improve our ARMA model. (Fig 1)
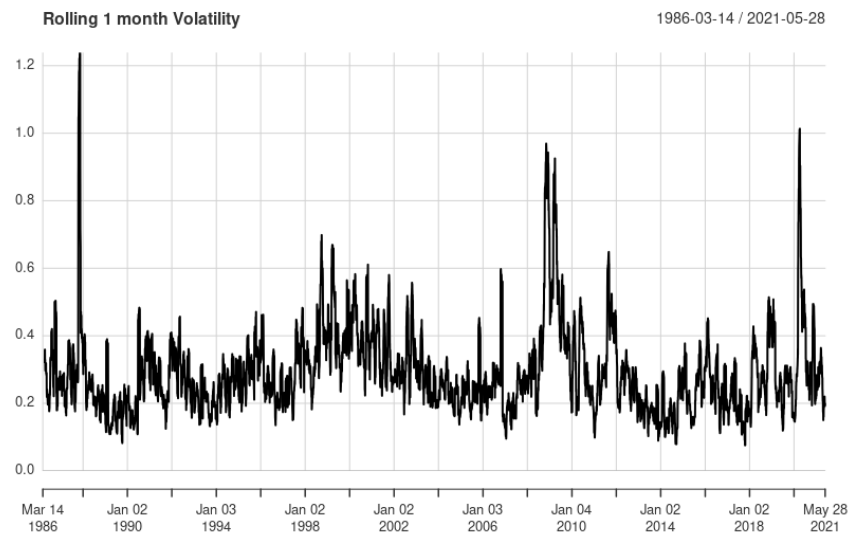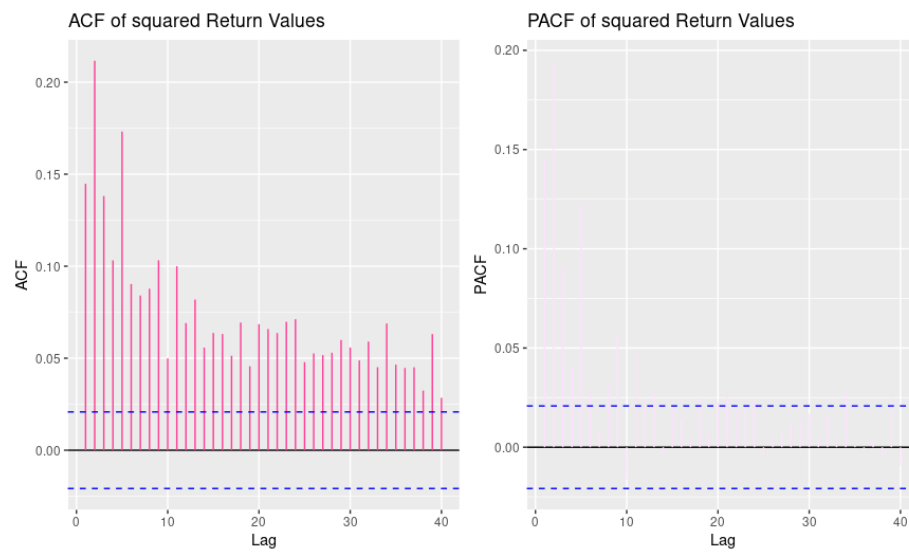
Figure 1: Rolling 1 month volatility for CAT.

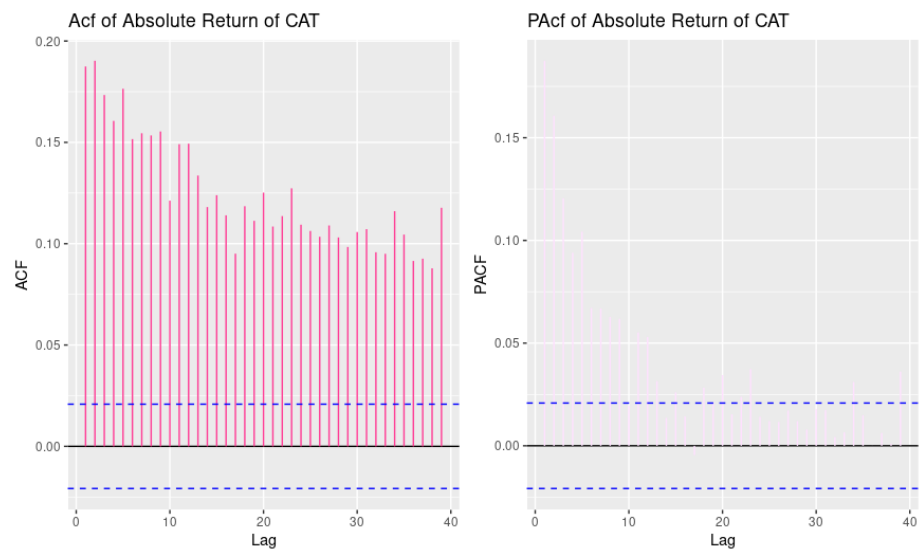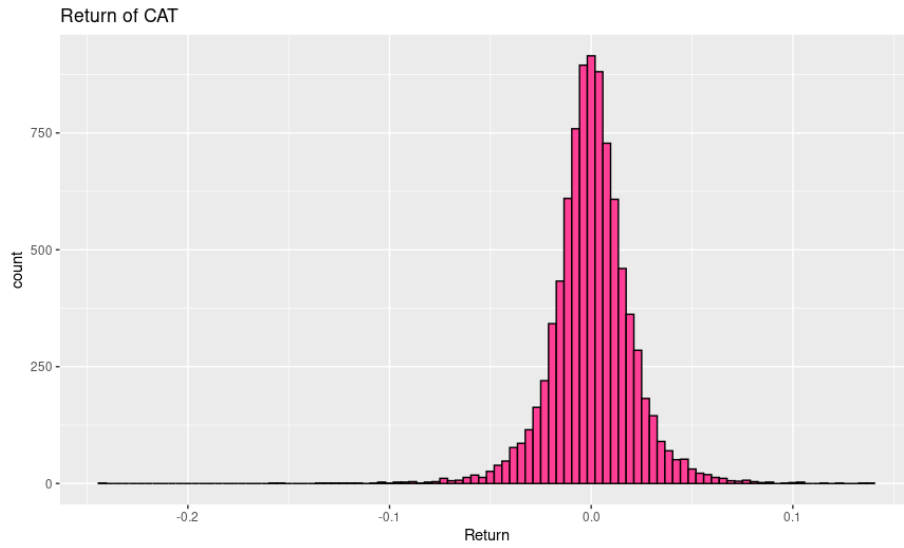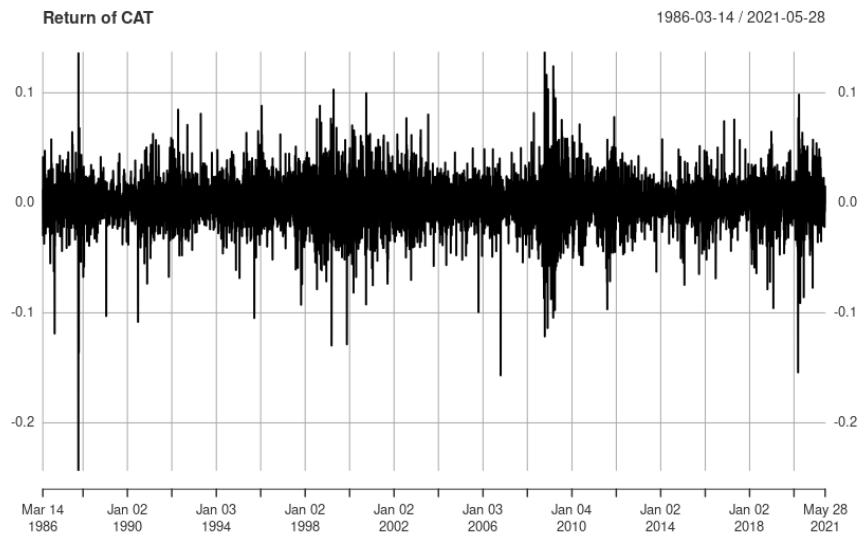Figure 2: ACF of return values (left) and PACF of return values(right)

Figure 3: ACF of return values (left) and PACF of return values(right)

(a) Histogram for fig 4b

(b) Return of CAT as a function of time, at monthly intervals
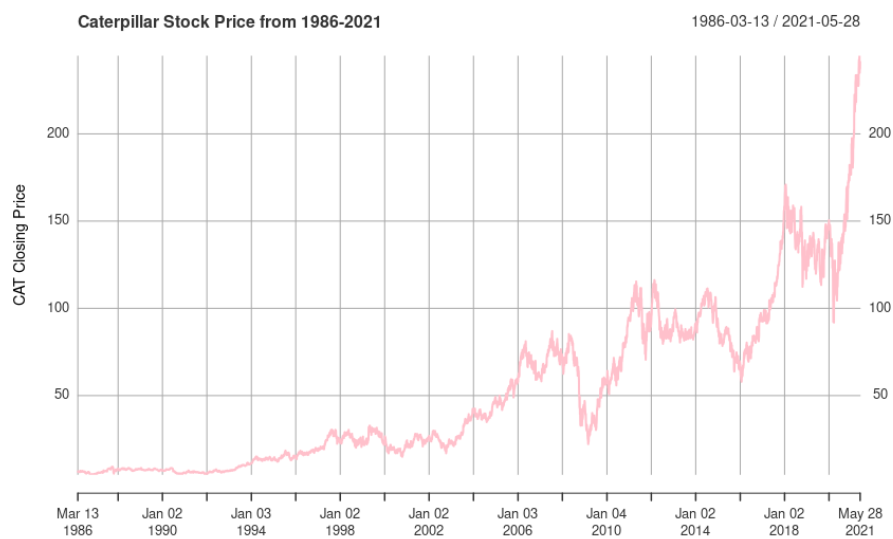
Figure 4: The returns of CAT over time.

Figure 5: The stock price of caterpillar as a function of time from 1986 - 2021