Buy and Hold Strategy

September 29, 2024

Functions (IGNORE)

[ ]:
```
# import packages that will be used for analysis
import yfinance as yf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import random
```

Get Stock Data

[ ]:
```
import yfinance as yf
missing_data_tickers = [] # use this as a list of tickers with missing data

def get_data_from_start_to_end(ticker, start_date, end_date):
    global missing_data_tickers  # Use the global list to accumulate missing␣
 ↪tickers
    try:
        stock_data = yf.download(ticker, start=start_date, end=end_date)
        if stock_data.empty:
            missing_data_tickers.append(ticker)
            raise ValueError(f"Stock data for ticker {ticker} during the period␣
 ↪from {start_date} to {end_date} was not found.")
        return stock_data
    except Exception as e:
        print(f"An error occurred for ticker {ticker}: {e}")
        missing_data_tickers.append(ticker)
        return None
```

[ ]:
```
# for a variety of periods load in different list of tickers
def download_stock_data_for_periods(tickers, periods):
    all_data = {}

    for period, (start_date, end_date) in periods.items():
        period_data = {}
        for ticker in tickers:
            data = get_data_from_start_to_end(ticker, start_date, end_date)
            if data is not None:
                period_data[ticker] = data
```

```
        all_data[period] = period_data

    return all_data
```

[ ]:
```
import pandas as pd

# Get the adjusted close prices
adj_close_sector_etf = {}

# Create adjusted close price only listing of sector ETFs
def get_adjusted_closed_price(nested_dict, tickers, periods):
    for period in periods:
        stock_price_df = pd.DataFrame()  # Create a new DataFrame for each␣
↪period
        for ticker in tickers:
            stock_price_df[ticker] = nested_dict[period][ticker]['Adj Close']

        adj_close_sector_etf[period] = stock_price_df  # Store the complete␣
↪DataFrame for the period

    return adj_close_sector_etf
```

Stochastic Modeling

[ ]:
```
def stochastic_modeling(nested_dict, tickers,␣
↪periods,num_samples,investment_period):
    # Store the returns in a nested dictionary
    nested_dict_returns = {period: {ticker: [] for ticker in tickers} for␣
↪period in periods}

    # Go through each economic time period
    for period in periods:
        max_index = len(nested_dict[period]) - investment_period  # Ensure␣
↪there's enough data to calculate ROI

        # Generate random samples from the valid range
        random_dates = random.choices(range(max_index), k=num_samples)

        for ticker in tickers:
            for date_idx in random_dates:
                start_price = nested_dict[period][ticker].iloc[date_idx]
                end_price = nested_dict[period][ticker].iloc[date_idx +␣
↪investment_period]

                # Get the return by the Holding Period Return
                roi = (((end_price - start_price) / start_price) * 100)
```

```
                nested_dict_returns[period][ticker].append(roi)

    return nested_dict_returns  # Return the nested dictionary with returns
```

[ ]:
```
def stochastic_roi(tickers,periods,return_rates_list,analysis_type):
    df = pd.DataFrame(index=tickers,columns=periods)
    for period in periods:
        for ticker in tickers:
            data = pd.Series(return_rates_list[period][ticker])
            if analysis_type=='Mean':
                df.at[ticker,period] = data.mean()
            elif analysis_type=='Median':
                df.at[ticker,period] = data.median()
            elif analysis_type=='Std':
                df.at[ticker,period] = data.std()
            elif analysis_type=='Variance':
                df.at[ticker,period] = data.var()

    return df
```

Plot Data

[ ]:
```
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np

# Function to plot percentage-based histogram
def plot_percentage_histogram(data, title, xlabel, ylabel, bins=10,␣
 ↪color='skyblue'):
    """
    Plots a percentage-based histogram for the given data.

    Parameters:
    data (array-like): Data to plot the histogram for.
    title (str): Title of the plot.
    xlabel (str): Label for the x-axis.
    ylabel (str): Label for the y-axis.
    bins (int): Number of bins for the histogram.
    color (str): Color for the histogram bars.
    """
    # Set modern aesthetic
    sns.set_style("whitegrid")

    # Create the histogram
    plt.figure(figsize=(10, 6))
    plt.hist(data, bins=bins, color=color, edgecolor='black',
             weights=np.ones_like(data) / len(data))
```

```
    # Convert y-axis to percentages
    plt.gca().yaxis.set_major_formatter(plt.FuncFormatter(lambda y, _: f'{y*100:
↪.0f}%'))

    # Add titles and labels with improved font sizes
    plt.title(title, fontsize=16, fontweight='bold')
    plt.xlabel(xlabel, fontsize=14)
    plt.ylabel(ylabel, fontsize=14)

    # Add gridlines for better readability
    plt.grid(True, which='both', linestyle='--', linewidth=0.7, alpha=0.7)

    # Adjust layout for better spacing
    plt.tight_layout()

    # Show the plot
    plt.show()
```

1 Chapter 1: Buy and Hold Strategy

A Buy and Hold Strategy is an investment approach where an investor purchases stocks or other assets and holds onto them for an extended period, regardless of short-term market fluctuations. This strategy operates on the assumption that, over time, the market tends to increase in value, thus yielding returns on investments held over years. It's particularly popular among novice investors for its simplicity and potential to minimize the stress of frequent trading decisions.

1.1 Buy and Hold Strategy using Sector ETF's

Sector ETFs are the accumulation of a variety of stocks within one of the 11 GICS Sectors (see documentation). They are meant to be a representation of a sector's overall movement. This will allow for a better understanding of which sectors perform best over time. To add further complexity, different economic time periods will be used to evaluate the changing success of an investment based on macroeconomic environments. For example some stocks out perform benchmarks during a recession due to their defensive nature such as the Health Care ETF (XLV).

1.2 Sector ETF and Time Period Setup

[ ]:
```
# create time periods for where this takes place
economic_cycle_periods = {

    "trough": ("2008-10-01", "2009-06-01"),
    "expansion": ("2012-01-01", "2015-01-01"),
    "peak": ("2019-06-01", "2020-02-01"),
    "contraction": ("2007-12-01", "2008-10-01"),
    'all_data': ('2005-01-01','2024-06-01')
}
```

```
economic_cycle_periods_list =␣
 ↪['trough','expansion','peak','contraction','all_data']
```

```
[ ]: # create etf tickers for sectors
sector_etf_tickers = [
    'XLB', # materials sector
    'XLI', # industrials sector
    'XLF', # financials
    'XLK', # information technology
    'XLY', # consumer discretionary
    'XLP', # consumer staples
    'XLE', # energy
    'XLV', # healthcare
    'VOX', # communication services
    'XLU', # utilities
    'IYR' # real estate
    ]
```

```
[ ]: # save nested dictionary data as a variable to be accessed.
sector_etf_data =␣
 ↪download_stock_data_for_periods(sector_etf_tickers,economic_cycle_periods)
```

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```

1.3 Perform Stochastic Modeling using Buy and Hold Strategies

Using stochastic modeling is essential for financial investment backtesting. When you have a strategy it needs to be tested in lots of different environments. By having different buy days with a set investment period, this is going to reduce the deviation in returns. You should get a distribution of how the returns is spread over many iterations as well as the deviation from the average.

1.3.1 Get Sector ETF Adjusted Close

The only data that is required for this investigation is the adjusted close price. This data can create a dataframe in which the columns are populated by adjusted closed price for stocks on days of the sample.

[ ]:
```
# using the function 'get_adjusted_closed_price' you can create a nested␣
↪dictionary which can go into different periods to get adjusted close data
sector_etf_adjusted_close =␣
↪get_adjusted_closed_price(sector_etf_data,sector_etf_tickers,economic_cycle_periods_list)
```

[ ]:
```
# 'sector_etf_adjusted_close' is now a dataframe that can be accessed during different business cycles
trough_adjusted_close = sector_etf_adjusted_close['trough']
trough_adjusted_close
```

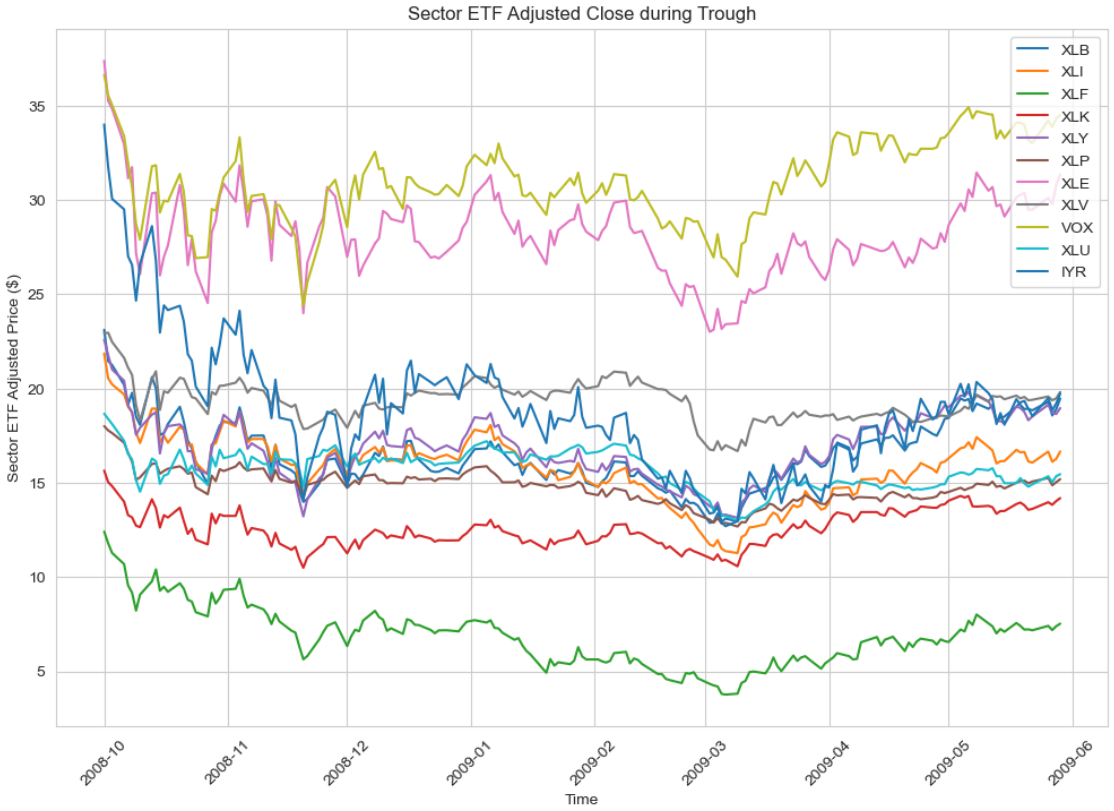
[ ]:
```
                 XLB        XLI        XLF        XLK        XLY        XLP  \
Date
2008-10-01  23.119263  21.858324  12.413445  15.649681  22.589596  18.009504
2008-10-02  21.458340  20.549891  11.794873  15.037060  21.771833  17.782764
2008-10-03  21.247196  20.222771  11.278401  14.822242  21.010752  17.640247
2008-10-06  20.198572  19.692133  10.689857  14.002764  20.419703  17.128458
2008-10-07  19.156969  19.037899   9.560819  13.286714  19.108046  16.584291
…                 …          …          …          …          …          …
2009-05-22  18.848721  16.073530   7.178294  13.618086  18.520382  15.070187
2009-05-26  19.300220  16.658962   7.412233  13.971802  19.143747  15.260787
2009-05-27  18.576372  16.117989   7.190604  13.835139  18.725447  14.873023
2009-05-28  18.906054  16.273617   7.393763  14.036113  18.651630  15.030751
2009-05-29  19.472223  16.666370   7.529201  14.188848  18.963299  15.195062

                 XLE        XLV        VOX        XLU        IYR
Date
2008-10-01  37.393250  22.927481  36.648041  18.666506  34.011742
2008-10-02  35.261120  22.965391  35.561859  18.395731  31.759153
2008-10-03  34.840694  22.472725  35.039410  18.119316  30.064146
2008-10-06  32.966835  21.631418  33.396397  17.233658  29.512152
2008-10-07  31.159033  21.108442  31.966482  16.528517  27.019821
…                 …          …          …          …          …
2009-05-22  29.497366  19.404512  33.037392  14.918159  18.541613
2009-05-26  30.122383  19.580990  34.221859  15.351318  19.500561
2009-05-27  29.794701  19.381498  33.881416  15.039446  18.851517
2009-05-28  30.783812  19.481239  34.314072  15.351318  19.208202
2009-05-29  31.360281  19.818840  34.512665  15.461066  19.734449

[166 rows x 11 columns]
```

[ ]:
```
# a plot of adjusted close price of tickers during trough
plt.figure(figsize=(12,8))
for idx,ticker in enumerate(trough_adjusted_close.columns):
    plt.plot(trough_adjusted_close[ticker],label=f'{ticker}')
plt.xlabel('Time')
plt.xticks(rotation=45)
plt.ylabel('Sector ETF Adjusted Price ($)')
plt.legend()
plt.title('Sector ETF Adjusted Close during Trough')
```

[ ]:
```
Text(0.5, 1.0, 'Sector ETF Adjusted Close during Trough')
```



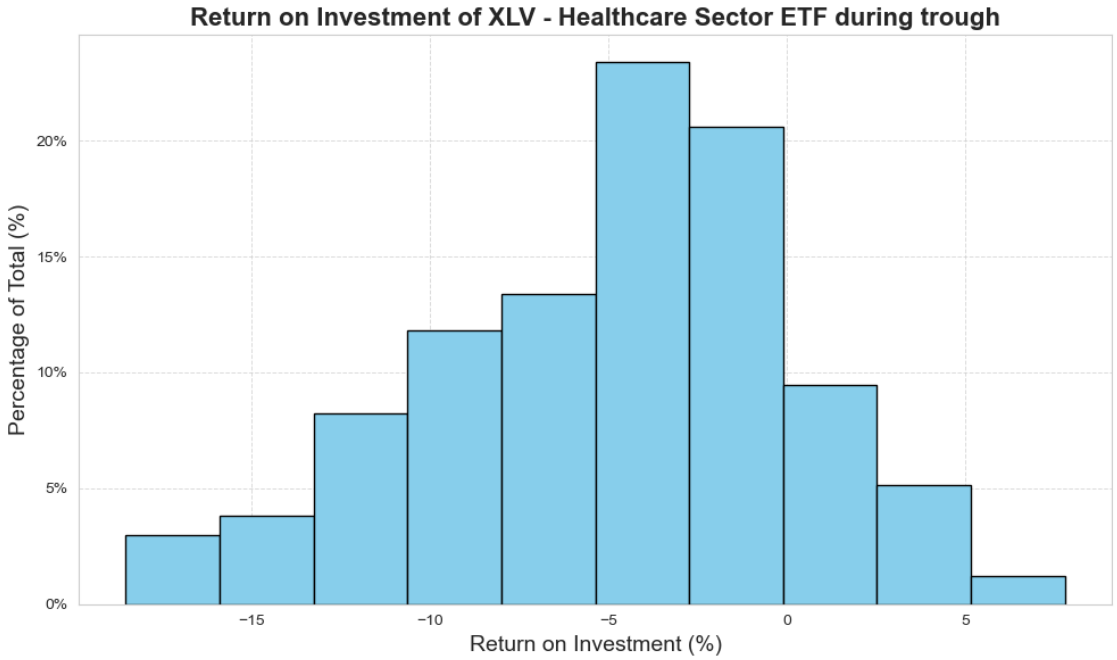
1.3.2 Stochastic Model

The stochastic model is going to perform the following methdology.

1. Choose 10000 start dates (within each business cycle)
2. Loop through each start day
3. Purchase 1 stock of each sector ETF and hold onto it for 90 calendar days
4. Get the ROI from the stock investment

[ ]:
```
# save the nested dictionary of returnings for each ticker in each period using␣
 ↪10000 sample days across a 90 day investment period
period_return =␣
 ↪stochastic_modeling(sector_etf_adjusted_close,sector_etf_tickers,economic_cycle_periods_lis
```

[ ]:
```
# plot the histogram of the XLV healthcare during a trough
plot_percentage_histogram(
    data=period_return['trough']['XLV'],
    title=f'Return on Investment of XLV - Healthcare Sector ETF during trough',
    xlabel='Return on Investment (%)',
        ylabel='Percentage of Total (%)'
)
```



[ ]:
```
# get the average returns from the list of sectors during different time periods
mean_average_return =␣
 ↪stochastic_roi(sector_etf_tickers,economic_cycle_periods_list,period_return,'Mean')
mean_average_return
```

[ ]:

	trough	expansion	peak	contraction	all_data
XLB	-1.064495	4.979527	4.188008	-0.32123	3.944755
XLI	-13.284115	6.464632	6.918579	-4.535156	4.372334
XLF	-21.83167	7.417343	9.668537	-15.511792	3.252801
XLK	3.31728	5.664431	12.701312	-2.841855	5.932229
XLY	-1.193952	7.09759	3.471831	-4.200303	4.67005
XLP	-8.196526	5.863069	5.207061	0.49211	3.462648
XLE	-4.726092	3.631232	-0.273897	3.535435	3.975506
XLV	-4.733877	9.185574	8.596328	-3.832189	4.046522
VOX	4.171252	5.434144	6.197651	-5.491315	3.334933
XLU	-8.692614	4.956183	6.30816	-2.758492	3.174207
IYR	-17.480399	4.371322	4.315682	-0.079943	3.23313

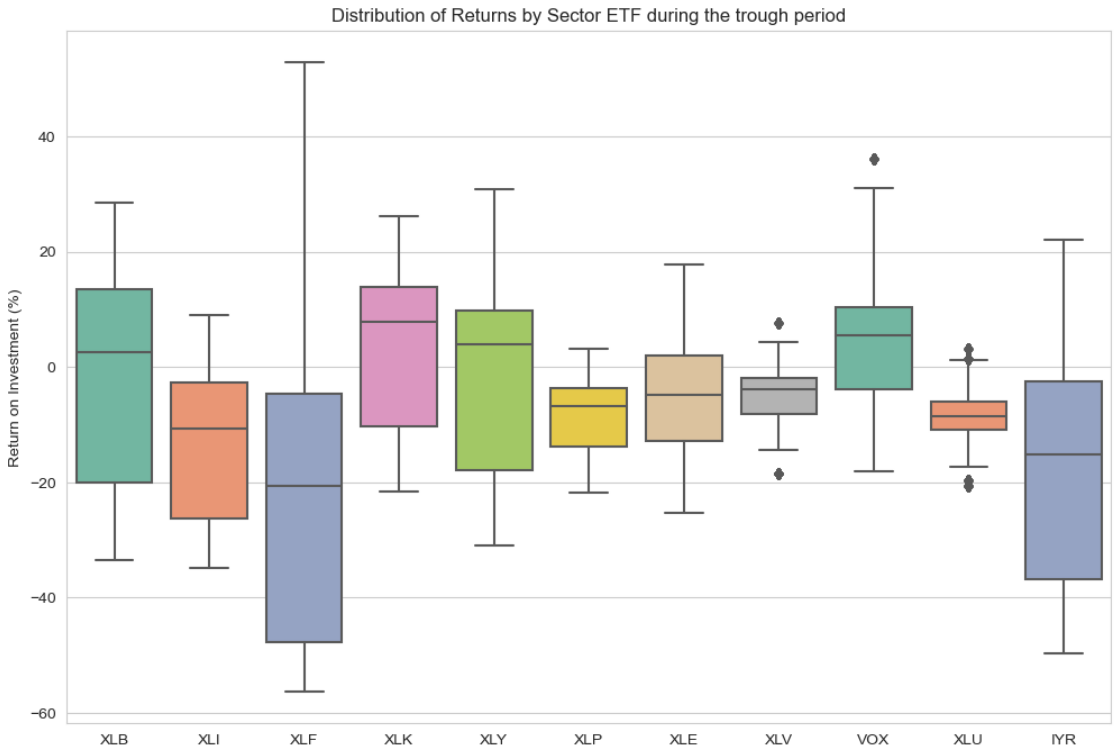
[ ]:
```
std_average_return =␣
 ↪stochastic_roi(sector_etf_tickers,economic_cycle_periods_list,period_return,'Std')
std_average_return
```

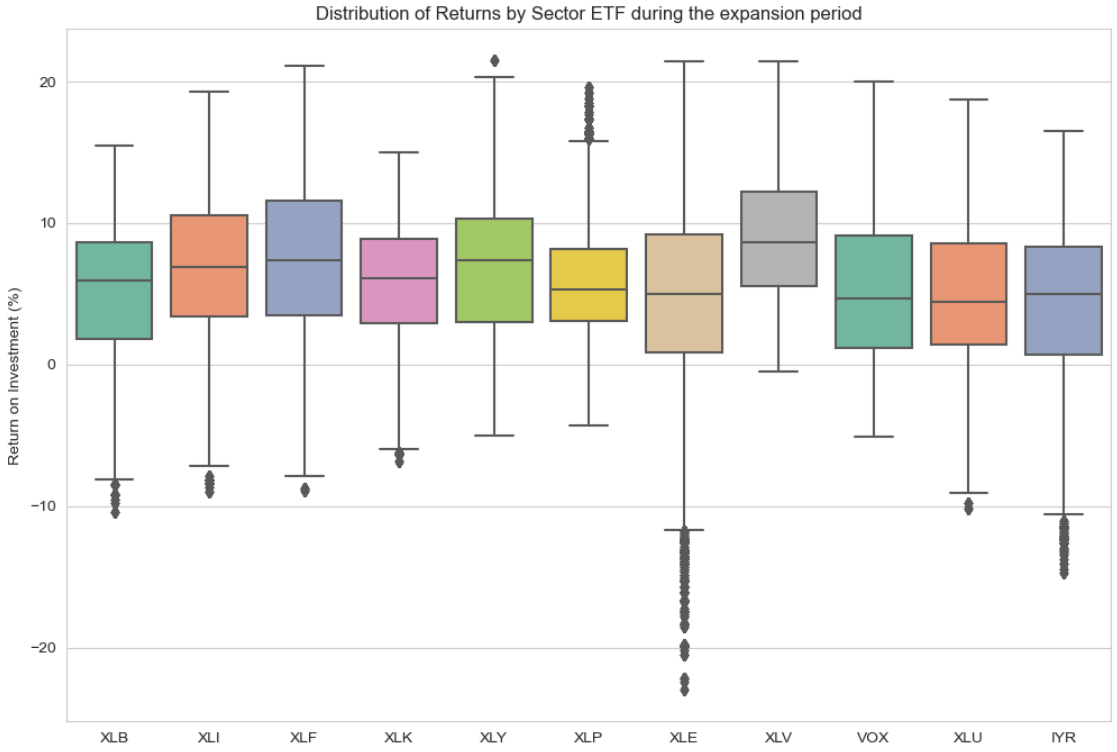
[ ]:

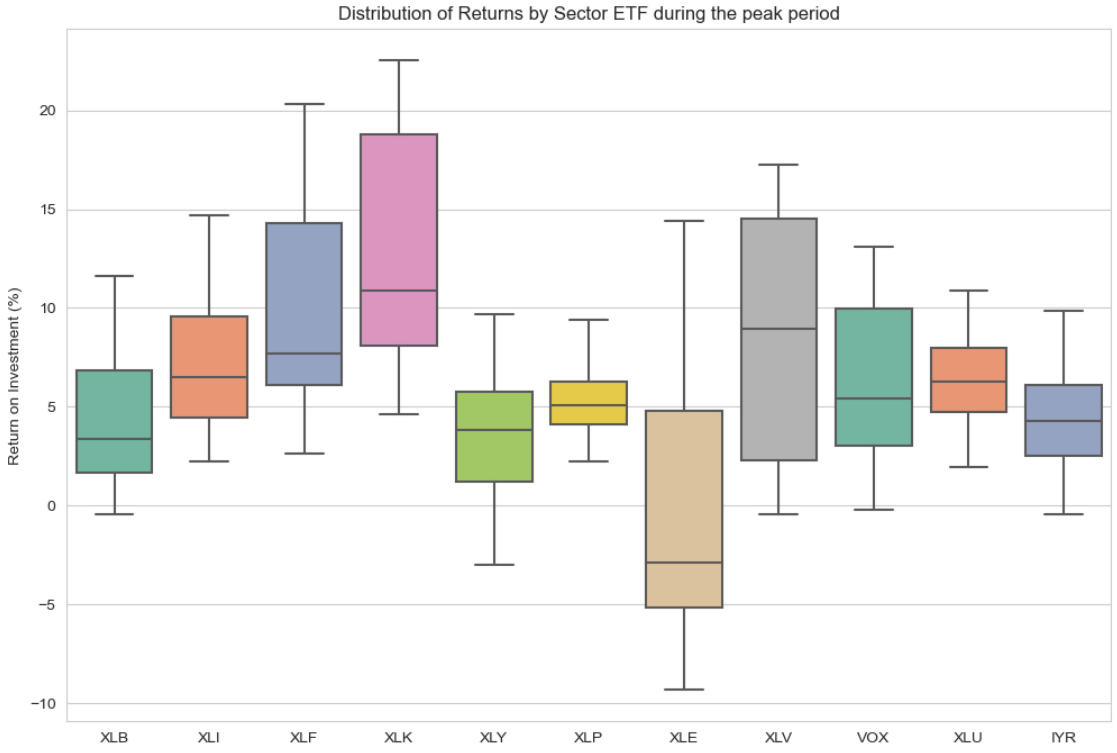
	trough	expansion	peak	contraction	all_data
XLB	17.972399	5.474867	3.117157	10.661207	11.85522
XLI	12.311095	5.708901	3.265997	6.953038	11.12007

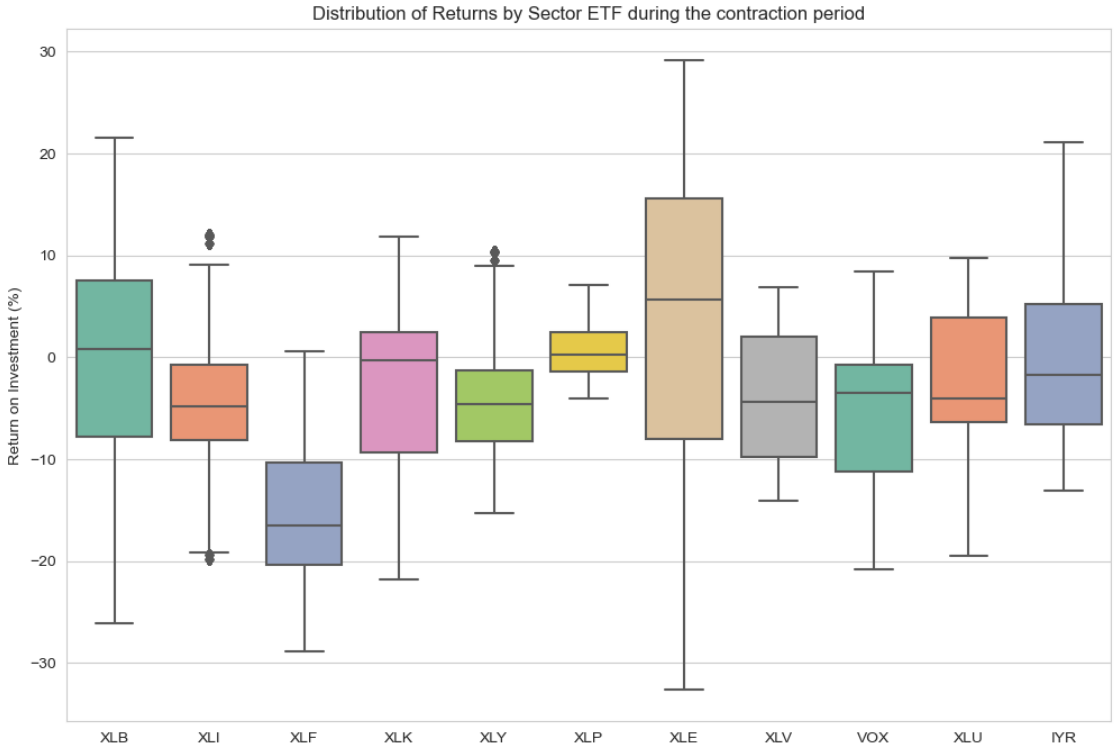
```
XLF  24.564174  5.729303  4.757598    6.712705  14.534847
XLK  12.951741  4.518308  5.498791    7.908915  10.629056
XLY  15.013168  5.335813  3.233997    6.037021  10.957167
XLP   5.888703  4.372726  1.551857    2.679588   6.113985
XLE   9.662532  8.940841  6.332909    15.13302  15.557247
XLV    5.16577  4.506533  5.767607    6.434492   7.439571
VOX   9.912841  5.263906  3.604169    7.170781  10.527509
XLU   4.614458  5.984067  2.044658    6.747162   7.676685
IYR  18.548687  6.329258  2.199723    8.188481  12.494478
```

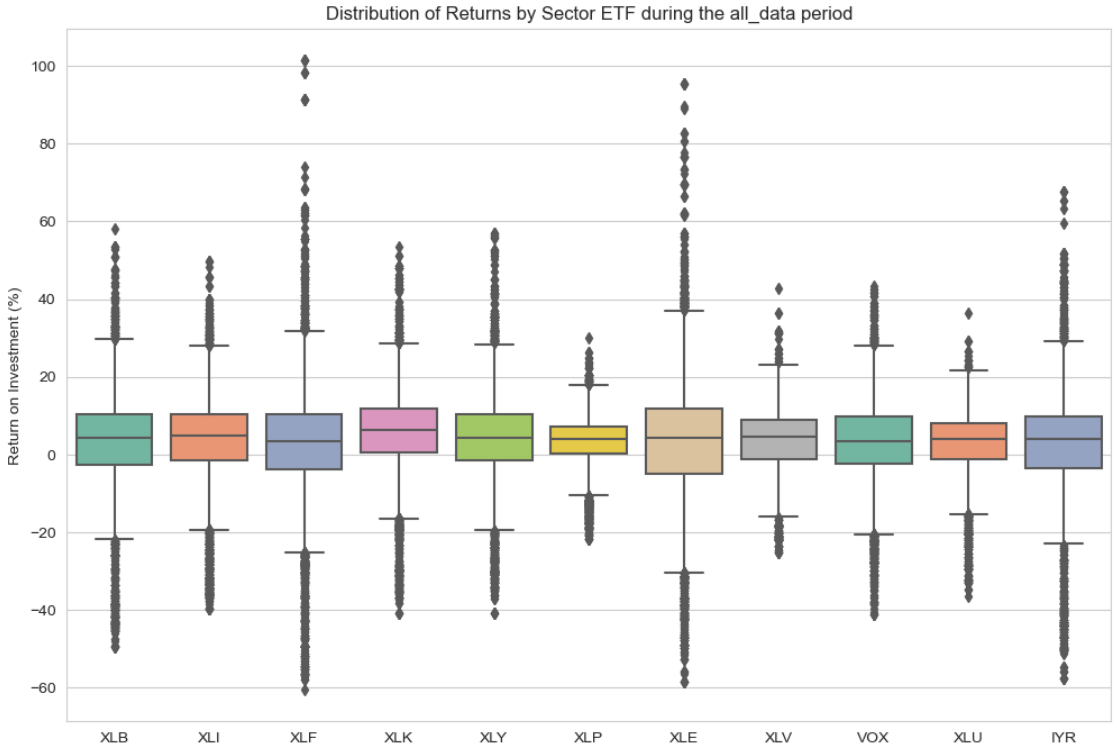
[ ]:
```
# create a boxplot of the above information for visualization
for period in economic_cycle_periods_list:
        # Boxplot of returns for each sector during the trough
        plt.figure(figsize=(12,8))
        sns.boxplot(data=[period_return[period][ticker] for ticker in␣
 ↪sector_etf_tickers], palette='Set2')
        plt.xticks(range(len(sector_etf_tickers)), sector_etf_tickers)
        plt.title(f'Distribution of Returns by Sector ETF during the {period}␣
 ↪period')
        plt.ylabel('Return on Investment (%)')
        plt.show()
```




Distribution of Returns by Sector ETF during the expansion period
Return on Investment (%)
20
10
0
−10
−20
XLB
XLI
XLF
XLK
XLY
XLP
XLE
XLV
VOX
XLU
IYR


Distribution of Returns by Sector ETF during the peak period
Return on Investment (%)
20
15
10
5
0
−5
−10
XLB
XLI
XLF
XLK
XLY
XLP
XLE
XLV
VOX
XLU
IYR


Distribution of Returns by Sector ETF during the contraction period
Return on Investment (%)
30
20
10
0
−10
−20
−30
XLB
XLI
XLF
XLK
XLY
XLP
XLE
XLV
VOX
XLU
IYR


Distribution of Returns by Sector ETF during the all_data period
Return on Investment (%)
100
80
60
40
20
0
−20
−40
−60
XLB
XLI
XLF
XLK
XLY
XLP
XLE
XLV
VOX
XLU
IYR

1.3.3 Conclusion

The buy and hold strategy is a simple yet effective strategy over the long term. However, it is clear that there are certain improvements that are made during different macreconomic cycles. During an expansion most stocks increase by a greater amount than during a constraction. The standard deviation also seems to be far greater during troughs which means that the expected return is much more volatile.

The full analysis can be found in the report.