$ARKK Rebalancing

Evaluation of $ARKK portfolio through Back Testing and Monte Carlo simulations

August 14, 2021

Leader: David Dannenberg

Team: Tom Banerjee
Anthony Barone
Gabriela Corrochano
David Danenberg
Kian Momeni

Project Summary

$ARKK- Portfolio Rebalancing and Testing

User Story: Investment analyst at ARK Research is tasked with assessing the performance of the $ARKK holdings when changing the stock selection to determine opportunities for improvement in $ARKK.

Overview:

1. Evaluate existing ARKK performance relative to benchmark and its effect on individual stocks (e.g. do stocks perform better following ARKK investment and worse following divestment?)

2. What effect will selections of alternative stocks (up to 2) have had on the returns of ARKK from 2018 through present?

3. What effect will selections of alternative stocks (up to 2) have on the projected future performance of ARKK according to a Monte Carlo analysis?

4. What effect will selections of alternative stocks (up to 2) have had on the volatility of ARKK?

Goal:

To create a tool that not only would allow user to evaluate the performance of a portfolio, but that it will also help increase his/her efficiency and ability to adjust holdings on the spot to reach peak portfolio optimization.

Data Collection

Why $ARKK?

" ARKK is an actively managed ETF that seeks long-term growth of capital by investing under normal circumstances primarily (at least 65% of its assets) in domestic and foreign equity securities of companies that are relevant to the Fund's investment theme of disruptive innovation.

Companies within ARKK include those that rely on or benefit from the development of new products or services, technological improvements and advancements in scientific research relating to the areas of DNA technologies ("Genomic Revolution"), industrial innovation in energy, automation and manufacturing ("Industrial Innovation"), the increased use of shared technology, infrastructure and services ("Next Generation Internet'), and technologies that make financial services more efficient ("Fintech Innovation"). "

❖ Assessed various market indices as well as ETFs for potential test cases.

❖ Reviewed an ETF or a basket of securities that participated in exciting disruptive sectors, that also had positions in companies that were in their "early life cycle.

❖ Opted for companies with recent initial public offerings (last 5 years).

❖ $ARKK was selected because of its holdings in disruptive technologies as well as early lifecycle companies

❖ While our original focus was placed on mostly early stage companies, our alternative stock is made up of a blended list of early and late stage companies
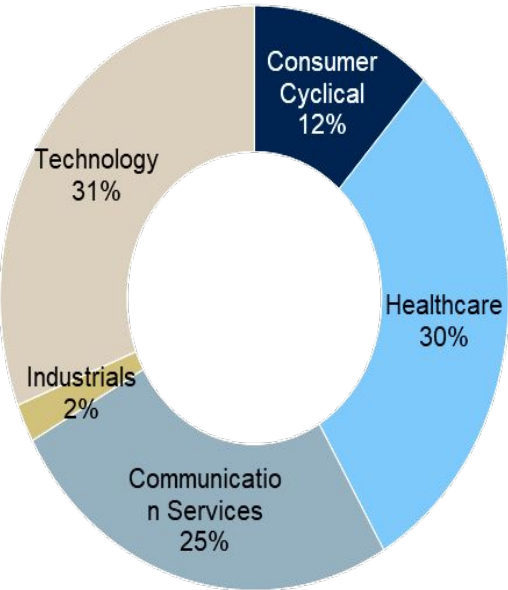
Data Collection (continued)

$ARKK Portfolio Composition

Base Portfolio by Weightings

Base Portfolio by Sector

Data Collection (continued)

Alternative Portfolio Composition
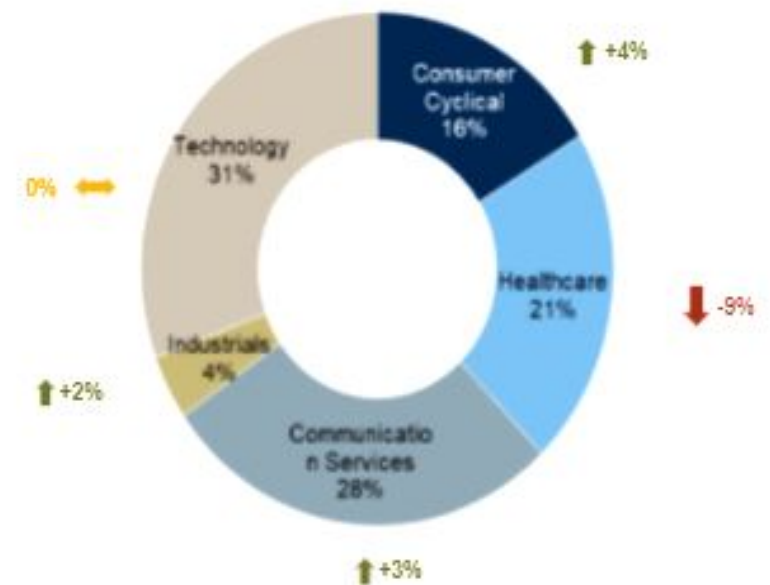
Alternative Options

Alternative Options by Sector

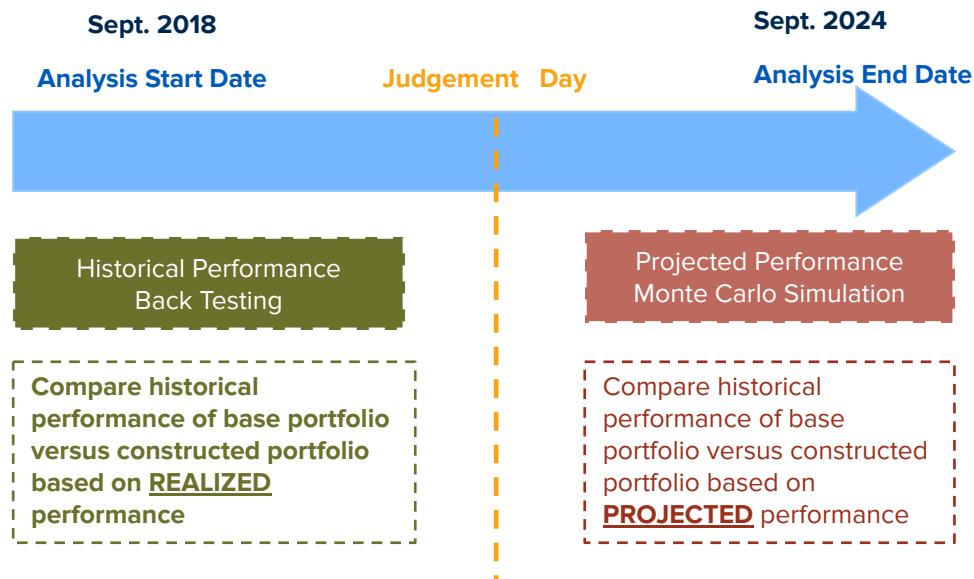**Alternative stock options are assumed to retain the weightings of the stocks they are selected to replace**

Data Exploration

Used Alpaca API to pull pricing data for the $ARKK holdings selection (17 stocks), as well as for each stock in our Alternative Portfolio option.

New data frames were created to contain data for each portfolio, and later used to calculate the following:

- ❖ Daily Return
- ❖ Cumulative Return
- ❖ Average Return
- ❖ Standard Deviation
- ❖ Annual Standard Deviation
- ❖ Sharpe Ratio

Sept. 2018

Sept. 2024

Analysis Start Date   **Judgement Day**   **Analysis End Date**

Historical Performance
Back Testing

Projected Performance
Monte Carlo Simulation

**Compare historical
performance of base portfolio
versus constructed portfolio
based on REALIZED
performance**

Compare historical
performance of base
portfolio versus constructed
portfolio based on
PROJECTED performance

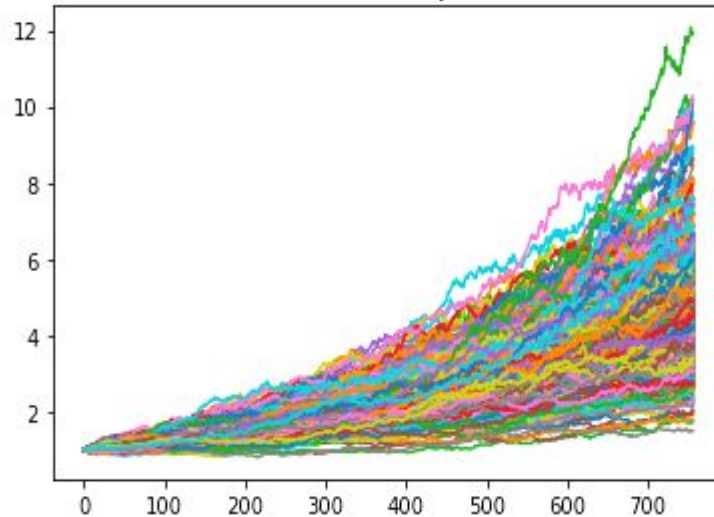# ARKK Portfolio Returns (continued)

ARK Porfolio Returns

```
Initial_Investment = 10000
Cumulative_Profits = Initial_Investment * cumulative_returns
Cumulative_Profits.plot(title="ARK Porfolio Returns", figsize=(15,7))
```
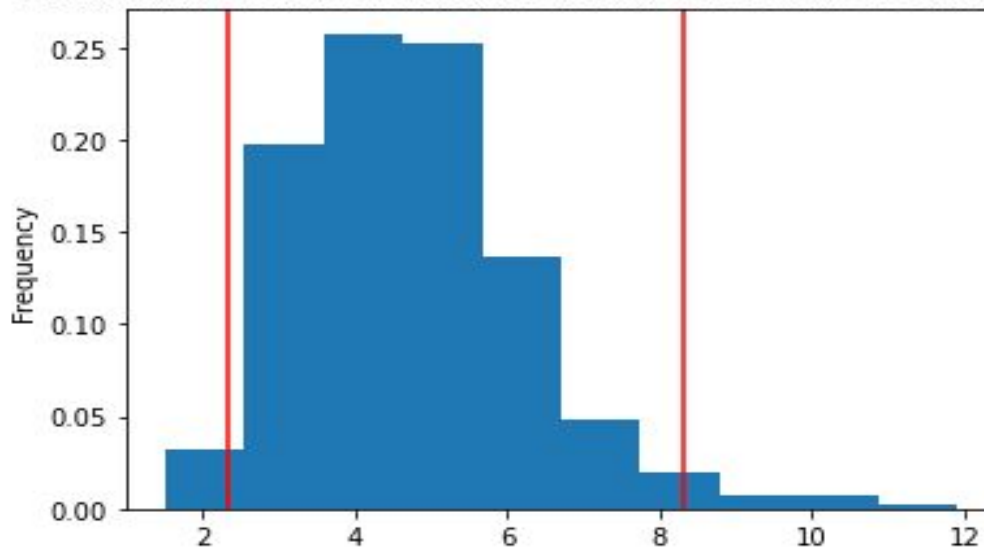
Monte Carlo Simulation

❖ Utilized Monte Carlo simulations to forecast 3 years of cumulative returns for our "baseline" $ARKK portfolio

❖ Used linear and bar plots to visualize the simulations results

500 Simulations of Cumulative Portfolio Return Trajectories Over the Next 756 Trading Days.

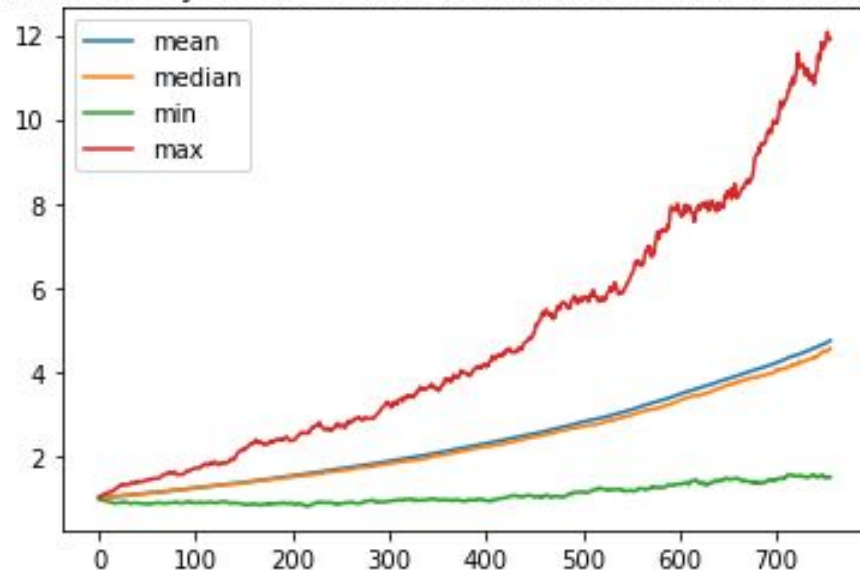Distribution of Final Cumuluative Returns Across All 500 Simulations

Monte Carlo Simulations
(3 years / 756 Trading days)

ARKK Portfolio Returns

Simulated Daily Returns Behavior of ARK Stock Over the Next 3 Year

```python
tbl = MC_threeyear.summarize_cumulative_return()
print(tbl)
```

```
count           500.000000
mean              4.627742
std               1.563510
min               1.493983
25%               3.562763
50%               4.398729
75%               5.440437
max              11.793448
95% CI Lower      2.157729
95% CI Upper      8.313668
Name: 756, dtype: float64
```

```python
# Use the lower and upper `95%` confidence intervals to calculate the range of the possible outcomes of our $10,000 investments in ARK ETF
ci_lower = round(tbl[8]*10000,2)
ci_upper = round(tbl[9]*10000,2)

# Print results
print(f"There is a 95% chance that an initial investment of $10,000 in the portfolio"
      f" over the next three years will end within in the range of"
      f" ${ci_lower} and ${ci_upper}.")
```

```
There is a 95% chance that an initial investment of $10,000 in the portfolio over the next three years will end within in the range of $21577.29 and $83136.68.
```

Data Cleanup

❖ ALpaca limitation (35 months)

❖ Utilized .dropna( ) function to eliminate null or empty values.

❖ Modified indexes using .index( ) function to organize dataframes.

```
# Drop the time component of the date
ARK_closing_prices.index = ARK_closing_prices.index.date

# Compute daily returns
ARK_daily_returns = ARK_closing_prices.pct_change().dropna()
```
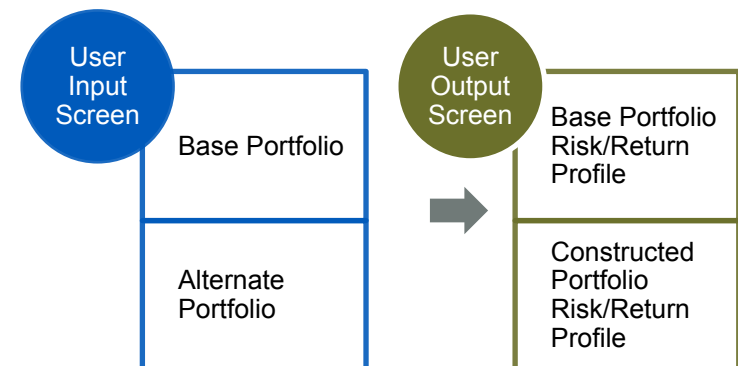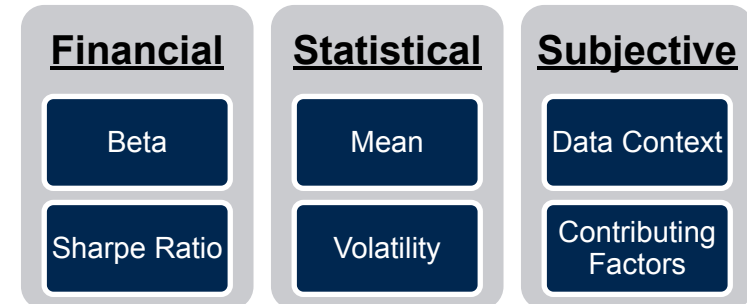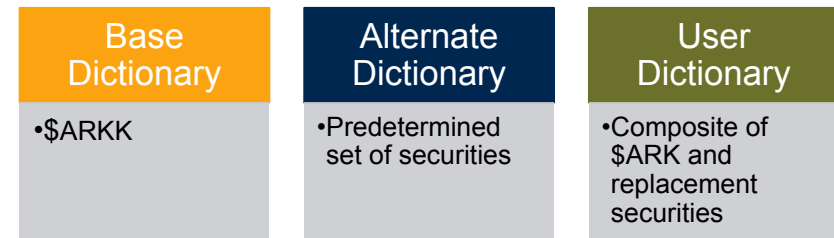
Approach

Work Process Flowchart

Project Objectives

|	
1	Create base dictionary with historical closing prices of base tickers
2	Create second dictionary with closing prices of alternate tickers
3	Create an empty List that will be populated with base dictionary and user selection of replacement tickers
4	Create functions that calculate statistical metrics like mean, variance, dispersion etc. and financial metrics like Beta, Sharpe ratio etc.
5	Import Monte Carlo Module provided in class. Attempt to improve on it
6	**USER INPUT INTERFACE:** Design a user interface that displays the base portfolio and possible alternatives
7	**USER OUTPUT REPORT:** Design a report that compares statistics associated with the base and user constructed portfolio in a clear and concise manner

Metrics used to evaluate portfolios

Base Dictionary	Alternate Dictionary	User Dictionary
•$ARKK	•Predetermined set of securities	•Composite of $ARK and replacement securities

Financial	**Statistical**	**Subjective**
Beta	Mean	Data Context
Sharpe Ratio	Volatility	Contributing Factors

User Input Screen

Base Portfolio
Alternate Portfolio

→

User Output Screen

| Base Portfolio Risk/Return Profile |
|---|
| Constructed Portfolio Risk/Return Profile |

Demonstration

Created a user interface by utilizing *Interact*

This allows the user to select 2 stocks from the Alternative Stock List, and swap them for 2 stocks in our Baseline $ARKK Portfolio to analyze how the modified portfolio would have performed against the baseline selection.
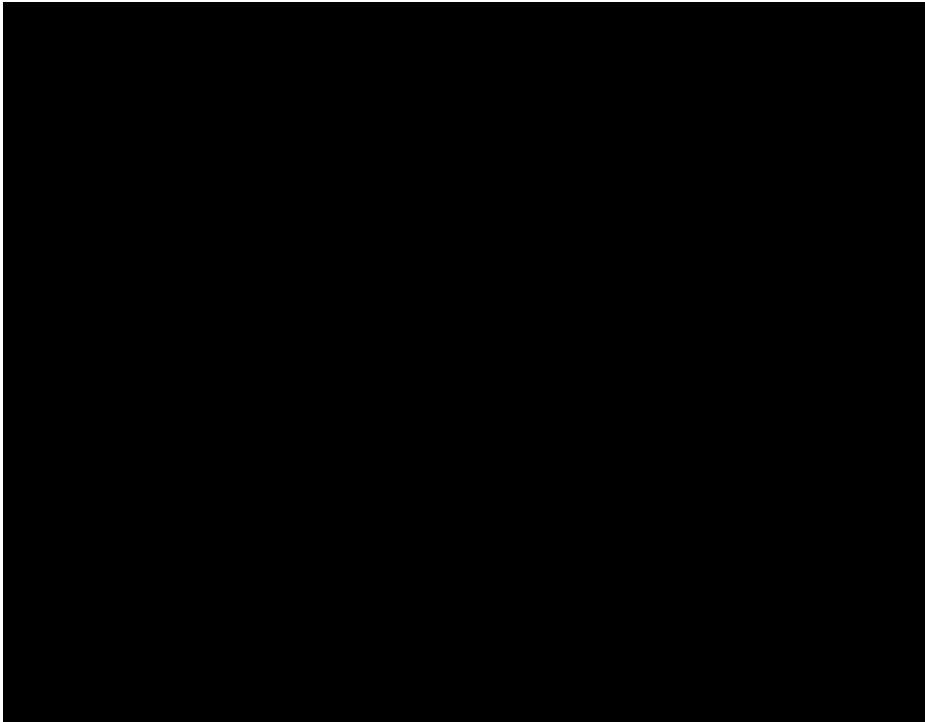
Backtesting to determine whether or not the user selection would have outperformed ARKK (0:40 sec video)
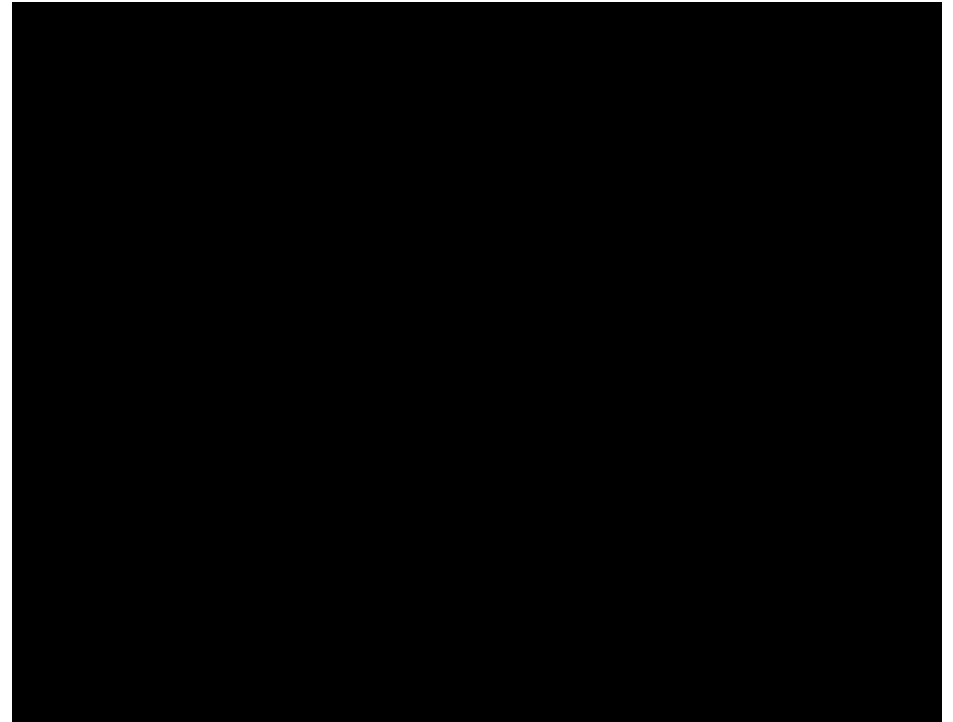
Projections using Monte Carlo simulation to determine future modified portfolio return ARKK (0:35 sec video)

Next Steps

❖ Automate data pulls and create new dataframes for modified portfolios based on user input

❖ Index portfolio weights to original list to maintain data integrity when swapping

❖ Ensure stocks swap appropriately (i.e. that they are not simply added)

❖ Questionary integration or modify user interface to allow for additional stock swap and to calculate new portfolio returns, as opposed to one stock

Appendix

Git Hub Repository: https://github.com/anthonybarone0211/project_1.git

Alpaca API: https://alpaca.markets/

ARKK Invest: https://ark-funds.com/arkk