harry-browne-permanent-portfolio

June 4, 2025

1 Does Harry Browne's permanent portfolio withstand the test of time?

1.1 Python Imports

[1]:
```
# Standard Library
import datetime
import io
import os
import random
import sys
import warnings

from datetime import datetime, timedelta
from pathlib import Path

# Data Handling
import numpy as np
import pandas as pd

# Data Visualization
import matplotlib.dates as mdates
import matplotlib.pyplot as plt
import matplotlib.ticker as mtick
import seaborn as sns
from matplotlib.ticker import FormatStrFormatter, FuncFormatter, MultipleLocator

# Data Sources
import yfinance as yf

# Statistical Analysis
import statsmodels.api as sm

# Machine Learning
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
```

```
# Suppress warnings
warnings.filterwarnings("ignore")
```

1.2 Add Directories To Path

[2]:
```
# Add the source subdirectory to the system path to allow import config from␣
 ↪settings.py
current_directory = Path(os.getcwd())
website_base_directory = current_directory.parent.parent.parent
src_directory = website_base_directory / "src"
sys.path.append(str(src_directory)) if str(src_directory) not in sys.path else␣
 ↪None

# Import settings.py
from settings import config

# Add configured directories from config to path
SOURCE_DIR = config("SOURCE_DIR")
sys.path.append(str(Path(SOURCE_DIR))) if str(Path(SOURCE_DIR)) not in sys.path␣
 ↪else None

QUANT_FINANCE_RESEARCH_BASE_DIR = config("QUANT_FINANCE_RESEARCH_BASE_DIR")
sys.path.append(str(Path(QUANT_FINANCE_RESEARCH_BASE_DIR))) if␣
 ↪str(Path(QUANT_FINANCE_RESEARCH_BASE_DIR)) not in sys.path else None

QUANT_FINANCE_RESEARCH_SOURCE_DIR = config("QUANT_FINANCE_RESEARCH_SOURCE_DIR")
sys.path.append(str(Path(QUANT_FINANCE_RESEARCH_SOURCE_DIR))) if␣
 ↪str(Path(QUANT_FINANCE_RESEARCH_SOURCE_DIR)) not in sys.path else None

# Add other configured directories
BASE_DIR = config("BASE_DIR")
CONTENT_DIR = config("CONTENT_DIR")
POSTS_DIR = config("POSTS_DIR")
PAGES_DIR = config("PAGES_DIR")
PUBLIC_DIR = config("PUBLIC_DIR")
SOURCE_DIR = config("SOURCE_DIR")
DATA_DIR = config("DATA_DIR")
DATA_MANUAL_DIR = config("DATA_MANUAL_DIR")

# Print system path
for i, path in enumerate(sys.path):
    print(f"{i}: {path}")
```

```
0: /usr/lib/python313.zip
1: /usr/lib/python3.13
2: /usr/lib/python3.13/lib-dynload
3:
```

```
4: /home/jared/python-virtual-envs/general_313/lib/python3.13/site-packages
5: /home/jared/Cloud_Storage/Dropbox/Websites/jaredszajkowski.github.io/src
6: /home/jared/Cloud_Storage/Dropbox/Quant_Finance_Research
7: /home/jared/Cloud_Storage/Dropbox/Quant_Finance_Research/src
```

1.3 Track Index Dependencies

[3]:
```
# Create file to track markdown dependencies
dep_file = Path("index_dep.txt")
dep_file.write_text("")
```

[3]:
```
0
```

1.4 Python Functions

[4]:
```
from bb_clean_data import bb_clean_data
from df_info import df_info
from df_info_markdown import df_info_markdown
from export_track_md_deps import export_track_md_deps
from load_data import load_data
from pandas_set_decimal_places import pandas_set_decimal_places
from strategy_harry_brown_perm_port import strategy_harry_brown_perm_port
from summary_stats import summary_stats
```

1.5 Data Overview

1.5.1 Load Data

[5]:
```
# Set decimal places
pandas_set_decimal_places(2)

# Bonds dataframe
bb_clean_data(
    base_directory=DATA_DIR,
    fund_ticker_name="SPBDU10T_S&P US Treasury Bond 7-10 Year Total Return␣
 ↪Index",
    source="Bloomberg",
    asset_class="Indices",
    excel_export=True,
    pickle_export=True,
    output_confirmation=True,
)

bonds_data = load_data(
    base_directory=DATA_DIR,
    ticker="SPBDU10T_S&P US Treasury Bond 7-10 Year Total Return Index_Clean",
    source="Bloomberg",
    asset_class="Indices",
```

```
    timeframe="Daily",
)

bonds_data['Date'] = pd.to_datetime(bonds_data['Date'])
bonds_data.set_index('Date', inplace = True)
bonds_data = bonds_data[(bonds_data.index >= '1990-01-01') & (bonds_data.index␣
 ↪<= '2023-12-31')]
bonds_data.rename(columns={'Close':'Bonds_Close'}, inplace=True)
bonds_data['Bonds_Daily_Return'] = bonds_data['Bonds_Close'].pct_change()
bonds_data['Bonds_Total_Return'] = (1 + bonds_data['Bonds_Daily_Return']).
 ↪cumprod()
display(bonds_data.head())
```

```
The first and last date of data for SPBDU10T_S&P US Treasury Bond 7-10 Year
Total Return Index is:

           Close
Date
1989-12-29   100

            Close
Date
2024-04-30 579.02

Bloomberg data cleaning complete for SPBDU10T_S&P US Treasury Bond 7-10 Year
Total Return Index
--------------------
```

Date	Bonds_Close	Bonds_Daily_Return	Bonds_Total_Return
1990-01-02	99.97	NaN	NaN
1990-01-03	99.73	-0.00	1.00
1990-01-04	99.81	0.00	1.00
1990-01-05	99.77	-0.00	1.00
1990-01-08	99.68	-0.00	1.00

[6]:
```
# Copy this <!-- INSERT_01_Bonds_Data_Head_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="01_Bonds_Data_Head.md",␣
 ↪content=bonds_data.head().to_markdown(floatfmt=".3f"))
```

```
 Exported and tracked: 01_Bonds_Data_Head.md
```

[7]:
```
# Stocks dataframe
bb_clean_data(
    base_directory=DATA_DIR,
    fund_ticker_name="SPXT_S&P 500 Total Return Index",
    source="Bloomberg",
    asset_class="Indices",
    excel_export=True,
    pickle_export=True,
```

```
    output_confirmation=True,
)

stocks_data = load_data(
    base_directory=DATA_DIR,
    ticker="SPXT_S&P 500 Total Return Index_Clean",
    source="Bloomberg",
    asset_class="Indices",
    timeframe="Daily",
)

stocks_data['Date'] = pd.to_datetime(stocks_data['Date'])
stocks_data.set_index('Date', inplace = True)
stocks_data = stocks_data[(stocks_data.index >= '1990-01-01') & (stocks_data.
 ↪index <= '2023-12-31')]
stocks_data.rename(columns={'Close':'Stocks_Close'}, inplace=True)
stocks_data['Stocks_Daily_Return'] = stocks_data['Stocks_Close'].pct_change()
stocks_data['Stocks_Total_Return'] = (1 + stocks_data['Stocks_Daily_Return']).
 ↪cumprod()
display(stocks_data.head())
```

```
The first and last date of data for SPXT_S&P 500 Total Return Index is:

            Close
Date
1988-01-04 256.02

              Close
Date
2024-04-30 10951.66

Bloomberg data cleaning complete for SPXT_S&P 500 Total Return Index
--------------------

            Stocks_Close  Stocks_Daily_Return  Stocks_Total_Return
Date
1990-01-01           NaN                  NaN                  NaN
1990-01-02        386.16                  NaN                  NaN
1990-01-03        385.17                -0.00                 1.00
1990-01-04        382.02                -0.01                 0.99
1990-01-05        378.30                -0.01                 0.98
```

[8]:
```
# Copy this <!-- INSERT_01_Stocks_Data_Head_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="01_Stocks_Data_Head.md",␣
 ↪content=stocks_data.head().to_markdown(floatfmt=".3f"))
```

```
 Exported and tracked: 01_Stocks_Data_Head.md
```

[9]:
```
# Gold dataframe
bb_clean_data(
```

```
    base_directory=DATA_DIR,
    fund_ticker_name="XAU_Gold USD Spot",
    source="Bloomberg",
    asset_class="Commodities",
    excel_export=True,
    pickle_export=True,
    output_confirmation=True,
)

gold_data = load_data(
    base_directory=DATA_DIR,
    ticker="XAU_Gold USD Spot_Clean",
    source="Bloomberg",
    asset_class="Commodities",
    timeframe="Daily",
)

gold_data['Date'] = pd.to_datetime(gold_data['Date'])
gold_data.set_index('Date', inplace = True)
gold_data = gold_data[(gold_data.index >= '1990-01-01') & (gold_data.index <=␣
↪'2023-12-31')]
gold_data.rename(columns={'Close':'Gold_Close'}, inplace=True)
gold_data['Gold_Daily_Return'] = gold_data['Gold_Close'].pct_change()
gold_data['Gold_Total_Return'] = (1 + gold_data['Gold_Daily_Return']).cumprod()
display(gold_data.head())
```

```
The first and last date of data for XAU_Gold USD Spot is:

            Close
Date
1949-12-30 34.69

              Close
Date
2024-05-01 2299.31

Bloomberg data cleaning complete for XAU_Gold USD Spot
--------------------

            Gold_Close  Gold_Daily_Return  Gold_Total_Return
Date
1990-01-02      399.00                NaN                NaN
1990-01-03      395.00              -0.01               0.99
1990-01-04      396.50               0.00               0.99
1990-01-05      405.00               0.02               1.02
1990-01-08      404.60              -0.00               1.01
```

[10]:
```
# Copy this <!-- INSERT_01_Gold_Data_Head_HERE --> to index_temp.md
```

```
export_track_md_deps(dep_file=dep_file, md_filename="01_Gold_Data_Head.md",␣
↪content=gold_data.head().to_markdown(floatfmt=".3f"))
```

```
Exported and tracked: 01_Gold_Data_Head.md
```

1.5.2 Combine Data

[11]:
```
# Merge the stock data and bond data into a single DataFrame using their␣
↪indices (dates)
perm_port = pd.merge(stocks_data['Stocks_Close'], bonds_data['Bonds_Close'],␣
↪left_index=True, right_index=True)

# Add gold data to the portfolio DataFrame by merging it with the existing data␣
↪on indices (dates)
perm_port = pd.merge(perm_port, gold_data['Gold_Close'], left_index=True,␣
↪right_index=True)

# Add a column for cash with a constant value of 1 (assumes the value of cash␣
↪remains constant at $1 over time)
perm_port['Cash_Close'] = 1

# Remove any rows with missing values (NaN) to ensure clean data for further␣
↪analysis
perm_port.dropna(inplace=True)

# Display the finalized portfolio DataFrame
display(perm_port)
```

Date	Stocks_Close	Bonds_Close	Gold_Close	Cash_Close
1990-01-02	386.16	99.97	399.00	1
1990-01-03	385.17	99.73	395.00	1
1990-01-04	382.02	99.81	396.50	1
1990-01-05	378.30	99.77	405.00	1
1990-01-08	380.04	99.68	404.60	1
…	…	…	…	…
2023-12-22	10292.37	604.17	2053.08	1
2023-12-26	10335.98	604.55	2067.81	1
2023-12-27	10351.60	609.36	2077.49	1
2023-12-28	10356.59	606.83	2065.61	1
2023-12-29	10327.83	606.18	2062.98	1

[8479 rows x 4 columns]

1.5.3 Check For Missing Values

[12]:
```
# Check for any missing values in each column
perm_port.isnull().any()
```

[12]:
```
Stocks_Close    False
Bonds_Close     False
Gold_Close      False
Cash_Close      False
dtype: bool
```

1.5.4 Permanent Portfolio DataFrame Info

[13]:
```
df_info(perm_port)
```

```
The columns, shape, and data types are:
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 8479 entries, 1990-01-02 to 2023-12-29
Data columns (total 4 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Stocks_Close  8479 non-null   float64
 1   Bonds_Close   8479 non-null   float64
 2   Gold_Close    8479 non-null   float64
 3   Cash_Close    8479 non-null   int64
dtypes: float64(3), int64(1)
memory usage: 331.2 KB
None
The first 5 rows are:

            Stocks_Close  Bonds_Close  Gold_Close  Cash_Close
Date
1990-01-02        386.16        99.97      399.00           1
1990-01-03        385.17        99.73      395.00           1
1990-01-04        382.02        99.81      396.50           1
1990-01-05        378.30        99.77      405.00           1
1990-01-08        380.04        99.68      404.60           1

The last 5 rows are:

            Stocks_Close  Bonds_Close  Gold_Close  Cash_Close
Date
2023-12-22      10292.37       604.17     2053.08           1
2023-12-26      10335.98       604.55     2067.81           1
2023-12-27      10351.60       609.36     2077.49           1
2023-12-28      10356.59       606.83     2065.61           1
2023-12-29      10327.83       606.18     2062.98           1
```

[14]:
```
# Copy this <!-- INSERT_02_Perm_Port_DF_Info_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="02_Perm_Port_DF_Info.md",␣
↪content=df_info_markdown(perm_port))
```

```
Exported and tracked: 02_Perm_Port_DF_Info.md
```

1.6 Execute Strategy

[15]:
```
# List of funds to be used
fund_list = ['Stocks', 'Bonds', 'Gold', 'Cash']

# Starting cash contribution
starting_cash = 10000

# Monthly cash contribution
cash_contrib = 0

strat = strategy_harry_brown_perm_port(
    fund_list=fund_list,
    starting_cash=starting_cash,
    cash_contrib=cash_contrib,
    close_prices_df=perm_port,
    rebal_month=1,
    rebal_day=1,
    rebal_per_high=0.35,
    rebal_per_low=0.15,
    excel_export=True,
    pickle_export=True,
    output_confirmation=True,
)

strat = strat.set_index('Date')
```

```
Strategy complete for Stocks_Bonds_Gold_Cash
```

[16]:
```
df_info(strat)
```

```
The columns, shape, and data types are:
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 8479 entries, 1990-01-02 to 2023-12-29
Data columns (total 34 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   Stocks_Close          8479 non-null   float64
 1   Bonds_Close           8479 non-null   float64
 2   Gold_Close            8479 non-null   float64
 3   Cash_Close            8479 non-null   int64
 4   Stocks_BA_Shares      8479 non-null   float64
 5   Stocks_BA_$_Invested  8479 non-null   float64
```

```
 6   Stocks_BA_Port_%      8479 non-null   float64
 7   Bonds_BA_Shares       8479 non-null   float64
 8   Bonds_BA_$_Invested   8479 non-null   float64
 9   Bonds_BA_Port_%       8479 non-null   float64
 10  Gold_BA_Shares        8479 non-null   float64
 11  Gold_BA_$_Invested    8479 non-null   float64
 12  Gold_BA_Port_%        8479 non-null   float64
 13  Cash_BA_Shares        8479 non-null   float64
 14  Cash_BA_$_Invested    8479 non-null   float64
 15  Cash_BA_Port_%        8479 non-null   float64
 16  Total_BA_$_Invested   8479 non-null   float64
 17  Contribution          8479 non-null   int64
 18  Rebalance             8479 non-null   object
 19  Stocks_AA_Shares      8479 non-null   float64
 20  Stocks_AA_$_Invested  8479 non-null   float64
 21  Stocks_AA_Port_%      8479 non-null   float64
 22  Bonds_AA_Shares       8479 non-null   float64
 23  Bonds_AA_$_Invested   8479 non-null   float64
 24  Bonds_AA_Port_%       8479 non-null   float64
 25  Gold_AA_Shares        8479 non-null   float64
 26  Gold_AA_$_Invested    8479 non-null   float64
 27  Gold_AA_Port_%        8479 non-null   float64
 28  Cash_AA_Shares        8479 non-null   float64
 29  Cash_AA_$_Invested    8479 non-null   float64
 30  Cash_AA_Port_%        8479 non-null   float64
 31  Total_AA_$_Invested   8479 non-null   float64
 32  Return                8478 non-null   float64
 33  Cumulative_Return     8478 non-null   float64
dtypes: float64(31), int64(2), object(1)
memory usage: 2.3+ MB
None
The first 5 rows are:

            Stocks_Close  Bonds_Close  Gold_Close  Cash_Close  \
Date
1990-01-02        386.16        99.97      399.00           1
1990-01-03        385.17        99.73      395.00           1
1990-01-04        382.02        99.81      396.50           1
1990-01-05        378.30        99.77      405.00           1
1990-01-08        380.04        99.68      404.60           1

            Stocks_BA_Shares  Stocks_BA_$_Invested  Stocks_BA_Port_%  \
Date
1990-01-02              6.47               2500.00              0.25
1990-01-03              6.47               2493.59              0.25
1990-01-04              6.47               2473.20              0.25
1990-01-05              6.47               2449.11              0.25
1990-01-08              6.47               2460.38              0.25
```

```
            Bonds_BA_Shares  Bonds_BA_$_Invested  Bonds_BA_Port_%  …  \
Date                                                                  …
1990-01-02           25.01              2500.00             0.25  …
1990-01-03           25.01              2494.02             0.25  …
1990-01-04           25.01              2496.02             0.25  …
1990-01-05           25.01              2494.92             0.25  …
1990-01-08           25.01              2492.72             0.25  …

            Bonds_AA_Port_%  Gold_AA_Shares  Gold_AA_$_Invested  \
Date
1990-01-02             0.25            6.27             2500.00
1990-01-03             0.25            6.27             2474.94
1990-01-04             0.25            6.27             2484.34
1990-01-05             0.25            6.27             2537.59
1990-01-08             0.25            6.27             2535.09

            Gold_AA_Port_%  Cash_AA_Shares  Cash_AA_$_Invested  \
Date
1990-01-02            0.25         2500.00             2500.00
1990-01-03            0.25         2500.00             2500.00
1990-01-04            0.25         2500.00             2500.00
1990-01-05            0.25         2500.00             2500.00
1990-01-08            0.25         2500.00             2500.00

            Cash_AA_Port_%  Total_AA_$_Invested Return  Cumulative_Return
Date
1990-01-02            0.25             10000.00    NaN                NaN
1990-01-03            0.25              9962.55  -0.00               1.00
1990-01-04            0.25              9953.56  -0.00               1.00
1990-01-05            0.25              9981.63   0.00               1.00
1990-01-08            0.25              9988.19   0.00               1.00

[5 rows x 34 columns]
```

The last 5 rows are:

```
            Stocks_Close  Bonds_Close  Gold_Close  Cash_Close  \
Date
2023-12-22      10292.37       604.17     2053.08           1
2023-12-26      10335.98       604.55     2067.81           1
2023-12-27      10351.60       609.36     2077.49           1
2023-12-28      10356.59       606.83     2065.61           1
2023-12-29      10327.83       606.18     2062.98           1

            Stocks_BA_Shares  Stocks_BA_$_Invested  Stocks_BA_Port_%  \
Date
2023-12-22              1.81              18595.87              0.29
2023-12-26              1.81              18674.66              0.29
```

```
2023-12-27              1.81              18702.89              0.29
2023-12-28              1.81              18711.90              0.29
2023-12-29              1.81              18659.94              0.29

            Bonds_BA_Shares  Bonds_BA_$_Invested  Bonds_BA_Port_%  …  \
Date                                                                 …
2023-12-22           25.03              15124.46             0.23  …
2023-12-26           25.03              15134.20             0.23  …
2023-12-27           25.03              15254.36             0.23  …
2023-12-28           25.03              15191.10             0.23  …
2023-12-29           25.03              15175.01             0.23  …

            Bonds_AA_Port_%  Gold_AA_Shares  Gold_AA_$_Invested  \
Date
2023-12-22             0.23            8.00            16426.12
2023-12-26             0.23            8.00            16543.97
2023-12-27             0.23            8.00            16621.42
2023-12-28             0.23            8.00            16526.37
2023-12-29             0.23            8.00            16505.33

            Gold_AA_Port_%  Cash_AA_Shares  Cash_AA_$_Invested  \
Date
2023-12-22            0.25        14717.17            14717.17
2023-12-26            0.25        14717.17            14717.17
2023-12-27            0.25        14717.17            14717.17
2023-12-28            0.25        14717.17            14717.17
2023-12-29            0.25        14717.17            14717.17

            Cash_AA_Port_%  Total_AA_$_Invested Return  Cumulative_Return
Date
2023-12-22            0.23             64863.62   0.00               6.49
2023-12-26            0.23             65070.01   0.00               6.51
2023-12-27            0.23             65295.84   0.00               6.53
2023-12-28            0.23             65146.54  -0.00               6.51
2023-12-29            0.23             65057.44  -0.00               6.51

[5 rows x 34 columns]
```

[17]:
```
# Copy this <!-- INSERT_03_Strategy_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="03_Strategy.md",␣
 ↪content=df_info_markdown(strat))
```

```
Exported and tracked: 03_Strategy.md
```

1.7 Summary Statistics

[18]:
```
sum_stats = summary_stats(
    fund_list=fund_list,
    df=strat[['Return']],
    period="Daily",
    excel_export=True,
    pickle_export=True,
    output_confirmation=True,
)

strat_pre_1999 = strat[strat.index < '2000-01-01']
sum_stats_pre_1999 = summary_stats(
    fund_list=fund_list,
    df=strat_pre_1999[['Return']],
    period="Daily",
    excel_export=False,
    pickle_export=False,
    output_confirmation=True,
)

strat_post_1999 = strat[strat.index >= '2000-01-01']
sum_stats_post_1999 = summary_stats(
    fund_list=fund_list,
    df=strat_post_1999[['Return']],
    period="Daily",
    excel_export=False,
    pickle_export=False,
    output_confirmation=True,
)

strat_post_2009 = strat[strat.index >= '2010-01-01']
sum_stats_post_2009 = summary_stats(
    fund_list=fund_list,
    df=strat_post_2009[['Return']],
    period="Daily",
    excel_export=False,
    pickle_export=False,
    output_confirmation=True,
)
```

```
Summary stats complete for Stocks_Bonds_Gold_Cash
Summary stats complete for Stocks_Bonds_Gold_Cash
Summary stats complete for Stocks_Bonds_Gold_Cash

Summary stats complete for Stocks_Bonds_Gold_Cash
```

[19]:
```
all_sum_stats = pd.concat([sum_stats])
all_sum_stats = all_sum_stats.rename(index={'Return': '1990 - 2023'})
all_sum_stats = pd.concat([all_sum_stats, sum_stats_pre_1999])
all_sum_stats = all_sum_stats.rename(index={'Return': 'Pre 1999'})
all_sum_stats = pd.concat([all_sum_stats, sum_stats_post_1999])
all_sum_stats = all_sum_stats.rename(index={'Return': 'Post 1999'})
all_sum_stats = pd.concat([all_sum_stats, sum_stats_post_2009])
all_sum_stats = all_sum_stats.rename(index={'Return': 'Post 2009'})
display(all_sum_stats)
```

	Annualized Mean	Annualized Volatility	Annualized Sharpe Ratio	\
1990 - 2023	0.06	0.06	0.96	
Pre 1999	0.06	0.05	1.21	
Post 1999	0.06	0.06	0.88	
Post 2009	0.06	0.06	0.93	

	CAGR	Daily Max Return	Daily Max Return (Date)	Daily Min Return	\
1990 - 2023	0.06	0.03	2020-03-24	-0.03	
Pre 1999	0.06	0.02	1999-09-28	-0.02	
Post 1999	0.06	0.03	2020-03-24	-0.03	
Post 2009	0.06	0.03	2020-03-24	-0.03	

	Daily Min Return (Date)	Max Drawdown	Peak	Bottom	\
1990 - 2023	2020-03-12	-0.15	2008-03-18	2008-11-12	
Pre 1999	1993-08-05	-0.06	1998-07-20	1998-08-31	
Post 1999	2020-03-12	-0.15	2008-03-18	2008-11-12	
Post 2009	2020-03-12	-0.13	2021-12-27	2022-10-20	

	Recovery Date
1990 - 2023	2009-10-06
Pre 1999	1998-11-05
Post 1999	2009-10-06
Post 2009	2023-12-01

[20]:
```
# Copy this <!-- INSERT_04_Summary_Stats_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="04_Summary_Stats.md",␣
↪content=all_sum_stats.to_markdown(floatfmt=".3f"))
```

```
Exported and tracked: 04_Summary_Stats.md
```

1.8 Annual Returns

[21]:
```
# Create dataframe for the annual returns
strat_annual_returns = strat['Cumulative_Return'].resample('Y').last().
↪pct_change().dropna()
strat_annual_returns_df = strat_annual_returns.to_frame()
strat_annual_returns_df['Year'] = strat_annual_returns_df.index.year  # Add a␣
↪'Year' column with just the year
```

```
strat_annual_returns_df.reset_index(drop=True, inplace=True)  # Reset the index␣
 ↪to remove the datetime index

# Now the DataFrame will have 'Year' and 'Cumulative_Return' columns
strat_annual_returns_df = strat_annual_returns_df[['Year',␣
 ↪'Cumulative_Return']]  # Keep only 'Year' and 'Cumulative_Return' columns
strat_annual_returns_df.rename(columns = {'Cumulative_Return':'Return'},␣
 ↪inplace=True)
strat_annual_returns_df.set_index('Year', inplace=True)
display(strat_annual_returns_df)
```

Year	Return
1991	0.10
1992	0.03
1993	0.10
1994	-0.02
1995	0.15
1996	0.05
1997	0.06
1998	0.10
1999	0.04
2000	0.00
2001	-0.01
2002	0.04
2003	0.12
2004	0.05
2005	0.06
2006	0.10
2007	0.12
2008	-0.03
2009	0.11
2010	0.14
2011	0.07
2012	0.07
2013	-0.01
2014	0.05
2015	-0.02
2016	0.05
2017	0.09
2018	-0.01
2019	0.15
2020	0.13
2021	0.06
2022	-0.08
2023	0.11

[22]:
```
# Copy this <!-- INSERT_05_Annual_Returns_HERE --> to index_temp.md
export_track_md_deps(dep_file=dep_file, md_filename="05_Annual_Returns.md",␣
 ↪content=strat_annual_returns_df.to_markdown(floatfmt=".3f"))
```

```
Exported and tracked: 05_Annual_Returns.md
```

[23]:
```
# Export the annual returns DataFrame to Excel and pickle files
plan_name = '_'.join(fund_list)
strat_annual_returns_df.to_excel(f"{plan_name}_Annual_Returns.xlsx",␣
 ↪sheet_name="data")
strat_annual_returns_df.to_pickle(f"{plan_name}_Annual_Returns.pkl")
```

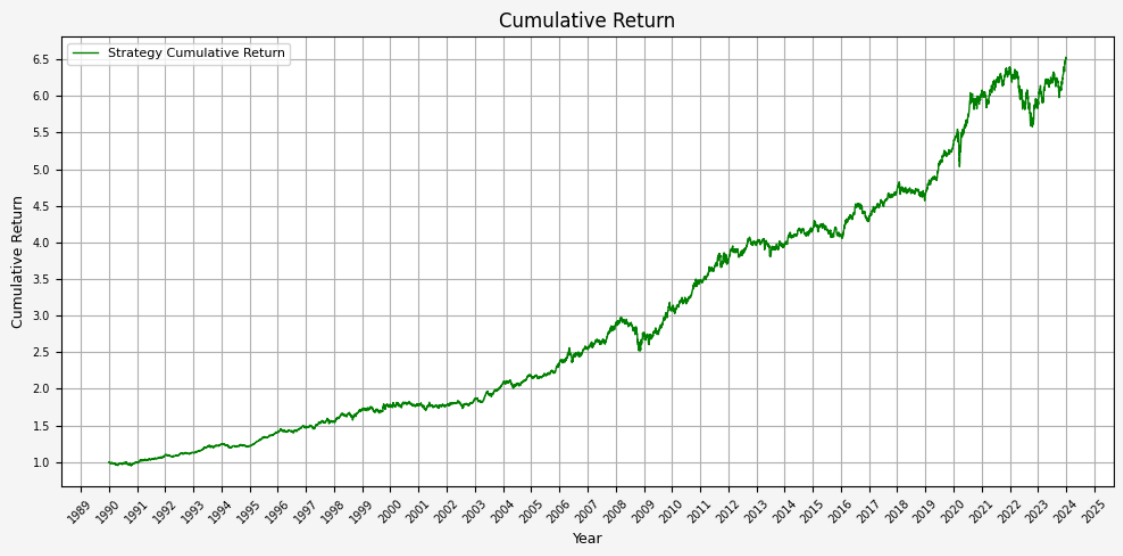
1.9 Plots

1.9.1 Plot Cumulative Return

[24]:
```
def plot_cumulative_return(strat_df):
    # Generate plot
    plt.figure(figsize=(10, 5), facecolor = '#F5F5F5')

    # Plotting data
    plt.plot(strat_df.index, strat_df['Cumulative_Return'], label = 'Strategy␣
 ↪Cumulative Return', linestyle='-', color='green', linewidth=1)

    # Set X axis
    # x_tick_spacing = 5  # Specify the interval for x-axis ticks
    # plt.gca().xaxis.set_major_locator(MultipleLocator(x_tick_spacing))
    plt.gca().xaxis.set_major_locator(mdates.YearLocator())
    plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
    plt.xlabel('Year', fontsize = 9)
    plt.xticks(rotation = 45, fontsize = 7)
    # plt.xlim(, )

    # Set Y axis
    y_tick_spacing = 0.5  # Specify the interval for y-axis ticks
    plt.gca().yaxis.set_major_locator(MultipleLocator(y_tick_spacing))
    plt.ylabel('Cumulative Return', fontsize = 9)
    plt.yticks(fontsize = 7)
    # plt.ylim(0, 7.5)

    # Set title, etc.
    plt.title('Cumulative Return', fontsize = 12)

    # Set the grid & legend
    plt.tight_layout()
    plt.grid(True)
    plt.legend(fontsize=8)
```

```
    # Save the figure
    plt.savefig('06_Cumulative_Return.png', dpi=300, bbox_inches='tight')

    # Display the plot
    return plt.show()
```

[25]:
```
plot_cumulative_return(strat)
```

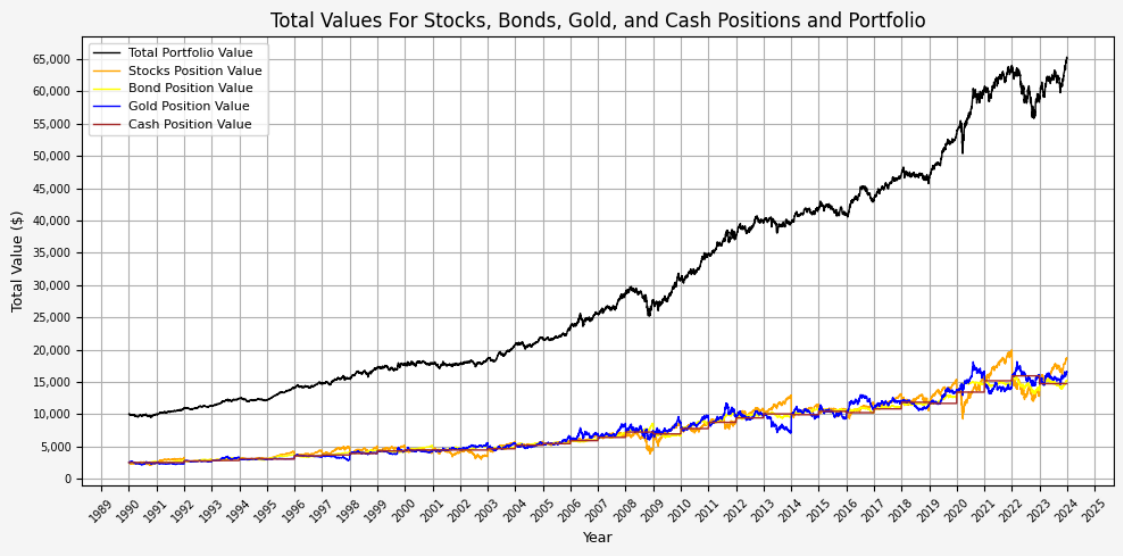


1.9.2 Plot Portfolio & Component Values

[26]:
```
def plot_values(strat_df):
    # Generate plot
    plt.figure(figsize=(10, 5), facecolor = '#F5F5F5')

    # Plotting data
    plt.plot(strat_df.index, strat_df['Total_AA_$_Invested'], label='Total␣
 ↪Portfolio Value', linestyle='-', color='black', linewidth=1)
    plt.plot(strat_df.index, strat_df['Stocks_AA_$_Invested'], label='Stocks␣
 ↪Position Value', linestyle='-', color='orange', linewidth=1)
    plt.plot(strat_df.index, strat_df['Bonds_AA_$_Invested'], label='Bond␣
 ↪Position Value', linestyle='-', color='yellow', linewidth=1)
    plt.plot(strat_df.index, strat_df['Gold_AA_$_Invested'], label='Gold␣
 ↪Position Value', linestyle='-', color='blue', linewidth=1)
    plt.plot(strat_df.index, strat_df['Cash_AA_$_Invested'], label='Cash␣
 ↪Position Value', linestyle='-', color='brown', linewidth=1)

    # Set X axis
    # x_tick_spacing = 5  # Specify the interval for x-axis ticks
```

```
    # plt.gca().xaxis.set_major_locator(MultipleLocator(x_tick_spacing))
    plt.gca().xaxis.set_major_locator(mdates.YearLocator())
    plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
    plt.xlabel('Year', fontsize = 9)
    plt.xticks(rotation = 45, fontsize = 7)
    # plt.xlim(, )

    # Set Y axis
    y_tick_spacing = 5000  # Specify the interval for y-axis ticks
    plt.gca().yaxis.set_major_locator(MultipleLocator(y_tick_spacing))
    plt.gca().yaxis.set_major_formatter(mtick.FuncFormatter(lambda x, pos: '{:,.
↪0f}'.format(x))) # Adding commas to y-axis labels
    plt.ylabel('Total Value ($)', fontsize = 9)
    plt.yticks(fontsize = 7)
    # plt.ylim(0, 75000)

    # Set title, etc.
    plt.title('Total Values For Stocks, Bonds, Gold, and Cash Positions and␣
↪Portfolio', fontsize = 12)

    # Set the grid & legend
    plt.tight_layout()
    plt.grid(True)
    plt.legend(fontsize=8)

    # Save the figure
    plt.savefig('07_Portfolio_Values.png', dpi=300, bbox_inches='tight')

    # Display the plot
    return plt.show()
```

[27]:
```
plot_values(strat)
```

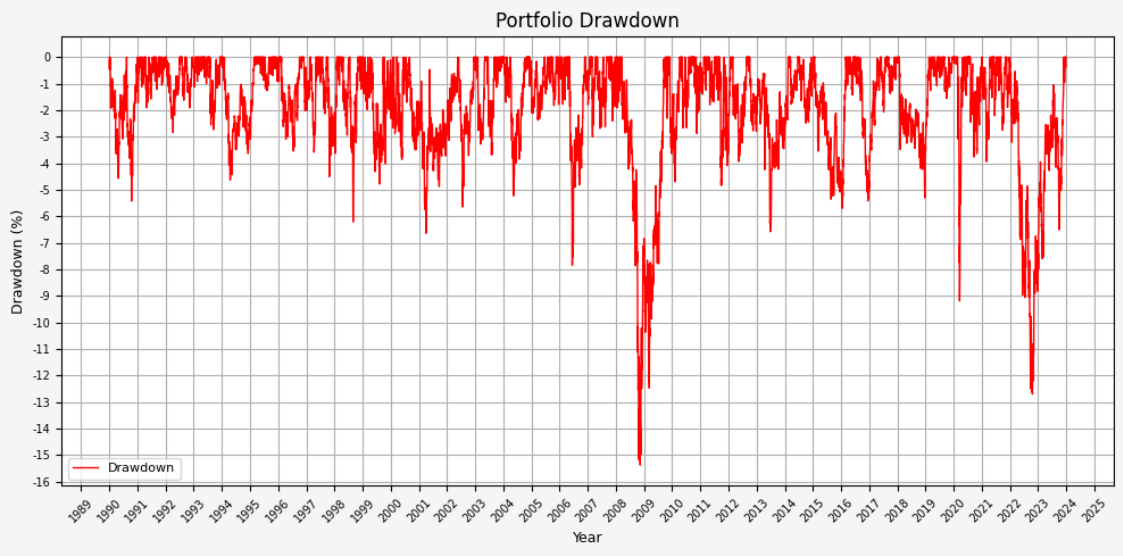


1.9.3 Plot Portfolio Drawdown

[28]:
```
def plot_drawdown(strat_df):
    rolling_max = strat_df['Total_AA_$_Invested'].cummax()
    drawdown = (strat_df['Total_AA_$_Invested'] - rolling_max) / rolling_max *␣
↪100

    # Generate plot
    plt.figure(figsize=(10, 5), facecolor = '#F5F5F5')

    # Plotting data
    plt.plot(strat_df.index, drawdown, label='Drawdown', linestyle='-',␣
↪color='red', linewidth=1)

    # Set X axis
    # x_tick_spacing = 5  # Specify the interval for x-axis ticks
    # plt.gca().xaxis.set_major_locator(MultipleLocator(x_tick_spacing))
    plt.gca().xaxis.set_major_locator(mdates.YearLocator())
    plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
    plt.xlabel('Year', fontsize = 9)
    plt.xticks(rotation = 45, fontsize = 7)
    # plt.xlim(, )

    # Set Y axis
    y_tick_spacing = 1  # Specify the interval for y-axis ticks
    plt.gca().yaxis.set_major_locator(MultipleLocator(y_tick_spacing))
    # plt.gca().yaxis.set_major_formatter(mtick.FuncFormatter(lambda x, pos: '{:
↪,.0f}'.format(x))) # Adding commas to y-axis labels
```

```
    plt.gca().yaxis.set_major_formatter(mtick.FuncFormatter(lambda x, pos: '{:.
↪0f}'.format(x))) # Adding 0 decimal places to y-axis labels
    plt.ylabel('Drawdown (%)', fontsize = 9)
    plt.yticks(fontsize = 7)
    # plt.ylim(-20, 0)

    # Set title, etc.
    plt.title('Portfolio Drawdown', fontsize = 12)

    # Set the grid & legend
    plt.tight_layout()
    plt.grid(True)
    plt.legend(fontsize=8)

    # Save the figure
    plt.savefig('08_Portfolio_Drawdown.png', dpi=300, bbox_inches='tight')

    # Display the plot
    return plt.show()
```

[29]:
```
plot_drawdown(strat)
```

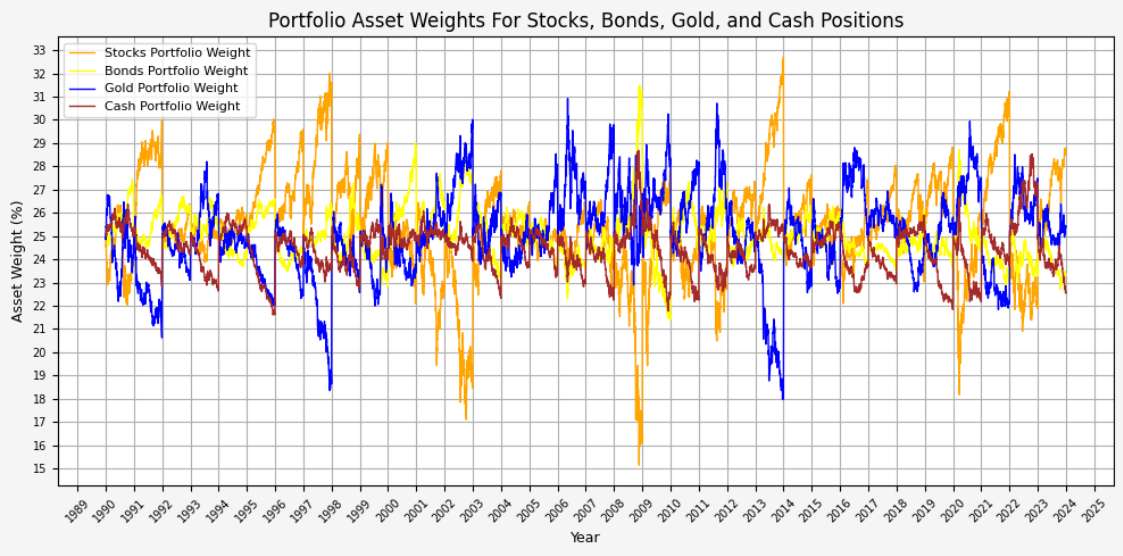


1.9.4 Plot Asset Weights

[30]:
```
def plot_asset_weights(strat_df):
    # Generate plot
    plt.figure(figsize=(10, 5), facecolor = '#F5F5F5')
```

```
    # Plotting data
    plt.plot(strat_df.index, strat_df['Stocks_AA_Port_%'] * 100, label='Stocks␣
↪Portfolio Weight', linestyle='-', color='orange', linewidth=1)
    plt.plot(strat_df.index, strat_df['Bonds_AA_Port_%'] * 100, label='Bonds␣
↪Portfolio Weight', linestyle='-', color='yellow', linewidth=1)
    plt.plot(strat_df.index, strat_df['Gold_AA_Port_%'] * 100, label='Gold␣
↪Portfolio Weight', linestyle='-', color='blue', linewidth=1)
    plt.plot(strat_df.index, strat_df['Cash_AA_Port_%'] * 100, label='Cash␣
↪Portfolio Weight', linestyle='-', color='brown', linewidth=1)

    # Set X axis
    # x_tick_spacing = 5  # Specify the interval for x-axis ticks
    # plt.gca().xaxis.set_major_locator(MultipleLocator(x_tick_spacing))
    plt.gca().xaxis.set_major_locator(mdates.YearLocator())
    plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
    plt.xlabel('Year', fontsize = 9)
    plt.xticks(rotation = 45, fontsize = 7)
    # plt.xlim(, )

    # Set Y axis
    y_tick_spacing = 1  # Specify the interval for y-axis ticks
    plt.gca().yaxis.set_major_locator(MultipleLocator(y_tick_spacing))
    # plt.gca().yaxis.set_major_formatter(mtick.FuncFormatter(lambda x, pos: '{:
↪,.0f}'.format(x))) # Adding commas to y-axis labels
    plt.ylabel('Asset Weight (%)', fontsize = 9)
    plt.yticks(fontsize = 7)
    # plt.ylim(14, 36)

    # Set title, etc.
    plt.title('Portfolio Asset Weights For Stocks, Bonds, Gold, and Cash␣
↪Positions', fontsize = 12)

    # Set the grid & legend
    plt.tight_layout()
    plt.grid(True)
    plt.legend(fontsize=8)

    # Save the figure
    plt.savefig('09_Portfolio_Weights.png', dpi=300, bbox_inches='tight')

    # Display the plot
    return plt.show()
```

[31]:
```
plot_asset_weights(strat)
```

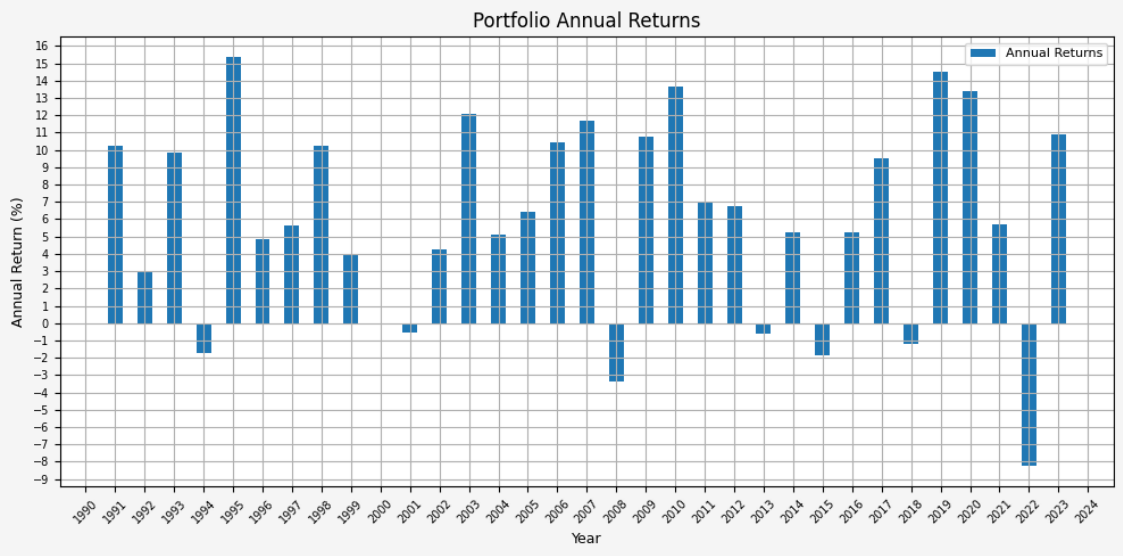


1.9.5 Plot Annual Returns

[32]:
```
def plot_annual_returns(return_df):
    # Generate plot
    plt.figure(figsize=(10, 5), facecolor = '#F5F5F5')

    # Plotting data
    plt.bar(return_df.index, return_df['Return'] * 100, label='Annual Returns',␣
 ↪width=0.5)  # width adjusted for better spacing

    # Set X axis
    x_tick_spacing = 1  # Specify the interval for x-axis ticks
    plt.gca().xaxis.set_major_locator(MultipleLocator(x_tick_spacing))
    # plt.gca().xaxis.set_major_locator(mdates.YearLocator())
    # plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y'))
    plt.xlabel('Year', fontsize = 9)
    plt.xticks(rotation = 45, fontsize = 7)
    # plt.xlim(, )

    # Set Y axis
    y_tick_spacing = 1  # Specify the interval for y-axis ticks
    plt.gca().yaxis.set_major_locator(MultipleLocator(y_tick_spacing))
    # plt.gca().yaxis.set_major_formatter(mtick.FuncFormatter(lambda x, pos: '{:
 ↪,.0f}'.format(x))) # Adding commas to y-axis labels
    plt.ylabel('Annual Return (%)', fontsize = 9)
    plt.yticks(fontsize = 7)
    # plt.ylim(-20, 20)
```

```
    # Set title, etc.
    plt.title('Portfolio Annual Returns', fontsize = 12)

    # Set the grid & legend
    plt.tight_layout()
    plt.grid(True)
    plt.legend(fontsize=8)

    # Save the figure
    plt.savefig('10_Portfolio_Annual_Returns.png', dpi=300, bbox_inches='tight')

    # Display the plot
    return plt.show()
```

[33]:
```
plot_annual_returns(strat_annual_returns_df)
```



1.10 Portfolio Summary Statistics For Various Rebalance Dates

[34]:
```
# # Set ranges for months and days
# months = list(range(1, 13))
# days = list(range(1, 32))

# # Create an empty DataFrame to store the results
# stats = pd.DataFrame(columns = ['Rebal_Month', 'Rebal_Day', 'Annualized␣
 ↪Mean', 'Annualized Volatility', 'Annualized Sharpe Ratio', 'CAGR',
#                                 'Daily Max Return', 'Daily Max Return␣
 ↪(Date)', 'Daily Min Return', 'Daily Min Return (Date)', 'Max Drawdown',
#                                 'Peak', 'Bottom', 'Recovery Date',])
```

```
# # Loop through each combination of month and day
# for month in months:
#     for day in days:
#         try:
#             strat = strategy_harry_brown_perm_port(
#                 fund_list=fund_list,
#                 starting_cash=starting_cash,
#                 cash_contrib=cash_contrib,
#                 close_prices_df=perm_port,
#                 rebal_month=month,
#                 rebal_day=day,
#                 rebal_per_high=0.35,
#                 rebal_per_low=0.15,
#                 excel_export=False,
#                 pickle_export=False,
#                 output_confirmation=False,
#             ).set_index('Date')

#             sum_stats = summary_stats(
#                 fund_list=fund_list,
#                 df=strat[['Return']],
#                 period="Daily",
#                 excel_export=False,
#                 pickle_export=False,
#                 output_confirmation=False,
#             )

#             stats = pd.concat([stats, sum_stats], ignore_index=True)
#             stats.loc[stats.index[-1], 'Rebal_Month'] = month
#             stats.loc[stats.index[-1], 'Rebal_Day'] = day
#             print(f"Month: {month}, Day: {day} - Stats added successfully.")

#         except Exception as e:
#             print(f"Error for month {month} and day {day}: {e}")
#             continue
```

[35]:
```
# # Export the stats DataFrame to Excel and pickle files
# plan_name = '_'.join(fund_list)
# stats.to_excel(f"{plan_name}_Various_Rebalance_Summary_Stats.xlsx",␣
 ↪sheet_name="data")
# stats.to_pickle(f"{plan_name}_Various_Rebalance_Summary_Stats.pkl")
```

[36]:
```
# Load the stats DataFrame from the pickle file
# stats = load_data(f"{plan_name}_Various_Rebalance_Summary_Stats.pkl")
```

[37]:
```
# stats
```