Name: Ameer Hamza ; RUID: 221007975

1. Calculate the average monthly return, standard deviation, skewness, and kurtosis for the stock market, the risk free asset, the CPI, the housing market, the gold market and the crude oil market. (Please note that you have to convert the housing, gold and oil prices to their respective returns.)

```
%% FINMOD1-Assignment1-Ameer Hamza-221007975

%% File Import Process

clc
format compact

%vwret_data = xlsread("data_VWRET_DATA_MonthlyReturn_20yr_Levels.xlsx")
%hog_data = xlsread("data_Housing_Oil_Gold_Data.xlsx")
%tbillcpi_data = xlsread("data_FINMOD1_DATA_90DTBILL&CPI.xlsx")

%% Answers

clc, clearvars -except hog_data tbillcpi_data vwret_data

%% data alignment

vwret_data;
tbillcpi_data;
hog_data;

%% calculations

avg_stk = mean(vwret_data(1:end,2),1)
avg_rfr = nanmean(tbillcpi_data(1:end,2),1)
avg_cpi = nanmean(tbillcpi_data(1:end,4),1)
avg_hou = nanmean(hog_data(1:end,4),1)
avg_oil = nanmean(hog_data(1:end,5),1)
avg_gol = nanmean(hog_data(1:end,6),1)

avg_crossasset = table

avg_crossasset = table(avg_stk,avg_rfr,avg_cpi,avg_hou,avg_oil,avg_gol)
```

```
>> avg_crossasset = table(avg_stk,avg_rfr,avg_cpi,avg_hou,avg_oil,avg_gol)
avg_crossasset =
  1×6 table
```

avg_stk	avg_rfr	avg_cpi	avg_hou	avg_oil	avg_gol
0.0081662	0.0010768	0.0019093	NaN	NaN	0.0087817

```
>>
```

```matlab
%skewness

skew_stk = skewness(vwret_data(1:end,2),1), ...
skew_rfr = skewness(tbillcpi_data(1:end,2),1), ...
skew_cpi = skewness(tbillcpi_data(1:end,4),1), ...
skew_hou = skewness(hog_data(1:end,4),1), ...
skew_oil = skewness(hog_data(1:end,5),1), ...
skew_gol = skewness(hog_data(1:end,6),1) ...

skew_crossasset = table( ...
                         sdev_stk, ...
                         skew_rfr, ...
                         skew_cpi, ...
                         skew_hou, ...
                         skew_oil, ...
                         skew_gol ...
                         )

%kurtosis
kurt_stk = kurtosis(vwret_data(1:end,2),1), ...
kurt_rfr = kurtosis(tbillcpi_data(1:end,2),1), ...
kurt_cpi = kurtosis(tbillcpi_data(1:end,4),1), ...
kurt_hou = kurtosis(hog_data(1:end,4),1), ...
kurt_oil = kurtosis(hog_data(1:end,5),1), ...
kurt_gol = kurtosis(hog_data(1:end,6),1) ...

kurt_crossasset = table( ...
                         kurt_stk, ...
                         kurt_rfr, ...
                         kurt_cpi, ...
                         kurt_hou, ...
                         kurt_oil, ...
                         kurt_gol ...
                         )
```

```
>> skew_crossasset
skew_crossasset =
  1×6 table
```

sdev_stk	skew_rfr	skew_cpi	skew_hou	skew_oil	skew_gol
0.043448	1.3846	-0.85617	-0.3596	0.53595	-0.13788

```
%kurtosis
kurt_stk = kurtosis(vwret_data(1:end,2),1), ...
kurt_rfr = kurtosis(tbillcpi_data(1:end,2),1), ...
kurt_cpi = kurtosis(tbillcpi_data(1:end,4),1), ...
kurt_hou = kurtosis(hog_data(1:end,4),1), ...
kurt_oil = kurtosis(hog_data(1:end,5),1), ...
kurt_gol = kurtosis(hog_data(1:end,6),1) ...

kurt_crossasset = table( ...
                         kurt_stk, ...
                         kurt_rfr, ...
                         kurt_cpi, ...
                         kurt_hou, ...
                         kurt_oil, ...
                         kurt_gol ...
                         )
```

```
>> kurt_crossasset
kurt_crossasset =
  1×6 table
    kurt_stk    kurt_rfr    kurt_cpi    kurt_hou    kurt_oil    kurt_gol
    ________    ________    ________    ________    ________    ________

     4.8935      4.1145      6.6355      3.0972      12.722      3.6207

>>
```

2. Note that the returns provided by CRSP are discrete returns. Now convert market return from discrete to continuously compounded return (we also call the continuously compounded return log return) and calculate the sample average. Do you see a big difference between the discrete returns and continuously compounded returns?

```
%% log returns and calculations


%Compute log returns

%Fetch Stck Prices & transform to log returns
stk_levels = vwret_data(1:end,2)
stk_levels = log(stk_levels(1:end,2))
stk_levels = stk_levels + 1


%mean
lnavg_stk = nanmean(vwretlevels(1:end,3),1)
lnavg_rfr = nanmean(tbillcpi_ln(1:end,6),1)
lnavg_cpi = nanmean(tbillcpi_ln(1:end,7),1)
lnavg_hou = nanmean(hog_ln(1:end,8),1)
lnavg_oil = nanmean(hog_ln(1:end,9),1)
lnavg_gol = nanmean(hog_ln(1:end,10),1)

lnavg_crossasset = table

lnavg_crossasset = table(lnavg_stk,lnavg_rfr,lnavg_cpi,lnavg_hou,lnavg_oil,lnavg_gol)
```

```
>> lnavg_crossasset = table(lnavg_stk,lnavg_rfr,lnavg_cpi,lnavg_hou,lnavg_oil,lnavg_gol)
lnavg_crossasset =
  1×6 table
```

lnavg_stk	lnavg_rfr	lnavg_cpi	lnavg_hou	lnavg_oil	lnavg_gol
0.0041163	0.0010737	0.0018987	0.003759	0.0059863	0.0075671

```
>>
```

```
%standard deviation
lnsdev_stk = nanstd(vwretlevels(1:end,3),1), ...
lnsdev_rfr = nanstd(tbillcpi_ln(1:end,6),1), ...
lnsdev_cpi = nanstd(tbillcpi_ln(1:end,7),1), ...
lnsdev_hou = nanstd(hog_ln(1:end,8),1), ...
lnsdev_oil = nanstd(hog_ln(1:end,9),1), ...
lnsdev_gol = nanstd(hog_ln(1:end,10),1) ...

lnstddev_crossasset = table( ...
                         lnsdev_stk, ...
                         lnsdev_rfr, ...
                         lnsdev_cpi, ...
                         lnsdev_cpi, ...
                         lnsdev_oil, ...
                         lnsdev_gol ...
                         )
```

```
lnstddev_crossasset =
  1×6 table
    lnsdev_stk    lnsdev_rfr    lnsdev_cpi    lnsdev_cpi_1    lnsdev_oil    lnsdev_gol
    __________    __________    __________    ____________    __________    __________
     0.047091     0.0012999     0.0038174      0.0038174       0.10714       0.04863
>>
```

```
%skewness
lnskew_stk = skewness(vwretlevels(1:end,2),1), ...
lnskew_rfr = skewness(tbillcpi_ln(1:end,2),1), ...
lnskew_cpi = skewness(tbillcpi_ln(1:end,4),1), ...
lnskew_hou = skewness(hog_ln(1:end,4),1), ...
lnskew_oil = skewness(hog_ln(1:end,5),1), ...
lnskew_gol = skewness(hog_ln(1:end,6),1) ...

lnskew_crossasset = table( ...
                    lnskew_stk, ...
                    lnskew_rfr, ...
                    lnskew_cpi, ...
                    lnskew_hou, ...
                    lnskew_oil, ...
                    lnskew_gol ...
                    )
```

```
lnskew_crossasset =
  1×6 table
```

lnskew_stk	lnskew_rfr	lnskew_cpi	lnskew_hou	lnskew_oil	lnskew_gol
1.235	1.3846	-0.85617	-0.21276	-0.3596	0.53595

```
>>
```

```
%kurtosis
lnkurt_stk = kurtosis(vwretlevels(1:end,2),1), ...
lnkurt_rfr = kurtosis(tbillcpi_ln(1:end,2),1), ...
lnkurt_cpi = kurtosis(tbillcpi_ln(1:end,4),1), ...
lnkurt_hou = kurtosis(hog_ln(1:end,4),1), ...
lnkurt_oil = kurtosis(hog_ln(1:end,5),1), ...
lnkurt_gol = kurtosis(hog_ln(1:end,6),1) ...

lnkurt_crossasset = table( ...
                    lnkurt_stk, ...
                    lnkurt_rfr, ...
                    lnkurt_cpi, ...
                    lnkurt_hou, ...
                    lnkurt_oil, ...
                    lnkurt_gol ...
                    )
```

```
lnkurt_crossasset =
  1×6 table
```

lnkurt_stk	lnkurt_rfr	lnkurt_cpi	lnkurt_hou	lnkurt_oil	lnkurt_gol
3.8017	4.1145	6.6355	1.9122	3.0972	12.722

```
fx >>
```

3. We know that in general investors may be better off by investing in stocks than in T-bills if the investment horizon is relatively long. The difference between the market return and the T-bill rate is called the equity risk premium. Using the 20-year data, test whether the equity risk premium is significantly positive using the standard t-test. Also calculate the average real return rate for the T-bill using the CPI index.

t-Test: Two-Sample Assuming Unequal Variances

	vwretd	*90dayTBIL*
Mean	0.8481%	0.1077%
Variance	0.1894%	0.0002%
Observations	240	240
Hypothesized Mean Difference	0	
df	239	
t Stat	2.634627822	
P(T<=t) one-tail	0.004486706	
t Critical one-tail	1.651254165	
P(T<=t) two-tail	0.008973412	
t Critical two-tail	1.969939406	

P(T<=t) one-tail and two-tail values are less than 0.05 we reject the null hypothesis that the difference between means of stocks and 90-day tbill are same. This means that we have sufficient evidence to say that two population means are different over a longer period.

Average real rate of return for 90d-TBILL is -0.08324625% (after adjusting for inflation rate).

4. Many people believe that real estate is always a good investment at least in the long run. Do you agree? People also argue that gold is a safe asset with a good return. Do you agree? Would you make a fortune by investing in the oil market compared to the stock market in the past 20 years (think about return vs. risk)?

Real-estate is a good investment based on the data available for the period of last 20years. Mean return for real-estate is 0.37%.

Average return from gold is 0.93% how ever the standard deviation is 4.901%, given the risk-reward, the average return of gold is not adequate for the given level of risk.

Investing in Oil has given the highest monthly return of 1.17%, however with standard deviation is 10.592% which make it the third best investment considering risk-return ratio.

	mean	std.dev	rfr	sharpe ratio	
housing	0.37%	0.658%	0.108%	0.4034	higher, it is better
cpi	0.19%	0.381%	0.108%	0.2185	
stocks	0.85%	4.343%	0.108%	0.1705	2nd best per unit of risk
gold	0.93%	4.901%	0.108%	0.1670	3rd best per unit of risk
oil	1.17%	10.592%	0.108%	0.1001	
tbill	0.11%	0.130%	0.108%	0.0000	

5. We often assume that stock returns are normally distributed. Calculate the skewness and kurtosis of market returns. Is the distribution skewed? Does the distribution have excess kurtosis? Use the Jarque-Bera test to see whether the market return follows a normal distribution. Also do the same analysis using daily and annual market returns data.

	mean	std.dev	skew	kurt
stocks	0.85%	4.343%	-0.6779	2.0228
tbill	0.11%	0.130%	1.3933	1.1635
cpi	0.19%	0.381%	-0.8616	3.7378
housing	0.37%	0.658%	-0.4843	0.2224
oil	1.17%	10.592%	0.5480	10.2466
gold	0.93%	4.901%	-0.1640	0.6839

The Jarque-Bera test statistic for normality can be calculated as follows:

$$JB = \frac{S^2}{6/T} + \frac{(K-3)^2}{24/T}$$

where

$S = \frac{\mu_3}{(\sigma)^3}$ is called skewness

$K = \frac{\mu_4}{(\sigma)^4}$ is called kurtosis

$$\sigma = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^2}$$

$$\bar{x} = \frac{1}{T}\sum_{t=1}^{T} x_t$$

$$\mu_3 = \frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^3$$

$$\mu_4 = \frac{1}{T}\sum_{t=1}^{T}(x_t - \bar{x})^4$$

T is the sample size and x is the returns data.
Under the null hypothesis that returns are normally distributed, we have

$$\frac{S}{\sqrt{6/T}} \sim N(0,1)$$

$$\frac{(K-3)}{\sqrt{24/T}} \sim N(0,1)$$

Furthermore, S and K are independent and therefore

$JB \sim \chi^2(2)$.