Financial Optimisation

Is real estate the most successful way to optimise our finances?

Presented by Pauline, Samuel, Venkata and Max

Core Goal:

Aim:

To compare and contrast returns of portfolios with varying weights of alternate asset classes.

Hypothesis:

The housing market due to being an investment safe haven and a prevalent conservative safety net against inflation for everyday investors. It can be predicted that portfolios which include a greater amount of investments in the real estate market will provide a greater return than those that do not.

Questions Raised by the Group

Why do people invest in the housing market above other forms of investments?

- Steady cash flow
- Protect against inflation
- Profits

Questions Raised by the Group

What Assets Best Represent Common Investment Portfolios?

Realestate → "VNQ" Real Estate ETF.

Bonds → "AGG" a representation of investment grade bonds.

Commodities → "GLD" a stock that gives access to the gold market.

Stocks → "SPY" S&P 500 ETF.

How And Where We Found The Data:

Alpaca

NASDAQ Data Link

The Data Process

Exploring the Data

We were able to begin to explore the data through concatenating it:

```
# Concatenate all daily returns data
combined_returns_close_rf = pd.concat([agg_returns, vnq_returns, gld_returns, spy_returns, rf_rate_data], axis="columns", join="inner")
combined_returns_close_rf
```

And renaming the columns, to make it easier to read.

```
# Rename all daily returns with different financial assets and risk free rate
combined_returns_close_rf.columns=['AGG', 'VNQ', 'GLD', 'SPY', 'RF RATE']
combined_returns_close_rf
```

	AGG	VNQ	GLD	SPY	RF RATE
2016-10-03	-0.002935	-0.018561	-0.002626	-0.003004	0.000009
2016-10-04	-0.003390	-0.013861	-0.034711	-0.004868	0.000009
2016-10-05	-0.001343	-0.020488	-0.001571	0.004705	0.000009
2016-10-06	0.000000	0.000730	-0.009273	0.000788	0.000009
2016-10-07	0.000179	-0.001701	0.000420	-0.003707	0.000009
...	...	...	...	...	...
2022-07-11	0.004643	-0.002172	-0.005360	-0.011424	0.000059
2022-07-12	0.001377	-0.003918	-0.003717	-0.008849	0.000060
2022-07-13	0.003633	-0.004808	0.004788	-0.005252	0.000065
2022-07-14	-0.003522	-0.009003	-0.014047	-0.002429	0.000065
2022-07-15	0.003927	0.016951	-0.002008	0.019105	0.000064

Cleaning the Data

```
df_portfolio.count()
```

```
# Checking for null
df_portfolio.isnull()
```

We concluded -through using Python- that the data did not have any nulls.

```
AGG  open           0
     high           0
     low            0
     close          0
     volume         0
     trade_count    0
     vwap           0
VNQ  open           0
     high           0
     low            0
     close          0
     volume         0
     trade_count    0
     vwap           0
```

```
GLD  open           0
     high           0
     low            0
     close          0
     volume         0
     trade_count    0
     vwap           0
SPY  open           0
     high           0
     low            0
     close          0
     volume         0
     trade_count    0
     vwap           0
dtype: int64
```

Historic View of Performance

Annualised Mean:

```
# Annualized Mean:
df_portfolio_date_time.groupby(pd.Grouper(freq='12M')).mean().drop("2016-09-30 00:00:00+00:00")
```

Annualised Standard Deviation (volatility)

```
# Annualized standard deviation (volatility):
df_portfolio_date_time.groupby(pd.Grouper(freq='12M')).std().drop("2016-09-30 00:00:00+00:00")
```

200 Days Moving Average:

```
# AGG 20, 50, 200 days Moving Average
ax = combined_close['AGG'].rolling(window=20).mean().plot(figsize=(20, 10), title='AGG 20, 50, 200 days Moving Average')
combined_close['AGG'].rolling(window=50).mean().plot(ax=ax, figsize=(20, 10), title='AGG 20, 50, 200 days Moving Average')
combined_close['AGG'].rolling(window=200).mean().plot(ax=ax, figsize=(20, 10), title='AGG 20, 50, 200 days Moving Average')
ax.legend(['MA20', 'MA50', 'MA200'])
```

Determining Volatility

```python
# Calculate variance of all daily returns of SPY
spy_variance = combined_close['SPY'].var()
spy_variance
```

Variance:

```python
# Calculate covariance of all daily returns of VNQ vs. SPY
agg_covariance = combined_close['AGG'].cov(combined_close['SPY'])
agg_covariance
```

Calculate covariance of all daily returns of VNQ vs. SPY

```python
# Calculate beta of all daily returns of AGG
agg_beta = agg_covariance / spy_variance
agg_beta
```

Calculate beta of all daily returns of AGG:

To Plot the Data

Calculate 30-day rolling covariance of AGG vs SPY and plot the data

```
# Calculate 30-day rolling covariance of AGG vs. SPY and plot the data
agg_rolling_covariance = combined_close['AGG'].rolling(window=30).cov(combined_close['SPY'])
agg_rolling_covariance.hvplot(figsize=(20, 10), title='Rolling 30-Day Covariance of AGG Returns vs. SPY')
```

Calculate 30-day rolling beta of AGG and plot the data

```
# Calculate 30-day rolling beta of AGG and plot the data
agg_rolling_beta = agg_rolling_covariance / spy_rolling_variance
agg_rolling_beta.hvplot(figsize=(20, 10), title='Rolling 30-Day Beta of AGG')
```

Sharpe ratio:

```
# Sharpe ratio
sharpe_ratios = ((combined_returns_close_rf.mean()-combined_returns_close_rf['RF RATE'].mean()) * 252) / (combined_returns_close_rf.std() * np.sqrt(252))
sharpe_ratios
```

Monte Carlo Simulation

```
# Configuring a Monte Carlo simulation to forecast ten years cumulative returns on AGG
MC_agg_ten_year = MCSimulation(
    portfolio_data = df_portfolio,
    weights = [1,0,0,0],
    num_simulation = 500,
    num_trading_days = 252*10
)
```

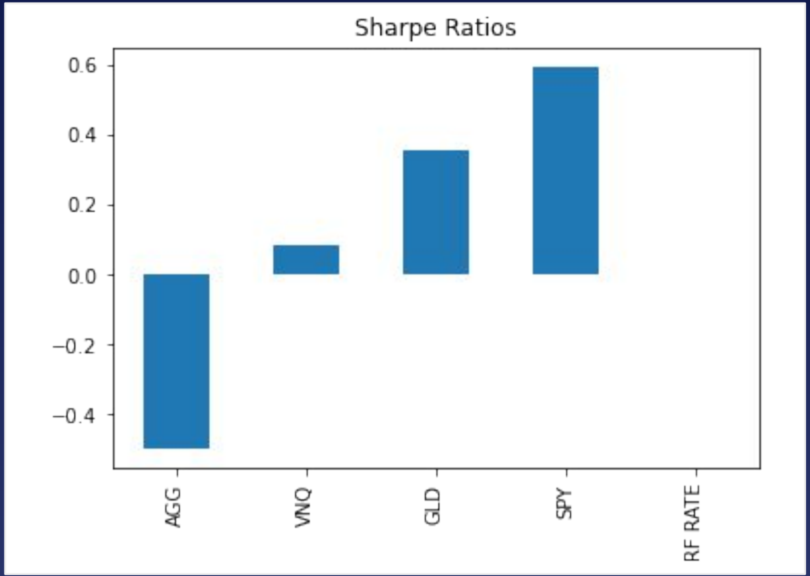
```
# Running a Monte Carlo simulation to forecast ten years cumulative returns on AGG
MC_agg_ten_year.calc_cumulative_return()
```

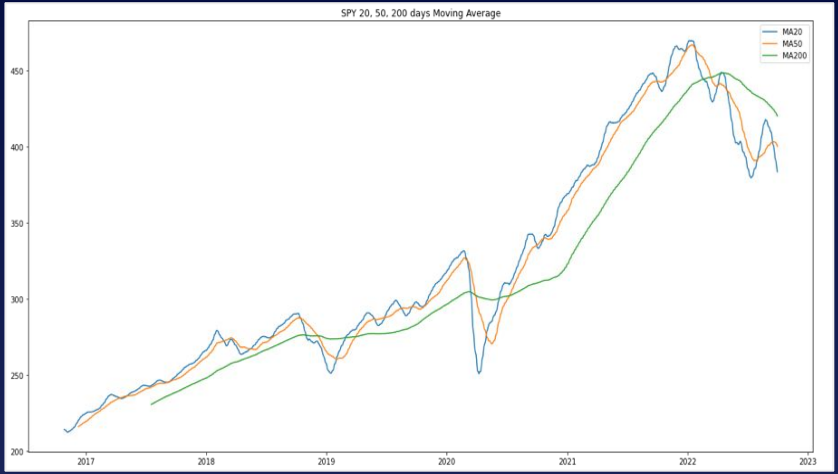
```
# Plot simulation outcomes on AGG
agg_line_plot = MC_agg_ten_year.plot_simulation()
```

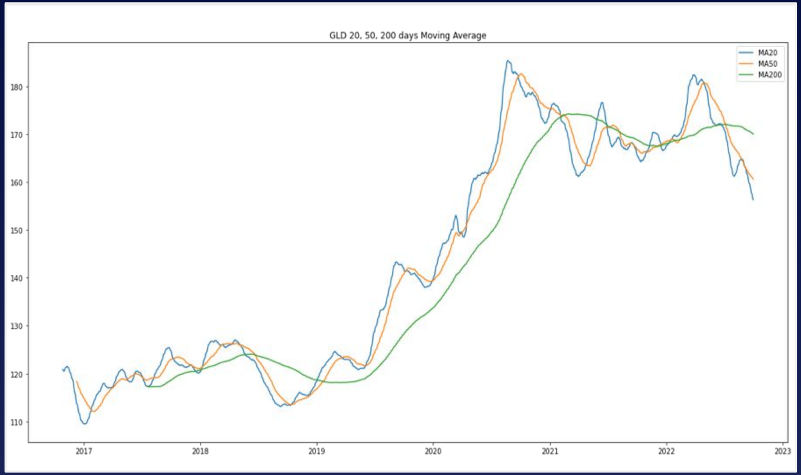
```
# Plot probability distribution and confidence intervals on AGG
agg_dist_plot = MC_agg_ten_year.plot_distribution()
```

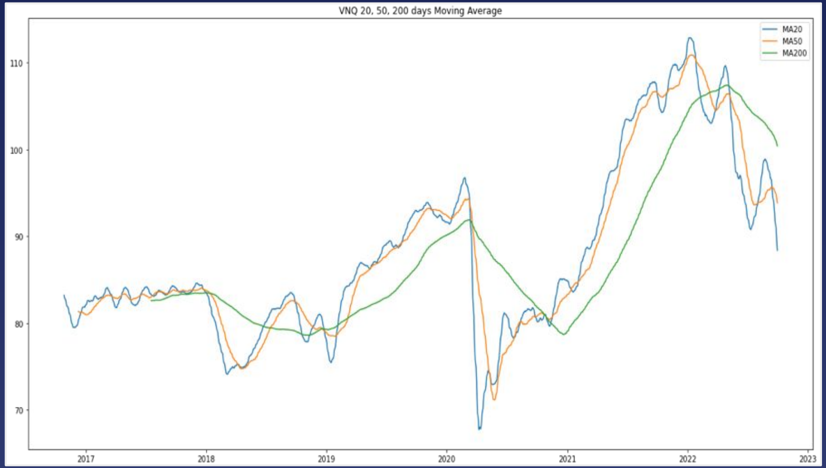
Conclusion of Data

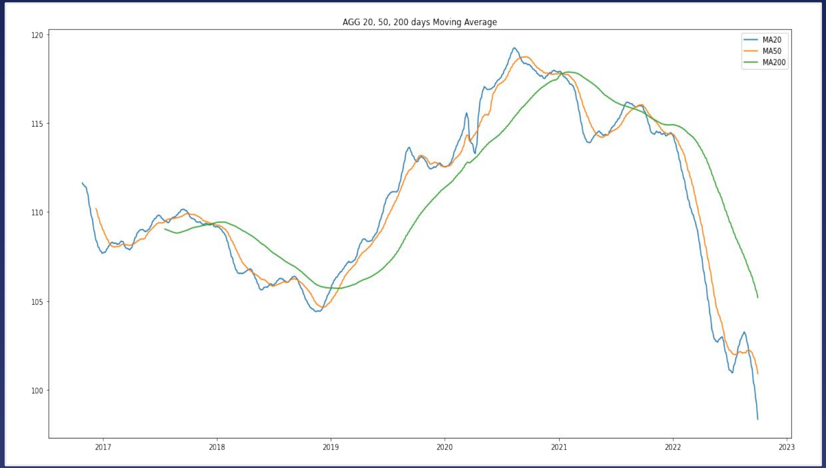
AGG	-0.499998
VNQ	0.081308
GLD	0.355018
SPY	0.595763
RF RATE	0.000000



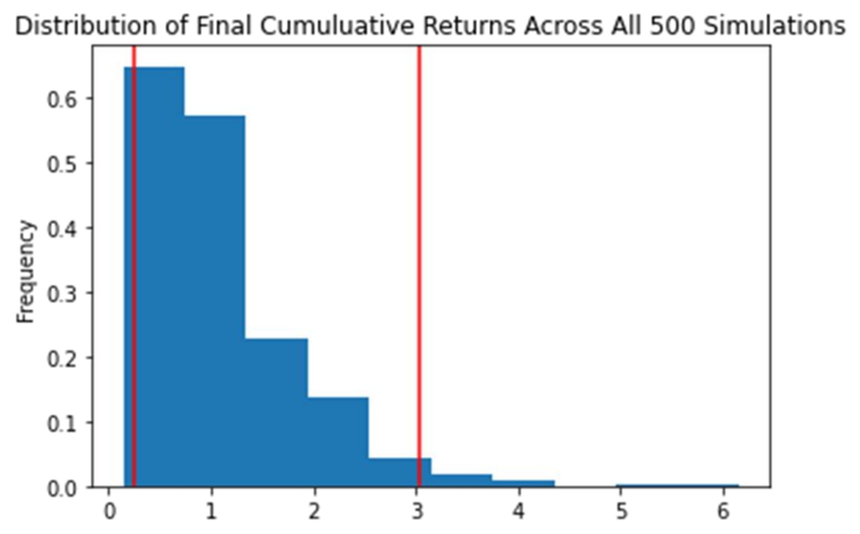

SPY 20, 50, 200 days Moving Average
MA20
MA50
MA200
450
400
350
300
250
200
2017
2018
2019
2020
2021
2022
2023


GLD 20, 50, 200 days Moving Average
MA20
MA50
MA200
180
170
160
150
140
130
120
110
2017
2018
2019
2020
2021
2022
2023


VNQ 20, 50, 200 days Moving Average
MA20
MA50
MA200
110
100
90
80
70
2017
2018
2019
2020
2021
2022
2023


AGG 20, 50, 200 days Moving Average
MA20
MA50
MA200
120
115
110
105
100
2017
2018
2019
2020
2021
2022
2023

Implications of Data




```
# Fetch summary statistics from the Monte Carlo simulation results for VNQ
vnq_tbl = MC_vnq_ten_year.summarize_cumulative_return()

# Print summary statistics
print(vnq_tbl)
```

```
count           500.000000
mean              1.089042
std               0.762508
min               0.140278
25%               0.577118
50%               0.855512
75%               1.414426
max               6.160681
95% CI Lower      0.254660
95% CI Upper      3.029485
Name: 2520, dtype: float64
```

```
The standard deviation of AGG is 0.11.
The standard deviation of VNQ is 0.76.
The standard deviation of GLD is 0.75.
The standard deviation of SPY is 1.72.
The standard deviation of diversified portfolio is 0.36.
There is a 95% chance that an initial investment of $10,000 in AGG over the next 10 years will end within the range of $6024.2 and $10165.95.
There is a 95% chance that an initial investment of $10,000 in VNQ over the next 10 years will end within the range of $2546.6 and $30294.85.
There is a 95% chance that an initial investment of $10,000 in GLD over the next 10 years will end within the range of $5745.68 and $35319.95.
There is a 95% chance that an initial investment of $10,000 in SPY over the next 10 years will end within the range of $7623.26 and $70946.55.
There is a 95% chance that an initial investment of $10,000 in the diversified portfolio that contains all four assets with equal weights over the next 10 years will end within the range of $7975.11 and $22043.39.
```

Risk Seeking: SPY & GLD

Considering both risk and return or risk averse: the diversified portfolio

Not recommended: AGG

```python
# Assuming the average inflation rate from the past 10 years continues at 2.5% for the next 10 years
inflation_rate = 0.025
```

```python
# Calculating the amount of money we will end up with if the initial $10000 investment grows at the rate of inflation
inflation_result = 10000 * (1 + inflation_rate)**10
inflation_result
```

```
12800.845441963567
```

Postmortem

What Difficulties Arose And How Were They Handled?

- Incomplete data
- How to pull risk free data?
- AGG is not a representation of inflation

Postmortem

What Additional Questions Arose?

- What is hedging in the banking sense

Postmortem

What other research could be done with more time?

- Understand the meaning of hedging better
- Try other assets
- Find a way to pull 10 years worth of data
- Crypto
- Forex
- Different metals (commodity)
- Use both fundamental and technical analysis on historical data, then forecasting
- Utilities (water, electricity)
- Freight/logistics
- Green Energy (Lithium)

References

Bellucco, A. (2022). *Beta: Definition, Calculation, and Explanation for Investors*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/terms/b/beta.asp

Charles Schwab. (2022). *Filtering the Market Using Technical Analysis.* Retrieved 7 November 2022, from https://www.schwab.com/learn/story/filtering-market-using-technical-analysis

Complete Dissertation. (2022). *Pearson's Correlation Coefficient - Statistics Solutions*. Retrieved 7 November 2022, from https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/pearsons-correlation-coefficient/

Cussen, M. (2022). *The Top 5 Ways to Hedge Against Inflation*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/articles/investing/060916/top-5-ways-hedge-against-inflation.asp

Fernando, J. (2022). *Inflation: What It Is, How It Can Be Controlled, and Extreme Examples*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/terms/i/inflation.asp

Fernando, J. (2022). *Sharpe Ratio Formula and Definition With Examples*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/terms/s/sharperatio.asp

References

Hayes, A. (2022). *What Is the Bloomberg Aggregate Bond Index, Who Tracks the Agg?* Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/terms/l/lehmanaggregatebondindex.asp#toc-composition-of-the-bloomberg-aggregate-bond-index

Hoz, J. D. L. (2022). *AGG: 3 Bond Market Trends.* Seeking Alpha. Retrieved 7 November 2022, from https://seekingalpha.com/article/4545548-agg-three-bond-market-trends

iShares by BlackRock. (2022). *iShares Core U.S. Aggregate Bond ETF | AGG.* Retrieved 7 November 2022, from https://www.ishares.com/us/products/239458/ishares-core-total-us-bond-market-etf

Lynn, S. (2022). *Delete Rows & Columns in DataFrames using Pandas Drop.* Retrieved 7 November 2022, from https://www.shanelynn.ie/pandas-drop-delete-dataframe-rows-columns/

Nasdaq Data Link. (2022). *Get Financial Data Directly Into Python.* Nasdaq Data Link. Retrieved 7 November 2022, from https://data.nasdaq.com/tools/python

Nasdaq Data Link. (2022). *USAGE.* Retrieved 7 November 2022, from https://docs.data.nasdaq.com/docs/in-depth-usage

Pandas. (2022). *pandas.DataFrame.reset_index — pandas 1.5.1 documentation.* Retrieved 7 November 2022, from https://pandas.pydata.org/docs/reference/api/pandas.DataFrame.reset_index.html

References

Pandas. (2022). *pandas.DatetimeIndex — pandas 1.5.1 documentation.* Retrieved 7 November 2022, from https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DatetimeIndex.html

Peters, K. (2022). *9 Assets for Protection Against Inflation and the ETFs that Track Them*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/articles/investing/081315/9-top-assets-protection-against-inflation.asp

Potters, C. (2022). *Risk-Seeking Definition*. Investopedia. Retrieved November 6, 2022, from https://www.investopedia.com/terms/r/risk-seeking.asp

Palmer, B. (2022). *Why Is the Consumer Price Index Controversial?* Investopedia. Retrieved 7 November 2022, from https://www.investopedia.com/articles/07/consumerpriceindex.asp

Quora. (2022). *How does one calculate daily Treasury bill (T bill) returns?.* Retrieved 7 November 2022, from https://www.quora.com/How-does-one-calculate-daily-Treasury-bill-T-bill-returns

Trader University. (2022). *Has Bitcoin Failed As An Inflation Hedge?* Youtube. Retrieved 7 November 2022, from https://www.youtube.com/watch?v=LqVGjziEpDk