Portfolio Analysis of NFLX, NVDA, AYI and NVR versus the S&P 500

Computational Finance and Financial Econometrics

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Introduction

This report consists of an analysis of the returns for four assets; Netflix, Inc. (NFLX), Nvidia Corporation (NVDA), Acuity Brands, Inc. (AYI), and NVR, Inc. (NVR). These companies each enjoyed positive returns between April 2013 and April 2018, with AYI seeing the most moderate returns while NVDA saw by far the greatest returns. Finally, we will compare the returns of a portfolio consisting of these three assets, which are all elements of the Standard and Poor's (S&P) 1500 Composite, to the returns of an similar investment in the S&P 500 Composite during the same period.

Netflix, Inc. is an internet based entertainment company headquartered in Los Gatos, CA and traded on NASDAQ. While they began by offering video rentals through the mail, they have largely shifted away from this model and have began to focus on streaming video content. This content is sourced from network and cable television programs as well as their own generated content. They monetize this content by offering a monthly subscription based service to users in exchange for unlimited streaming of their content. Netflix has seen steadly increasing revenue in recent years due to increasing tendency towards "cord-cutting", or a reduced use traditional viewing methods and shifting towards more on-demand viewing. With a 2017 revenue of $11.7 billion Netflix ranks as the 10th largest internet company by revenue. During the time period being analyzed they saw dramatic growth from an inital value of $30.85, to a final value of $291.94.

Nvidia Corporation is also a technologically focused company that is also traded on NASDAQ. Nvidia Corporation however produces computer hardware such as Advanced Micro Devices' (AMD's), Graphical Processing Unit's (GPU's) and System on a Chip units (SoCs). Headquartered in Santa Clara, CA; Nvidia has seen rapid growth since late-2015 growing from a stock price of just $22.00 per share in August 2015 to $224.80 per share in April 2018. This surge in price is likely due to increased demand for GPU's as a result of the rapid growth of Bitcoin which grew in value from $283.73 to $6,943.77 during this period peaking as high as $13.850.49 during the same time frame. The reason these two are likely tied is due to the use of GPU's in "mining" Bitcoin, a process in which people can earn this cryptocurrency by processing transactions completed utilizing the same currency. However the volatility of Bitcoin may be cause for concern for long-term investment in Nvidia as if there is a dramaitic drop in the price of Bitcoin we will also likely see a similar dip in Nvidia stock.

Acuity Brands, Inc. is an Atlanta, GA based company traded on the NYSE, and is in the Commercial and Industrial Lighting Industry. They operate throughout North America, Europe and Asia andare the largest lighting manufacturer in North America in terms of market share. During the analyzed period Acuity Brands saw steady growth until late 2016

peaking at nearly \$275.00 per share before steadily losing value through April 2018 to just \$119.70. The loss in value seems indicative of a potential long term issue as they follow repeated failures to meet projected quarterly earnings due to decreased margins. However if they are able to correct this issue they are likely due for a long-term rebound.

NVR, Inc. is a homebuilding and mortgage company based out of Reston Virginia, and is traded on the NYSE. Their heavy focus in the housing industry means they will see consistently positive returns, while the housing market continues to climb which would make them a safe investment. They would be highly succeptible to another market dip as they would see a reduction in revenue on the production front as well as the financial services front which could be compounded further if they were to see any increase in defaults on mortgages.

The Standard and Poor's 500 is a market index based on 500 large companies which has common stock issued on either the NYSE or NASDAQ. The S&P 500 weighs each company in it's index by using the number of shares each company has availible for public trading. During the period the index saw overall positive returns as the value increased from \$1598 to \$2648 during the period of analysis.
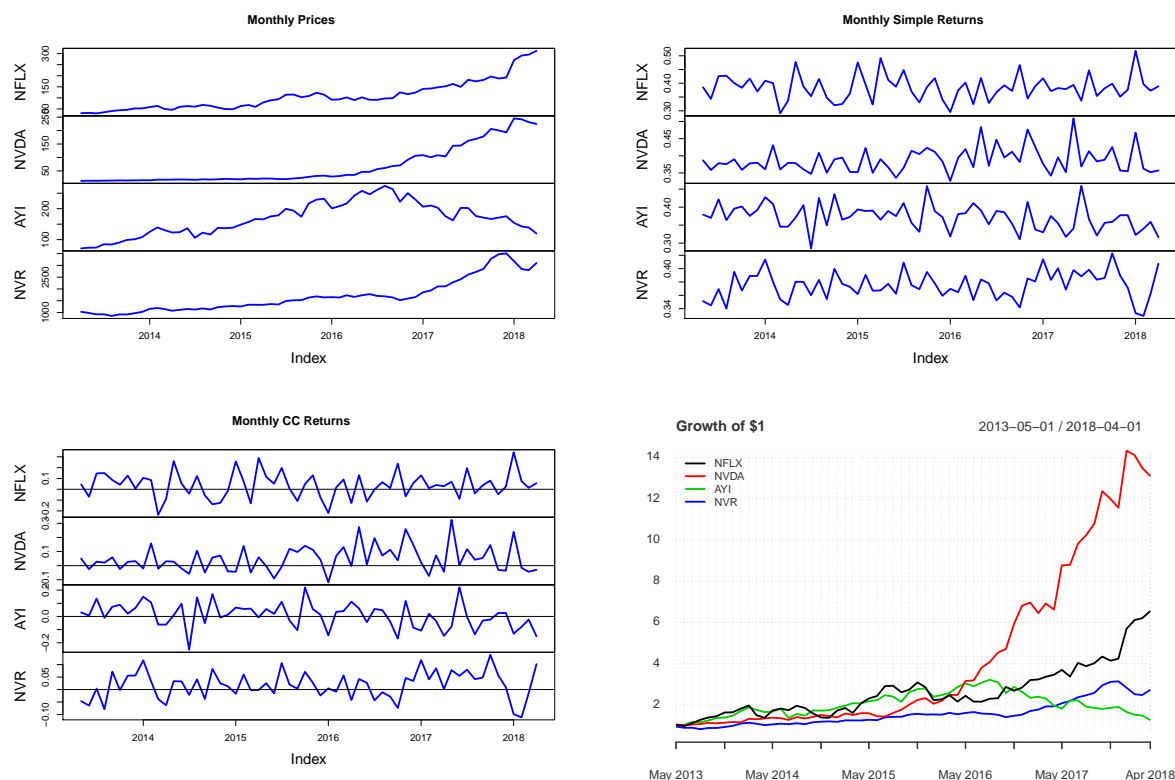
Descriptive Statistics

Figure 1: Asset activity between April 2013 and April 2018. In clockwise order: Monthly Asset Prices, Monthly Asset Simple Returns, Asset Equity Curves, Monthly Asset CC Returns.

The monthly continuously compounding returns appear to be time stationary for all four assets, as they all tended to be centered around 0. The time independence of NVDA's

variance however may be questionable as it appeared to be consistent before mid-2015 when the returns began varying greatly and the monthly prices began to increase rapidly. Additionally, after early 2016, NVDA appears to also not have zero mean as the continuously compounding returns are above zero for the majority of the period, dipping below zero only a few times and only for brief periods. These irregularities are likely due to the increased demand for graphics cards caused by the quick growth of bit coin during this time. There does appear to be a some positive correlation between NVDA and AYI as they seem to spike around the same periods as well as having decreasing rates of return together. During the time period April 2013-April 2018, a $1 investment in NFLX, NVDA, AYI and NVR would yield a return of approximately $6.50, $13.00, $1.50 and $3.00 respectively.
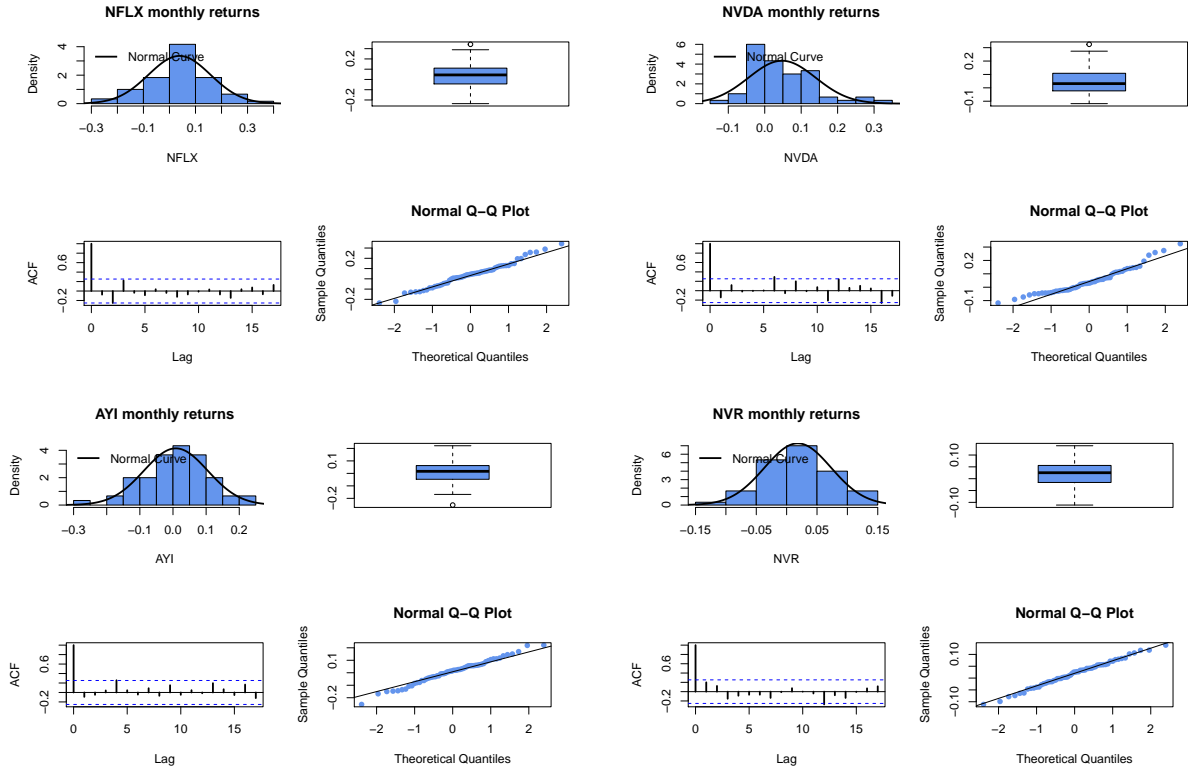

Figure 2: Four Panel Plots for Assets, based on monthly return data. From clockwise by quadrant; cc returns probability density, asset boxplot, Q-Q plot and ACF plot. Assets in clockwise order by quadrant; Netflix, Nvidia, NVR and Acuity Brands.

NVR appears to be the closest to being truly normally distributed as all of it's points closely follow the theoretical quantiles on the Q-Q plot. Similarly, their returns seem to closely follow a normal distribution while the box plot has a fairly compact inter-quartile range, with equally compact whiskers. NFLX is almost perfectly normally distributed, aside from an unusually high density of mean returns it follows the normal distribution curve nearly exactly, resulting is an unexpectedly narrow inter-quartile range in the boxplot. While NFLX's lower end tail events remain approximately normal, there is a higher concentration of high end tail events than would be expected with normally distributed returns. This is evidenced by the Asset's Q-Q plot as it begins to differ from the theoretical-sample line at the upper tail towards the sample quantiles indicating higher densities than expected.

With AYI we begin to see many more abnormalities in it's density. First, it appears to be slightly left skewed indicating a higher probability of positive continuously compounded returns. This is countered however by the slight abnormalities at the tail event. First, we see a higher concentration of tail events on both ends of the distribution than would be expected with a normally distributed curve, with an extreme outlier outside the lower second theoretical deviation. These extreme events are captured in their box plots; while NFLX has an expected box plot we see an extreme outlier above 0.3, while AYI has a relatively compact interquartile range we it has an unexpectedly long upper whisker and an extreme lower outlier below -0.2.

Finally, NVDA's returns show a great deal of abnormality. We first see a high density around the zero mean, however we see more events above, and fewer below, the mean than would be expected if returns were normal. This is also apparent in the Q-Q plot where we see an unusually high occurance of negative tail events and an unusually low occuance of upper tail events. When looking at the box plot there is a relatively normal interquartile range with the mean nearly in the center, but with a very small lower whisker and a long upper whisker as well as an upper outlier above 0.3.
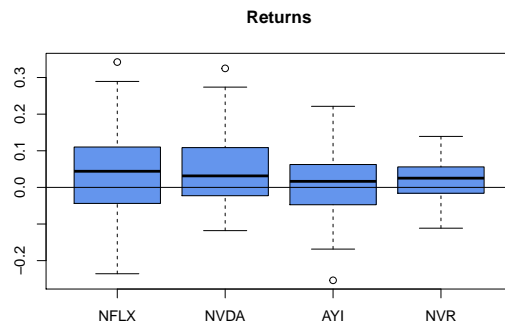

Figure 3: Boxplots of continuously compounding monthly asset returns

From the ACF plots it seems that all assets are time independent, although it appears that NVDA may have some time dependence during the 6th lag.

From Table 1, we see that NVDA has the highest expected returns at 4.76%, while AYI has the lowest expected returns of 0.86%. Additionally, the most volatile asset is NFLX at 11.9%, while the NVR is the most stable at 5.48%. NFLX appear to be the most nor-

	NFLX	NVDA	AYI	NVR
Mean	0.0386	0.0476	0.0086	0.0184
Std Dev	0.1190	0.092	0.0963	0.0548
Skewness	0.1371	0.8924	-0.1832	-0.1435
Excess Kurtosis	0.1078	0.6531	0.0565	-0.2886
1% Quantile	-0.2262	-0.1022	-0.2034	-0.104
5% Quantile	-0.1312	-0.0585	-0.1472	-0.0742

Table 1: Descriptive Statistics

mally distributed with very low skewness and excess kurtosis values, and NVDA is the least normally distributed with extremely high skewness values as well as a large level of excess kurtosis.

In Table 2, there is very little covariance between the assets, with the highest level of covariance NFLX and NVDA at 0.29% and the lowest covariance is between NVR and NFLX at 0.045%. There are no surprising relationships, we may expect the covariance between NFLX and NVDA to be the largest as they are in similar industries and increased use of Netflix may relate to an increase in the demand for graphics cards.

	NFLX	NVDA	AYI	NVR
NFLX	0.0142	0.003	0.0004	0.0005
NVDA	0.003	0.0085	0.0010	0.0009
AYI	0.0004	0.0010	0.0093	0.0015
NVR	0.0005	0.0009	0.0015	0.003

Table 2: Covariance

	NFLX	NVDA	AYI	NVR
NFLX	1.0000	0.2698	0.0368	0.069
NVDA	0.2698	1.0000	0.1155	0.1730
AYI	0.0368	0.1155	1.0000	0.2848
NVR	0.069	0.1730	0.2848	1.0000

Table 3: Correlation

We see the highest correlation (Table 3) between NVDA and NFLX at 26.98%, while the remaining assets have low correlation with NFLX and NVR being the least correlated. This suggests that they would compose a diverse portfolio, although substituting NFLX or NVDA for a less highly correlated asset would help to increase its diversity. The high positive correlation between NFLX and NVDA, suggests that they are both susceptible to similar market forces, causing their returns to react similarly. This could cause the portfolio to suffer greatly if there were an event that negatively effected one of the assets. However, by substituting one of these assets for a less highly correlated asset would make the portfolio more robust to these types of events, minimizing the negative effect on the portfolio.
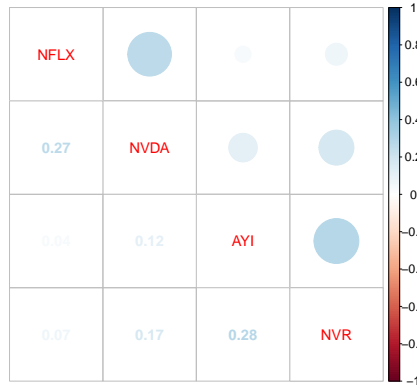

Figure 4: Asset Correlation Plots

Model Estimation

	Mean	SE	LCL (0.95)	UCL (0.95)
NFLX	0.0386	0.0154	0.0079	0.0693
NVDA	0.0476	0.0119	0.0239	0.0714
AYI	0.0086	0.0124	-0.0163	0.0334
NVR	0.0184	0.0071	0.0042	0.0325

Table 4: Estimated Mean Standard Error

	Standard Deviation	SE	LCL (0.95)	UCL (0.95)
NFLX	0.1190	0.0109	0.0973	0.1407
NVDA	0.092	0.0084	0.07518	0.1088
AYI	0.0963	0.0088	0.079	0.1139
NVR	0.0548	0.005	0.0448	0.0648

Table 5: Estimated Std Dev Standard Error

	Estimate	Boot S.E.
R=1000	0.0184	0.00702
R=10000	0.0184	0.00697

Table 6: NVR Bootstrapped Mean Standard Error

	Estimate	Boot S.E.
R=1000	0.0548	0.0046
R=10000	0.0548	0.0046

Table 7: NVR Bootstrapped Std Dev Standard Error

NVDA has the most precisely estimated mean at nearly double the standard error of the estimate (Tables 4 and 5), however the means of the remaining assets are not very precisely estimated as they have standard errors that are nearly as large as the estimates. The standard deviations for the assets on the other hand are much more precisely estimated as they are each nearly ten times as large as their standard errors.

The bootstrap standard errors are smaller for both mean and standard deviation. While the standard errors for estimates of the standard deviation remained the same as the number of samples increased to 10,000, the standard error estimates grew for mean as the number of samples increased. There is not a significant difference resulting from the increased number of samples as the change in standard errors for the mean was only 5 hundred thousandths.
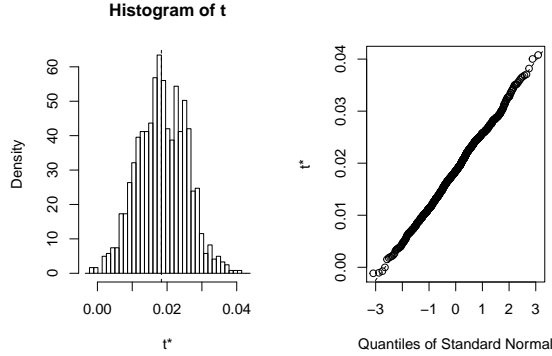

Figure 5: NVR Bootstrap Distribution

Although there appears to be slight skewness, when looking at the Q-Q plot (Figure 5) the mean appears to be nearly normally distributed. While there is an unexpected dip in density around 0.2, the remaining histogram follows an approximately normal distribution. The Q-Q plot does suggest that the central limit theorem does apply and that increasing the number of observations beyond 1,000 will lead to increasingly normally distributed returns.

The most inaccurate estimates are those for the correlation between NFLX and AYI and NVR, while the most accurate are the estimates for cor(AYI,NVR) and cor(NFLX, NVDA).

	Correlation	SE	LCL (0.95)	UCL (0.95)
NFLX,NVDA	0.2698	0.1197	0.0304	0.5092
NFLX,AYI	0.0368	0.1289	-0.2210	0.2947
NFLX,NVR	0.069	0.1285	-0.1880	0.326
NVDA,AYI	0.1155	0.1274	-0.1393	0.3702
NVDA,NVR	0.1730	0.1252	-0.0774	0.4235
AYI,NVR	0.2848	0.11865	0.0475	0.5221

Table 8: Bootstrapped Correlation Standard Error

	1%	5%
NFLX	-21202.09	-14544.777
NVDA	-15324.24	-9847.138
AYI	-19383.38	-13915.388
NVR	-10330.18	-6920.349

Table 9: Normally Distributed Value-at-Risk

The assets with the largest standard deviations have the largest Value-at-Risk estimates. This is expected since the estimate relates to the low frequency events in the distribution, so while the expected returns are a factor in the starting position it is quickly outweighed by the tail events.

	5% VaR	SE	LCL (0.95)	UCL (0.95)
NFLX	-14544.777	1899.834	-18501.631	-11054.418
NVDA	-9847.138	1259.499	-12493.484	-7556.339
AYI	-13915.388	1872.933	-17736.170	-10394.407
NVR	-6920.349	1033.874	-9097.064	-5044.351

Table 10: Bootstrapped 5% Normal VaR Standard Error and 95% CI

	1% VaR	SE	LCL (0.95)	UCL (0.95)
NFLX	-21202.09	2236.725	-25910.11	-17142.309
NVDA	-15324.24	1640.775	-18797.38	-12365.663
AYI	-19383.38	2194.909	-23891.01	-15287.129
NVR	-10330.18	1229.804	-12937.19	-8116.441

Table 11: Bootstrapped 1% Normal VaR Standard Error and 95% CI

The 5% VaR estimates (Table 10) are reasonably accurate although the standard error for the NVR is nearly a third of the estimated VaR. The 1% VaR estimates (Table 11) are much more accurate the all of the standard errors being about 10% of the estimated values. NFLX has the highest VaR at both the 1% and 5% level, and NVR is the lowest.

	5% VaR	1% VaR
NFLX	-12293.637	-20240.871
NVDA	-5682.158	-9712.928
AYI	-13690.279	-18407.666
NVR	-7147.487	-9874.059

Table 12: Empirically Distributed Value-at-Risk

	5% VaR	SE	LCL (0.95)	UCL (0.95)
NFLX	-12293.637	2845.771	-17002.104	-5846.888
NVDA	-5682.158	1611.777	-8498.559	-2180.508
AYI	-13690.279	1986.750	-17632.884	-9844.966
NVR	-7147.487	1467.583	-10271.160	-4518.339

Table 13: Bootstrapped 5% Empirical Value-at-Risk Standard Error and 95% CI

The difference in 5% VaR for NVDA and NFLX from normally distributed to empirical (Tables 10 and 13), is rather significant, while it is not very significant for AYI and NVR. For 1% VaR (Tables 11 and 14) however the only significant difference between empirical and normal VaR is for NVDA. This is rather expected as NVDA is the furthest from normal so the further towards tail events we get the more accurate the estimates will be for the assets with returns that are most normal.

	1% VaR	SE	LCL (0.95)	UCL (0.95)
NFLX	-20240.871	3031.666	-28291.26	-16407.353
NVDA	-9712.928	1718.430	-13717.46	-6981.336
AYI	-18407.666	3289.773	-25325.40	-12429.733
NVR	-9874.059	1238.449	-12993.60	-8138.965

Table 14: Bootstrapped 1% Empirical Value-at-Risk and 95% CI

Portfolio Theory

As expected NVDA has the highest risk-adjusted return, evidenced by its Sharpe's ratio (Table 15) which is significantly higher than that of any of the other assets in the portfolio. An investment in NVDA during this period would tend to yield greater than 51% excess return per unit of risk, while AYI, which had the lowest tended to yield only 8% excess return per unit of risk. Surprisingly AYI appears to have roughly equivalent returns although having significantly higher
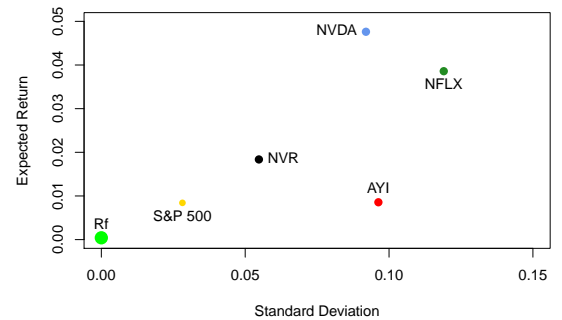
Figure 6: Asset Returns vs Standard Deviation with Risk-Free rate (green) and S&P 500 (gold).

volatility than the S&P 500. After verifying these
numbers by bootstrapping we see that these estimates are not very accurate however they do
all seem to have around the same standard error.

	Sharpe	SE	LCL (0.95)	UCL (0.95)
NFLX	0.3207	0.1374	0.0484	0.5870
NVDA	0.5132	0.1116	0.2934	0.7309
AYI	0.0845	0.1334	-0.1789	0.3439
NVR	0.3277	0.1376	0.0450	0.5843

Table 15: Sharpe Ratio's

```
Global Minimum Variance Portfolio
Portfolio expected return:      0.0237
Portfolio standard deviation:   0.0473
Portfolio weights:
  NFLX   NVDA   AYI   NVR
0.1035  0.1496  0.1185  0.6284
```

Table 16: Global Minimum Variance Portfolio
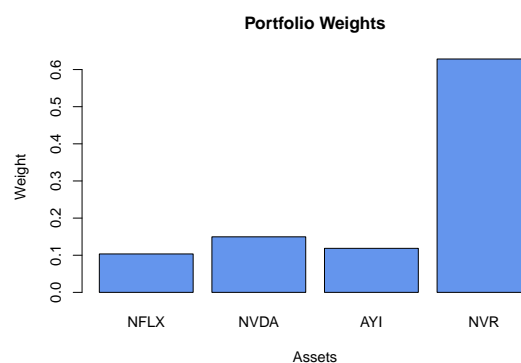
Figure 7: Global Minimum Variance Portfolio Weights

```
No-Short Global Minimum Variance Portfolio
Portfolio expected return:      0.0237
Portfolio standard deviation:   0.0473
Portfolio weights:
  NFLX    NVDA    AYI     NVR
0.1035  0.1496  0.1185  0.6284
```

Table 17: No-Short Global Minimum Variance Portfolio

	Shorts	No Shorts
Annual Mean	0.2840	0.2840
Annual SD	0.1639	0.1639
VaR.05	-5273.22	-5273.22
VaR.01	-8279.54	-8279.54

Table 18: Short vs No-Short Global Minimum Variance Portfolio

All asset weights in the Global minimum variance portfolio (Table 16) are greater than zero and surprisingly AYI which is has the lowest Sharpe ratio of all the assets has a larger weight than NFLX, which while having a higher volatility than AYI also has a much higher expected return. Unsurprisingly we see that NVR which has the lowest volatility of the group with a very significant proportion of the global minimum variance portfolio.

	5%	1%
GMV	-5273.23	-8279.548

Table 19: Global Minimum Variance Portfolio VaR

The Value-at-Risk of the Global Minimum Variance Portfolio (Table 19) is significantly lower than any individual asset in the portfolio. This outcome is not surprising as it consists mainly of NVR which has the lowest value at risk of the assets being analyzed, and is nearest to the global minimum variance portfolio.
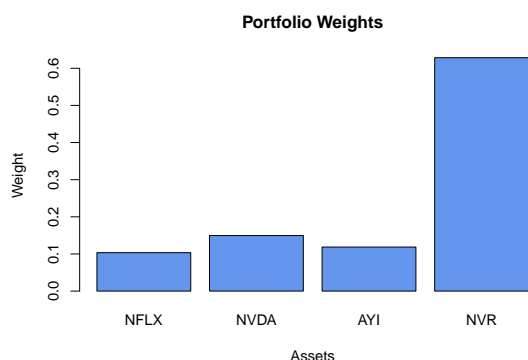

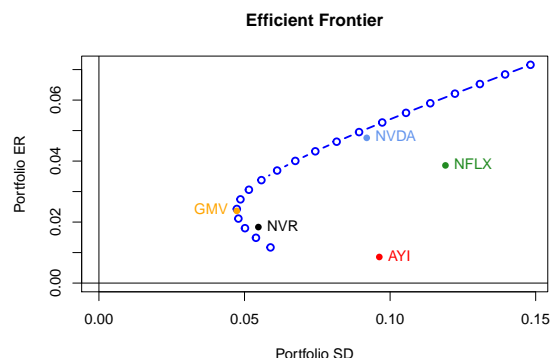Figure 8: Global Minimum Variance Portfolio, No-Shorts

Figure 9: Efficient Portfolio Frontier (blue), and Global Minimum Variance Portfolio (orange).

The GMV portfolio's Value-at-Risk are identical for the short and no-short portfolio's (Table 18) since the portfolio allowing for shorts did not contain any negative asset weights.

```
E[R_P] = E[R_{NVDA}]
Portfolio expected return:      0.0476
Portfolio standard deviation:   0.0847
Portfolio weights:
   NFLX    NVDA     AYI      NVR
 0.2123  0.7768 -0.2283   0.2392
```

Table 20: Portfolio Returns equal to Nvidia Returns

```
Tangency Portfolio
Portfolio expected return:      0.0349
Portfolio standard deviation:   0.0576
Portfolio Sharpe Ratio:         0.5980
Portfolio weights:
   NFLX    NVDA     AYI      NVR
 0.1543  0.4429 -0.0436   0.4464
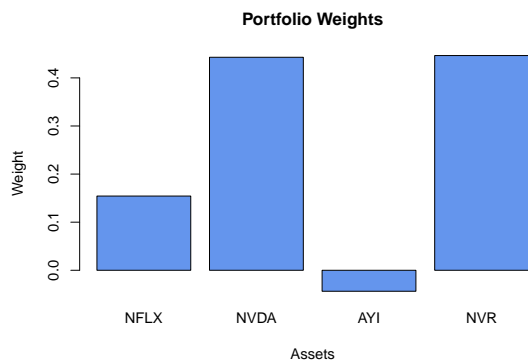```

Table 21: Tangency Portfolio
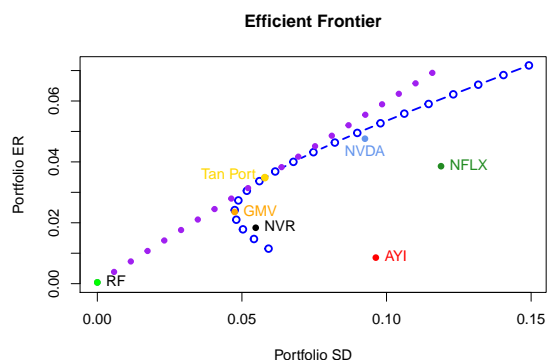


Figure 10: Tangency Portfolio Weights



Figure 11: Asset Efficient Frontier (blue), Efficient Tangency Portfolio's (purple), Global Minimum Variance Portfolio (orange), Tangency Portfolio (gold), Risk-Free Rate (green).
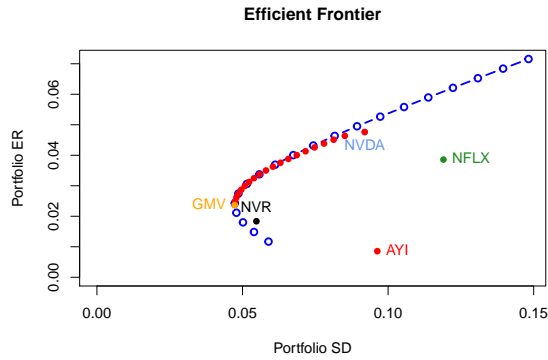
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Figure 12: Efficient Frontier with shorts (blue), No-Short Efficient Frontier (red), Global Minimum Variance Portfolio (orange)
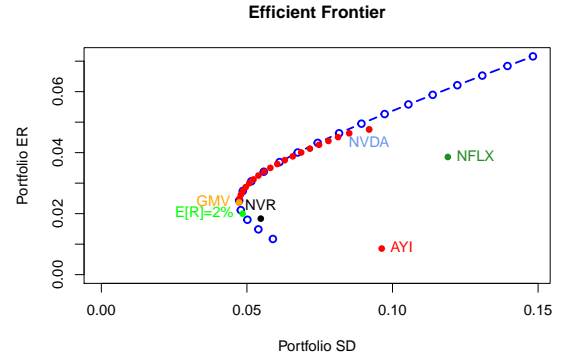


Figure 13: Efficient Frontier with shorts (blue), Portfolio with two percent Expected Returns (green), No-Short Efficient Frontier (red), Global Minimum Variance Portfolio (orange).

|      | Shorts   | No Shorts. |
|------|----------|------------|
| NFLX | 0.1543   | 0.1514     |
| NVDA | 0.4429   | 0.4313     |
| AYI  | -0.0436  | 0.0000     |
| NVR  | 0.4464   | 0.4173     |

Table 22: Short vs No-Sport Tangency Portfolio Weights

The only asset that has a negative weight in the tangency portfolio is the weight for AYI (Figure 10, Table 21), which is expected as it has the lowest expected return of all our assets. The Sharpe Ratio of the tangency portfolio is greater than that of any of the individual assets. The large value associated with the Shape Ratio for the tangency portfolio is expected, although it has nearly 1% less in expected returns than NVDA it has nearly 4% less volatility.

The efficient portfolio frontier with no shorts (Figure 12) is very similar for much of its frontier to the portfolio with shorts. The no-shorts efficient frontier only deviates as it approaches NVDA, which has the highest expected return of the assets but is not far below the efficient portfolio frontier with shorts.

Two percent returns portfolio (Figure 13) is below the efficient frontier for this portfolio, hence the short and no-short portfolios are identical.

The tangent portfolio without shorts has a Sharpe ratio that is roughly .023 less than the tangent portfolio with shorts. This portfolio also has an expected rate of return that is roughly .75% a month less with 1% less volatility. Surprisingly there is a significant share of AYI in the no shorts portfolio (Table 22), an asset that was shorted in the tangent portfolio that allowed shorts, as well as an increased share of NFLX, while decreasing NVDA and NVR.
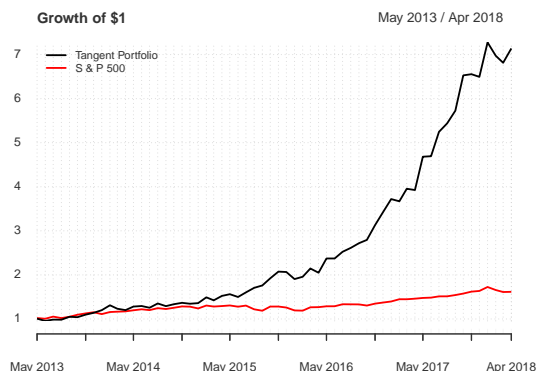
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# Can you beat the S&P 500?



Figure 14: Tangency Portfolio Equity Curve (black) vs.
S&P 500 Equity Curve (red).

Between April 2013 and April 2018 a $1.00 investment the S&P 500 would have yielded a return of approximately $1.75, while a similar investment in the tangent portfolio would have yielded a return of nearly $7.25 over the same period (Figure 14). The tangent portfolio was able to outperform the S&P 500 due to the rapid growth of NVDA as well as the steady growth by NFLX and NVR over the same period.

|  | Portfolio Weights |
| --- | --- |
| Tangency Portfolio | 0.4894 |
| Risk-Free | 0.5106 |

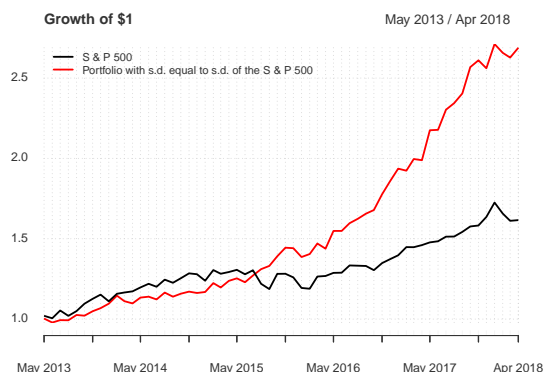Table 23: Portfolio Weights with Standard Deviation equal to the Standard Deviation of the S&P 500.



Figure 15: Equity Curve of portfolio with Standard Deviation equal to the Standard Deviation of the S&P 500 (black) vs S&P 500 Equity Curve (red).

|                  | SD$[R_P]$=SD$[R_{S\&P500}]$ | S&P 500 |
|------------------|:---------------------------:|:-------:|
| Expected Returns | 0.0171                      | 0.0084  |
| Std Dev          | 0.0282                      | 0.0282  |
| Sharpe Ratio     | 0.5905                      | 0.2840  |

Table 24: Portfolio with Standard Deviation equal to the Standard Deviation of the S&P 500, S&P 500.

This investor is very risk averse, as the portfolio volatility is not only below the Global Minimum Variance portfolio, but comprised more of the risk free rate than of the tangency portfolio (table 23). The efficient portfolio with the same risk level as the S&P 500 was still able to outperform the S&P 500 over the period April 2013-April 2018 (Figure 15), earning nearly $2.75 on a $1.00 investment, outperforming a similar investment in the S&P 500 by over $1.00.