Chapter_1_Gold

March 2, 2025

1 Chapter 1

[1]:
```
import requests_cache
import yfinance as yf
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import scipy as sp
from statsmodels.tsa.stattools import acf
```

[2]:
```
session = requests_cache.CachedSession('yfinance.cache')
session.headers['User-Leonardo'] = 'Chapter_1'
```

[8]:
```
ticker = 'GC=F'
data = yf.download(ticker)
```

```
[*********************100%***********************]  1 of 1 completed
```

[9]:
```
prices = data.Close[ticker]
prices
```

[9]:
```
Date
2000-08-30     273.899994
2000-08-31     278.299988
2000-09-01     277.000000
2000-09-05     275.799988
2000-09-06     274.200012
                  …
2025-02-24    2947.899902
2025-02-25    2904.500000
2025-02-26    2916.800049
2025-02-27    2883.199951
2025-02-28    2867.300049
Name: GC=F, Length: 6147, dtype: float64
```

[10]:
```
prices.describe()
```

[10]:
```
count    6147.000000
mean     1172.018448
std       594.010026
min       255.100006
25%       633.799988
50%      1236.199951
75%      1628.400024
max      2947.899902
Name: GC=F, dtype: float64
```

[11]:
```python
prices = prices.to_numpy()
```

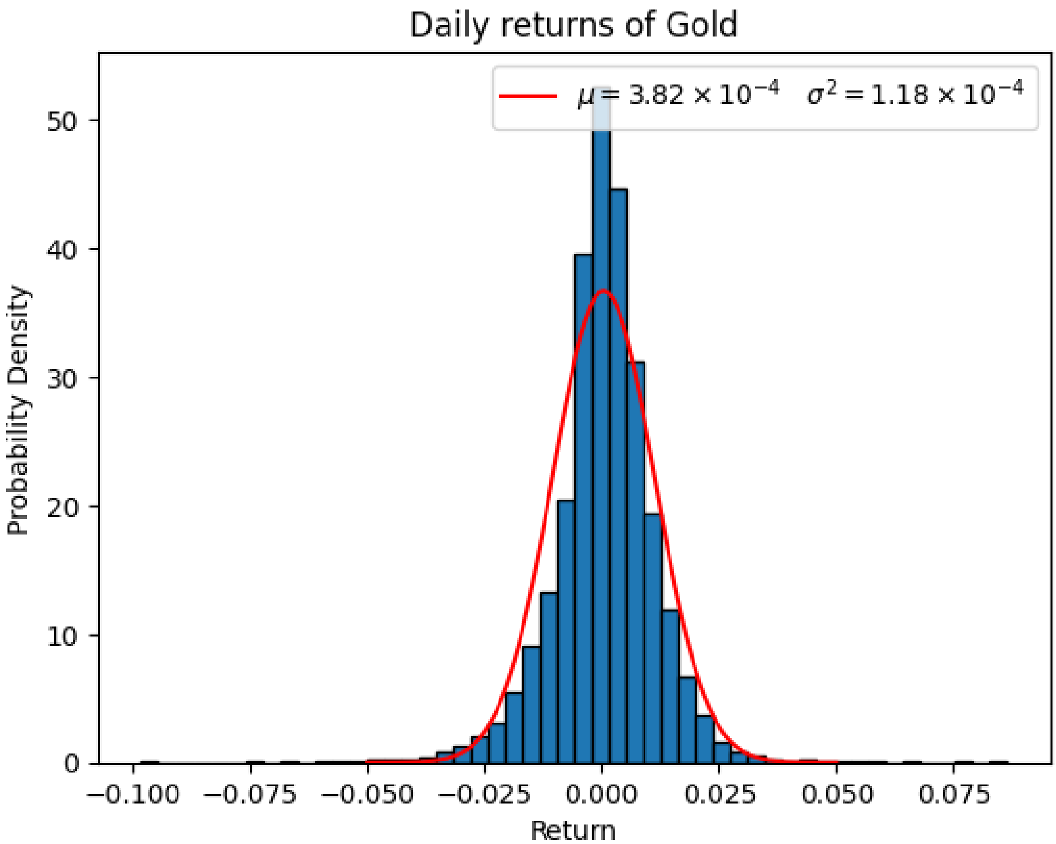
[12]:
```python
dates = data.Close[ticker].index
```

1.1 Returns

[13]:
```python
returns = np.log(prices[1:])- np.log(prices[:-1])
mean = returns.mean()
variance = returns.var()
print('average = ',mean, '\nvariance = ', variance)
```

```
average =  0.00038209617026498
variance =  0.00011792358757804685
```

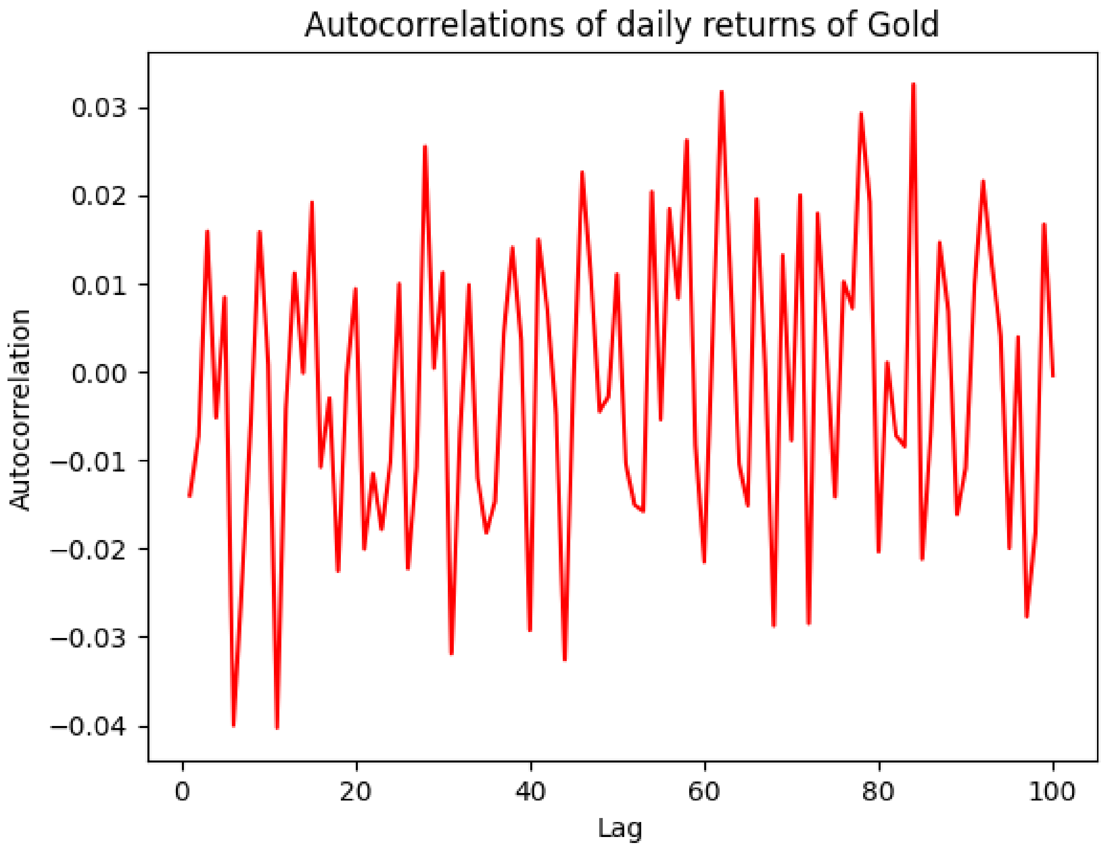
[37]:
```python
# Generate a range of x values for the normal distribution
x = np.linspace(-0.05, 0.05, 100)
# Evaluate the normal distribution at the x values
y = sp.stats.norm(loc =mean, scale = np.sqrt(variance)).pdf(x)

# Plot the histogram
plt.hist(returns, bins=50, edgecolor='black', density=True)
# Plot the fitted distribution
plt.plot(x, y, 'r-', label=r'$\mu = 3.82\times 10^{-4} \quad \sigma^2 = 1.
↪18\times 10^{-4}$')
plt.xlabel('Return')
plt.ylabel('Probability Density')
plt.title('Daily returns of Gold')
plt.legend()
plt.show()
```



1.2 Autocorrelations

[25]:
```
max_lag = 100
# Calculate autocorrelation for lags 1 to 100
autocorr_values = acf(returns, nlags=max_lag)
```

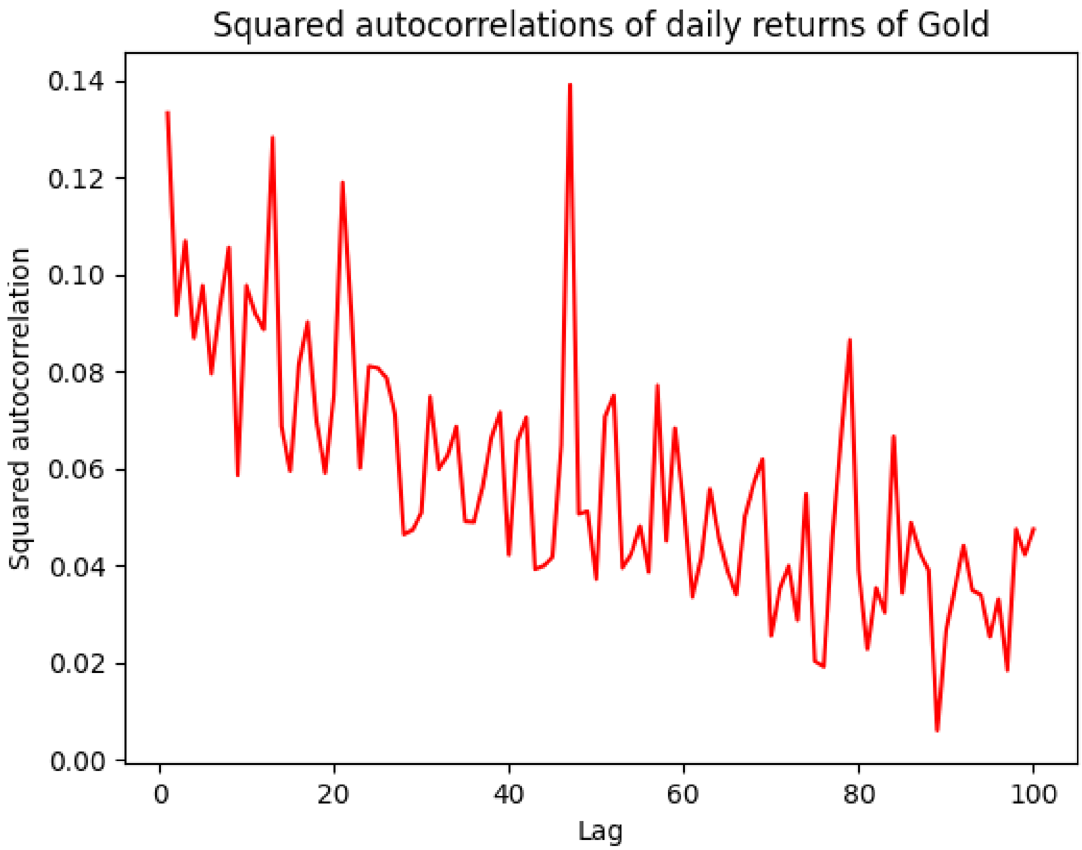
[26]:
```
x = np.arange(max_lag+1)

plt.plot(x[1:], autocorr_values[1:], 'r-')
plt.xlabel('Lag')
plt.ylabel('Autocorrelation')
plt.title('Autocorrelations of daily returns of Gold')
plt.show()
```



1.3 Squared Autocorrelations

[27]:
```
# Calculate autocorrelation for lags 1 to 100
sq_autocorr_values = acf(returns**2, nlags=max_lag)
```

[28]:
```
plt.plot(x[1:], sq_autocorr_values[1:], 'r-')
plt.xlabel('Lag')
plt.ylabel('Squared autocorrelation')
plt.title('Squared autocorrelations of daily returns of Gold')
plt.show()
```

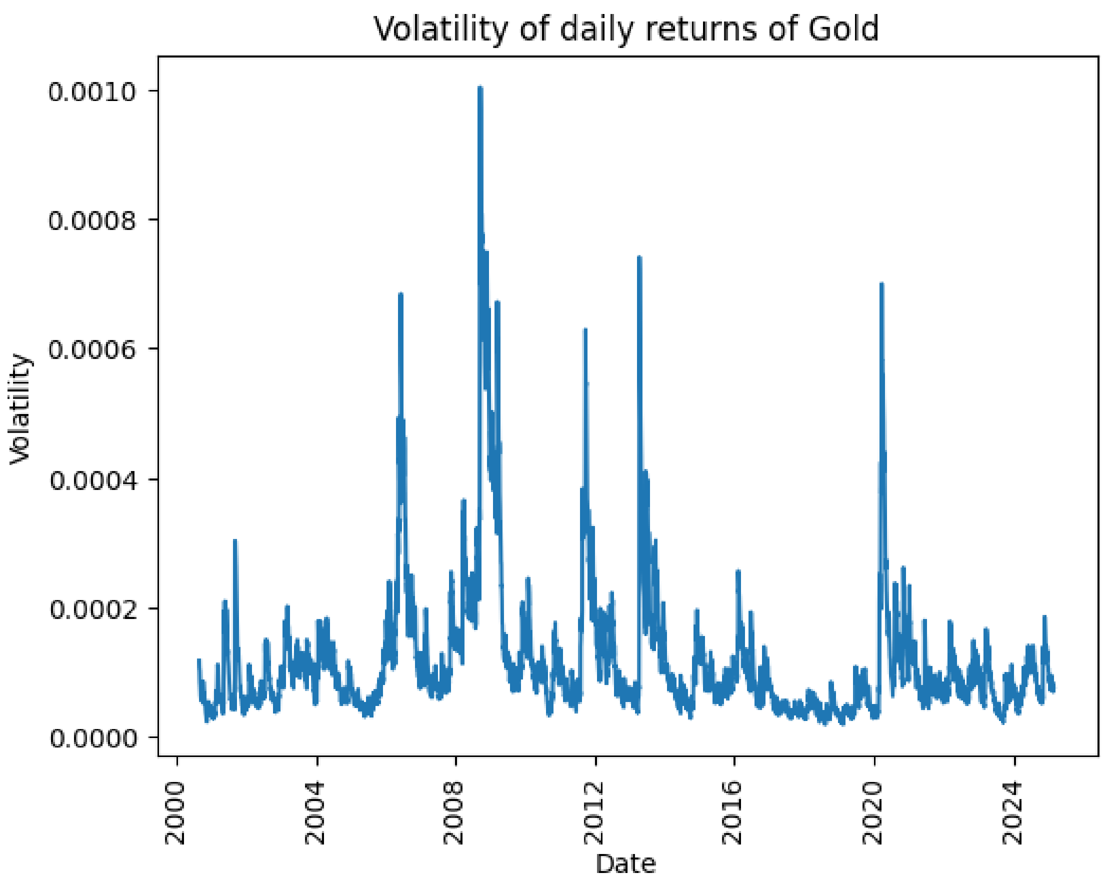


1.4 Riskmetrics

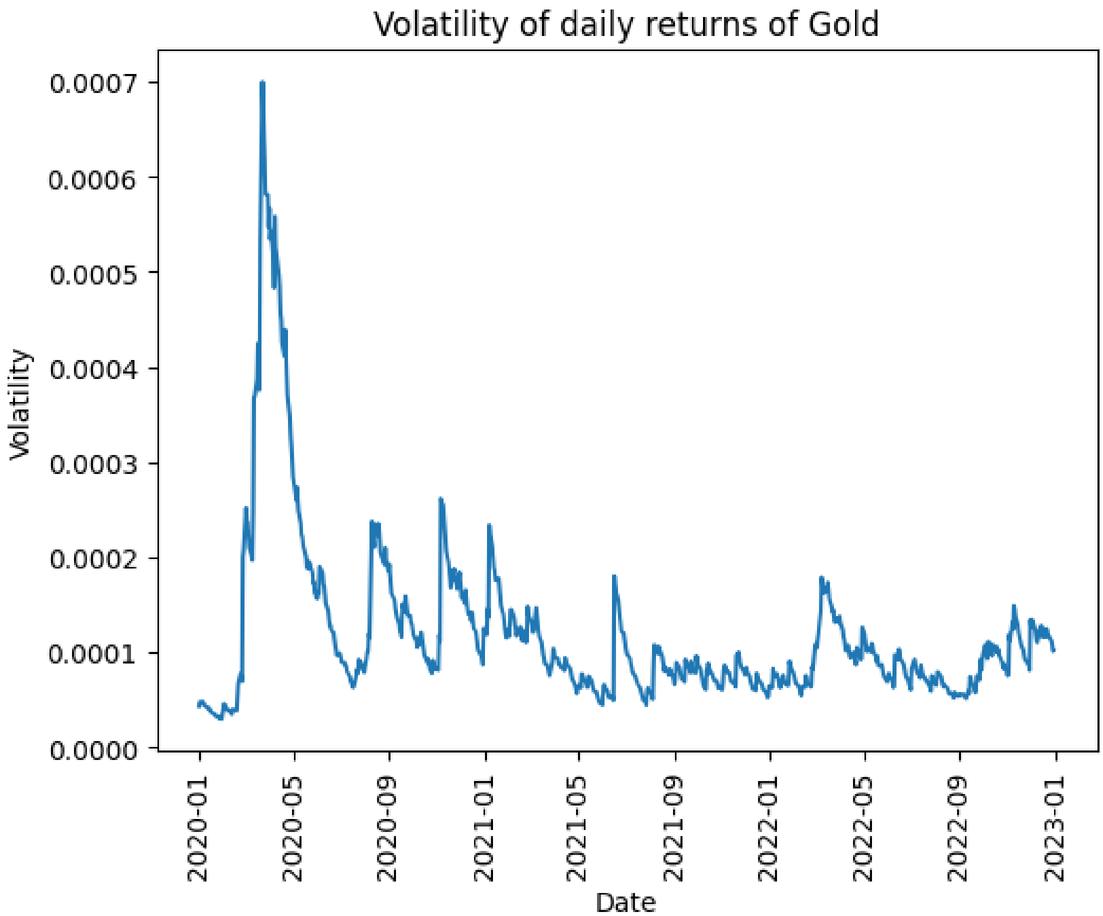
[29]:
```
def risk_metrics(returns, persistence):
    t_max = len(returns)
    volatility = np.zeros(t_max)
    volatility[0] = returns.var()
    for t in range(1, t_max):
        volatility[t] = persistence*volatility[t-1] +␣
 ↪(1-persistence)*returns[t]**2
    return volatility
```

[30]:
```
volatility = risk_metrics(returns, 0.94)
```

[31]:
```
plt.plot(dates[:-1],volatility)
# rotate x-tick-labels by 90°
plt.tick_params(axis='x',rotation=90)
plt.xlabel('Date')
plt.ylabel('Volatility')
plt.title('Volatility of daily returns of Gold')
plt.show()
```



[32]:
```
start_date = np.datetime64('2020-01-01')
end_date = np.datetime64('2022-12-31')

mask = (dates[:-1] >= start_date) & (dates[:-1] <= end_date)

plt.plot(dates[:-1][mask], volatility[mask])
# rotate x-tick-labels by 90°
plt.tick_params(axis='x', rotation=90)
plt.xlabel('Date')
plt.ylabel('Volatility')
plt.title('Volatility of daily returns of Gold')
plt.show()
```



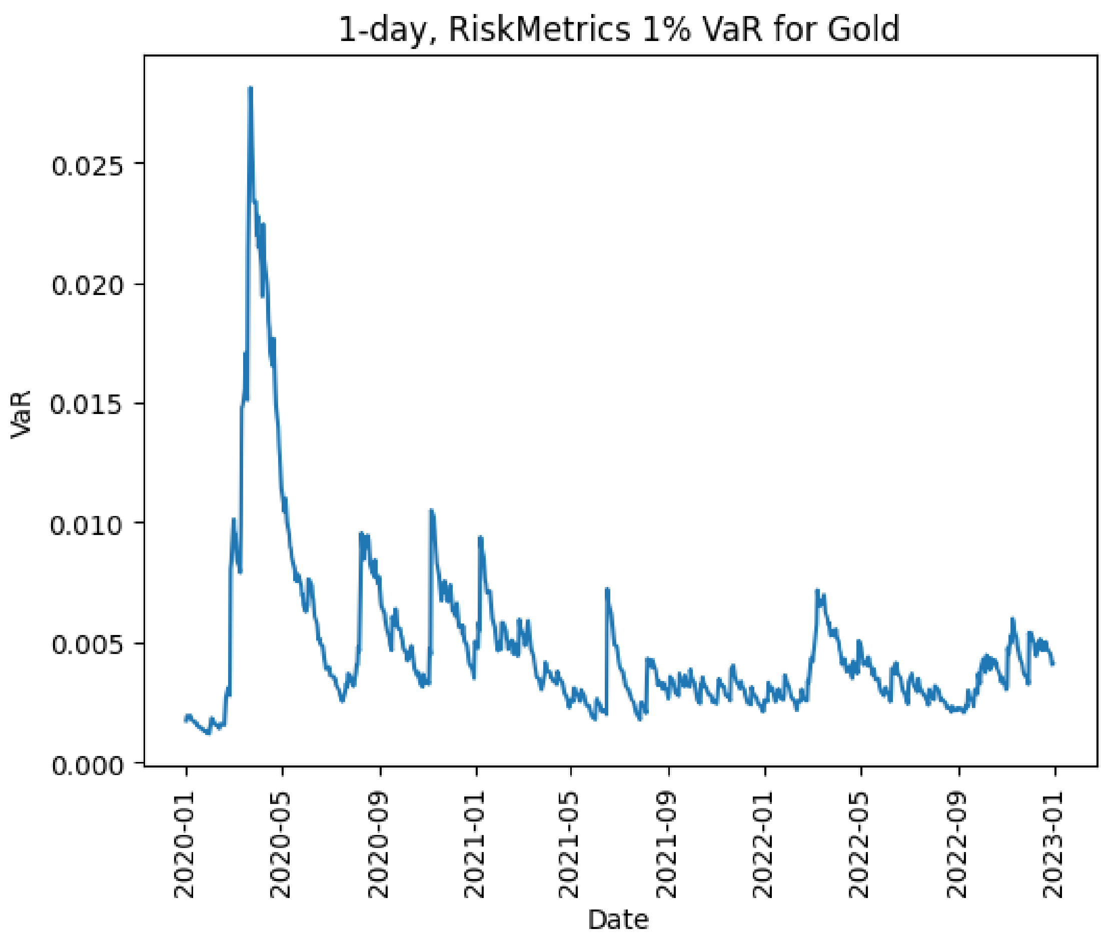
1.5 VaR

Assuming gaussian distribution of portfolio returns

[33]:
```
p = 0.01
quantile = sp.stats.norm.ppf(p, loc=mean, scale=np.sqrt(variance))
print(-quantile)
```

0.024880326653042774

[36]:
```
plt.plot(dates[:-1][mask], -quantile ** (-1) * volatility[mask])
# rotate x-tick-labels by 90°
plt.tick_params(axis='x', rotation=90)
plt.xlabel('Date')
plt.ylabel('VaR')
plt.title('1-day, RiskMetrics 1% VaR for Gold')
plt.show()
```


1-day, RiskMetrics 1% VaR for Gold
VaR
0.000
0.005
0.010
0.015
0.020
0.025
2020-01
2020-05
2020-09
2021-01
2021-05
2021-09
2022-01
2022-05
2022-09
2023-01
Date

```
[ ]:
```