Algorithmic Trading (Quantitative Value)

1. Introduction

This is my second personal project on algorithmic trading.

The strategy for this project is to select the 50 companies with the lowest Robust Value (RV) score from the S&P 500 and assign equal weights to these companies in the portfolio, rebalancing every 30 days.

The hypothesis for this strategy is that companies with lower valuation multiples (e.g., price-to-earnings, price-to-book) relative to their peers are undervalued by the market and may provide superior long-term returns, especially when combined with a disciplined rebalancing approach.

How this hypothesis may work:

1. **Value Investing Focus**: Stocks with low valuation multiples are often undervalued, and by targeting companies with the lowest RV scores, the strategy aims to capitalize on potential price corrections as the market revalues these companies over time.
2. **Equal Weighting**: Assigning equal weights to the top 50 undervalued stocks diversifies exposure across a range of sectors and reduces the over-concentration that can occur in traditional market-cap-weighted indices.
3. **Systematic Rebalancing**: By rebalancing every 30 days, the strategy regularly adjusts the portfolio to stay aligned with the evolving valuation metrics, ensuring that the portfolio remains focused on stocks that continue to exhibit attractive valuation characteristics.

The output of this project is an Excel sheet that lists the top 50 S&P 500 companies based on their RV score and recommends the number of shares to buy for each company, ensuring equal weight allocation across the portfolio.

2. Methodology

- Data processing
    - Loaded a csv file of 505 S&P500 companies

	Ticker
0	A
1	AAL
2	AAP
3	AAPL
4	ABBV
..	...
500	YUM
501	ZBH
502	ZBRA
503	ZION
504	ZTS

[505 rows x 1 columns]

Figure 1: Static List of S&P500 Companies

    - Obtain various metrics (Forward PE, Trailing PE, P/B Ratio, P/S Ratio and EV/EBITDA) of each company using yfinance library and created a DataFrame to store the data. Thereafter, calculated each stock's RV score by taking the mean of the percentile of each metric.

	Ticker	Price	Number of Shares to Buy	Forward Price-to-Earnings Ratio	Forward PE Percentile	Trailing Price-to-Earnings Ratio	Trailing PE Percentile	Price-to-Book Ratio	PB Percentile	Price-to-Sales Ratio	PS Percentile	EV/EBITDA	EV/EBITDA Percentile	RV Score
0	A	138.83	N/A	24.571682	0.702186	28.922916	0.571038	6.762299	0.699454	6.139718	0.770492	26.360	0.868852	0.722404
1	AAPL	235.00	N/A	31.417112	0.844262	35.714287	0.699454	53.628480	0.969945	9.265912	0.885246	27.413	0.887978	0.857377
2	ABBV	188.86	N/A	15.647059	0.344262	63.375840	0.918033	49.207920	0.967213	6.065290	0.751366	14.985	0.478142	0.691803
3	ABT	119.39	N/A	23.137598	0.65847	36.178787	0.702186	5.283211	0.614754	5.039830	0.702186	20.261	0.713115	0.678142
4	ACN	376.86	N/A	26.784647	0.759563	32.884815	0.644809	8.329870	0.765027	3.628599	0.562842	21.279	0.756831	0.697814
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
361	XOM	120.01	N/A	14.476478	0.273224	14.355264	0.174863	1.986493	0.20765	1.544856	0.26776	7.867	0.117486	0.208197
362	XYL	134.32	N/A	27.925158	0.789617	41.456790	0.778689	3.155051	0.418033	3.885825	0.595628	20.913	0.743169	0.665027
363	ZBH	106.31	N/A	12.404901	0.196721	22.194155	0.379781	1.709659	0.10929	2.877185	0.467213	10.820	0.237705	0.278142
364	ZBRA	375.45	N/A	24.300972	0.688525	84.751700	0.95082	5.890428	0.653005	4.444769	0.653005	32.584	0.937158	0.776503
365	ZTS	193.28	N/A	29.919504	0.822404	37.898040	0.734973	17.662434	0.904372	9.822288	0.893443	25.448	0.855191	0.842077

Figure 2: Data frame of Tickers and their various metrics

    - Selected 50 companies with the lowest RV score

	Ticker	Price	Number of Shares to Buy	Forward Price-to-Earnings Ratio	Forward PE Percentile	Trailing Price-to-Earnings Ratio	Trailing PE Percentile	Price-to-Book Ratio	PB Percentile	Price-to-Sales Ratio	PS Percentile	EV/EBITDA	EV/EBITDA Percentile	RV Score
0	KSS	20.80	N/A	10.400000	0.101093	8.156862	0.035519	0.602811	0.002732	0.135117	0.002732	6.752	0.060109	0.040437
1	GM	49.18	N/A	4.967677	0.008197	5.525843	0.013661	0.788217	0.008197	0.310368	0.02459	9.114	0.153005	0.04153
2	CNC	62.02	N/A	8.438095	0.054645	11.679850	0.098361	1.192738	0.04918	0.226458	0.008197	4.801	0.013661	0.044809
3	NOV	15.45	N/A	8.879311	0.071038	5.808270	0.016393	0.953586	0.021858	0.683534	0.076503	6.339	0.054645	0.048087
4	BWA	35.20	N/A	7.586207	0.027322	10.570571	0.071038	1.315839	0.057377	0.559020	0.060109	5.770	0.032787	0.049727
5	PVH	101.03	N/A	7.961387	0.035519	8.082400	0.032787	1.087689	0.032787	0.635083	0.071038	7.100	0.079235	0.050273
6	APA	25.16	N/A	7.292754	0.02459	2.722944	0.002732	1.715766	0.117486	1.044770	0.144809	3.150	0.002732	0.05847
7	UNM	63.62	N/A	7.124300	0.021858	9.342144	0.043716	1.143648	0.038251	0.932728	0.128415	6.753	0.062842	0.059016
40	HIG	122.00	N/A	10.562771	0.10929	12.842105	0.128415	2.337210	0.270492	1.401981	0.240437	8.804	0.147541	0.179235
41	FOX	38.97	N/A	16.582980	0.382514	12.450480	0.112022	1.677933	0.103825	1.332927	0.20765	7.766	0.106557	0.182514
42	PRU	127.40	N/A	8.684390	0.065574	16.250000	0.215847	1.626598	0.090164	0.735618	0.095628	14.491	0.45082	0.183607
43	DG	80.60	N/A	12.813991	0.215847	12.534992	0.114754	2.441388	0.289617	0.446736	0.04918	11.475	0.265027	0.186885
44	MOS	26.26	N/A	10.674797	0.117486	35.013332	0.685792	0.718606	0.005464	0.686204	0.079235	6.517	0.057377	0.189071
45	IPG	32.03	N/A	11.160278	0.139344	11.862963	0.103825	3.136506	0.409836	1.279099	0.188525	8.553	0.13388	0.195082
46	DXC	21.05	N/A	6.790323	0.019126	48.953487	0.846995	1.335236	0.062842	0.282835	0.016393	5.448	0.030055	0.195082
47	TRV	265.45	N/A	12.817481	0.218579	13.640803	0.15847	2.175659	0.245902	1.334398	0.210383	9.234	0.163934	0.199454
48	GPN	102.31	N/A	7.949495	0.032787	18.772478	0.284153	1.162389	0.046448	2.629849	0.437158	10.110	0.196721	0.199454
49	PFG	90.46	N/A	10.743467	0.120219	17.197718	0.243169	1.907956	0.185792	1.338292	0.215847	10.755	0.234973	0.2

Figure 3: The 50 S&P500 Companies with the lowest RV Score

- User Interface
    - Using input function of python, users can input their portfolio size
    - Calculated position size by dividing portfolio size with number of companies
    - Calculated number of shares to buy of respective companies by dividing position size with stock price

Position Size for each company is: $20000.0

	Ticker	Price	Number of Shares to Buy	Forward Price-to-Earnings Ratio	Forward PE Percentile	Trailing Price-to-Earnings Ratio	Trailing PE Percentile	Price-to-Book Ratio	PB Percentile	Price-to-Sales Ratio	PS Percentile	EV/EBITDA	EV/EBITDA Percentile	RV Score
0	KSS	20.80	961	10.400000	0.101093	8.156862	0.035519	0.602811	0.002732	0.135117	0.002732	6.752	0.060109	0.040437
1	GM	49.18	406	4.967677	0.008197	5.525843	0.013661	0.788217	0.008197	0.310368	0.02459	9.114	0.153005	0.04153
2	CNC	62.02	322	8.438095	0.054645	11.679850	0.098361	1.192738	0.04918	0.226458	0.008197	4.801	0.013661	0.044809
3	NOV	15.45	1294	8.879311	0.071038	5.808270	0.016393	0.953586	0.021858	0.683534	0.076503	6.339	0.054645	0.048087
4	BWA	35.20	568	7.586207	0.027322	10.570571	0.071038	1.315839	0.057377	0.559020	0.060109	5.770	0.032787	0.049727
5	PVH	101.03	197	7.961387	0.035519	8.082400	0.032787	1.087689	0.032787	0.635083	0.071038	7.100	0.079235	0.050273
6	APA	25.16	794	7.292754	0.02459	2.722944	0.002732	1.715766	0.117486	1.044770	0.144809	3.150	0.002732	0.05847
41	FOX	38.97	513	16.582980	0.382514	12.450480	0.112022	1.677933	0.103825	1.332927	0.20765	7.766	0.106557	0.182514
42	PRU	127.40	156	8.684390	0.065574	16.250000	0.215847	1.626598	0.090164	0.735618	0.095628	14.491	0.45082	0.183607
43	DG	80.60	248	12.813991	0.215847	12.534992	0.114754	2.441388	0.289617	0.446736	0.04918	11.475	0.265027	0.186885
44	MOS	26.26	761	10.674797	0.117486	35.013332	0.685792	0.718606	0.005464	0.686204	0.079235	6.517	0.057377	0.189071
45	IPG	32.03	624	11.160278	0.139344	11.862963	0.103825	3.136506	0.409836	1.279099	0.188525	8.553	0.13388	0.195082
46	DXC	21.05	950	6.790323	0.019126	48.953487	0.846995	1.335236	0.062842	0.282835	0.016393	5.448	0.030055	0.195082
47	TRV	265.45	75	12.817481	0.218579	13.640803	0.15847	2.175659	0.245902	1.334398	0.210383	9.234	0.163934	0.199454
48	GPN	102.31	195	7.949495	0.032787	18.772478	0.284153	1.162389	0.046448	2.629849	0.437158	10.110	0.196721	0.199454
49	PFG	90.46	221	10.743467	0.120219	17.197718	0.243169	1.907956	0.185792	1.338292	0.215847	10.755	0.234973	0.2

Figure 4: Data Frame with updated data on number of shares to buy

- Saving output into an excel file
    - By using xlsxwriter library in python, an excel sheet with the recommended trades will be created and saved

Ticker	Price	Number of Shares to Buy	Forward Price-to-Earnings Ratio	Forward PE Percentile	Trailing Price-to-Earnings Ratio	Trailing PE Percentile	Price-to-Book Ratio	PB Percentile	Price-to-Sales Ratio	PS Percentile	EV/EBITDA	EV/EBITDA Percentile	RV Score
KSS	$19.80	101	9.90	9.32%	7.76	3.01%	0.57	0.27%	0.13	0.27%	6.67	6.30%	3.84%
GM	$49.01	40	4.95	0.82%	5.51	1.37%	0.79	0.82%	0.31	2.19%	9.10	15.62%	4.16%
PVH	$98.70	20	7.78	3.01%	7.90	3.56%	1.06	3.01%	0.62	6.85%	6.99	7.95%	4.88%
NOV	$15.70	127	9.02	6.85%	5.90	1.64%	0.97	2.19%	0.69	8.22%	6.42	5.48%	4.88%
BWA	$35.04	57	7.55	2.74%	10.52	6.85%	1.31	5.48%	0.56	6.03%	5.75	3.42%	4.90%
APA	$24.80	80	7.07	2.19%	2.68	0.27%	1.69	10.96%	1.03	14.52%	3.13	0.27%	5.64%
UNM	$63.70	31	7.13	2.47%	9.35	4.38%	1.15	4.11%	0.93	12.60%	6.76	6.58%	6.03%
CNC	$69.30	28	9.43	7.95%	13.05	14.25%	1.33	6.30%	0.25	1.10%	5.41	2.74%	6.47%
CVS	$65.02	30	8.88	6.58%	11.57	9.32%	1.09	3.56%	0.23	0.55%	9.29	16.44%	7.29%
UAL	$72.02	27	6.08	1.37%	8.58	4.11%	2.09	24.11%	0.42	4.38%	5.76	3.84%	7.56%
TAP	$56.10	35	9.62	8.77%	10.29	6.30%	0.97	2.47%	0.97	13.70%	6.90	7.40%	7.73%
VLO	$135.52	14	12.46	20.27%	7.68	2.74%	1.71	12.05%	0.32	3.01%	4.78	1.37%	7.89%
APTV	$70.36	28	9.15	7.12%	5.31	0.82%	1.64	9.86%	0.83	10.14%	8.19	12.05%	8.00%
BEN	$20.54	97	7.87	3.56%	12.76	12.33%	0.83	1.64%	1.30	20.00%	7.42	8.77%	9.26%
ADM	$58.29	34	10.92	12.60%	11.61	9.59%	1.26	5.21%	0.31	2.74%	9.85	18.63%	9.75%
WHR	$104.85	19	8.42	4.93%	10.83	7.40%	1.86	16.44%	0.31	2.47%	10.45	22.19%	10.68%
AIG	$77.14	25	11.26	15.34%	14.69	18.08%	1.13	3.84%	1.08	15.62%	5.08	1.92%	10.96%
HPE	$20.89	95	9.95	9.59%	14.82	18.90%	1.23	4.93%	0.93	12.88%	7.33	8.49%	10.96%
DAL	$56.31	35	8.13	4.11%	7.81	3.29%	2.65	34.52%	0.60	6.30%	6.85	7.12%	11.07%
T	$21.71	92	9.56	8.22%	12.48	11.51%	1.48	7.67%	1.27	19.18%	7.56	10.14%	11.34%
DVN	$40.69	49	7.78	3.29%	7.36	2.19%	2.04	22.74%	1.82	31.51%	4.16	0.55%	12.05%
LKQ	$39.40	50	10.08	10.14%	14.33	16.99%	1.70	11.51%	0.72	8.77%	9.19	15.89%	12.66%
MRO	$26.58	75	10.98	12.88%	10.38	6.58%	1.33	5.75%	2.26	38.36%	4.69	1.10%	12.93%
HAL	$29.30	68	8.52	5.48%	9.73	4.93%	2.59	33.97%	1.12	16.16%	6.30	5.21%	13.15%
PSX	$132.31	15	12.16	18.90%	11.35	8.77%	1.88	17.53%	0.36	3.56%	9.53	16.99%	13.15%
CMCSA	$42.25	47	9.58	8.49%	11.24	8.22%	1.97	20.27%	1.35	22.19%	6.84	6.85%	13.21%
HUM	$255.57	7	12.93	22.74%	17.99	26.85%	1.85	15.62%	0.27	1.64%	4.97	1.64%	13.70%
LYB	$91.92	21	10.00	9.86%	12.93	12.88%	2.22	25.21%	0.73	9.32%	8.61	13.42%	14.14%
NUE	$154.27	12	14.38	26.85%	11.11	7.67%	1.77	13.70%	1.12	16.44%	6.67	6.03%	14.14%
F	$11.03	181	5.96	1.10%	11.26	8.49%	1.01	2.74%	0.24	0.82%	17.39	57.53%	14.14%
ALK	$46.39	43	8.42	4.66%	26.36	49.32%	1.39	6.58%	0.56	5.75%	5.96	4.66%	14.19%
GL	$110.87	18	8.37	4.38%	10.02	5.75%	1.91	18.36%	1.76	29.86%	8.65	13.97%	14.47%
AIZ	$196.86	10	11.15	14.52%	13.14	14.52%	2.04	23.01%	0.88	12.05%	7.81	11.23%	15.07%
FOXA	$42.08	47	11.59	16.71%	13.36	15.34%	1.81	14.79%	1.32	20.27%	8.27	12.33%	15.89%
CHTR	$330.22	6	9.41	7.67%	10.54	7.12%	3.66	47.12%	0.86	11.23%	6.95	7.67%	16.16%
VZ	$43.91	45	9.36	7.40%	16.51	22.19%	1.92	18.63%	1.38	23.01%	7.53	9.59%	16.16%
MPC	$157.90	12	16.11	37.26%	8.28	3.84%	2.53	32.33%	0.36	3.29%	5.95	4.38%	16.22%
LEN	$188.41	10	11.65	16.99%	12.52	11.78%	1.86	16.71%	1.39	23.84%	8.71	14.25%	16.71%
CVX	$148.73	13	12.68	21.92%	14.73	18.36%	1.71	12.33%	1.38	23.29%	7.13	8.22%	16.82%
LNC	$33.62	59	4.45	0.55%	3.53	0.55%	0.82	1.10%	0.42	4.11%	21.85	78.08%	16.88%
HIG	$119.62	16	10.36	10.41%	12.59	12.05%	2.29	26.58%	1.37	22.74%	8.64	13.70%	17.10%
FOX	$38.75	51	16.49	37.53%	12.30	10.96%	1.67	10.41%	1.32	20.55%	7.73	10.96%	18.08%
PRU	$127.03	15	8.66	6.03%	16.22	21.64%	1.62	9.04%	0.73	9.59%	14.46	44.66%	18.19%
MOS	$26.06	76	10.77	11.51%	33.84	65.75%	0.71	0.55%	0.68	7.40%	6.48	5.75%	18.19%
DXC	$21.00	95	6.77	1.92%	48.84	84.66%	1.33	6.03%	0.28	1.92%	5.44	3.01%	19.51%
IPG	$31.93	62	11.13	14.25%	11.83	10.41%	3.13	41.37%	1.28	19.45%	8.53	13.15%	19.73%
PHM	$146.80	13	10.75	11.23%	11.21	7.95%	2.72	35.89%	1.81	31.23%	8.42	12.88%	19.84%
WU	$11.84	168	6.51	1.64%	7.22	1.92%	9.07	79.45%	0.94	13.15%	5.75	3.42%	19.92%
DG	$82.23	24	13.07	23.01%	12.79	12.60%	2.49	31.23%	0.46	4.66%	11.59	28.22%	19.95%
GPN	$101.74	19	7.91	3.84%	18.67	28.77%	1.16	4.66%	2.62	43.56%	10.08	19.45%	20.05%

Figure 5: Excel Sheet of recommended trades

- Backtesting Strategy
    - I tried to backtest my strategy using Backtrader Lib, but realised that yfinance download call only retrieves historical data on Open, High, Low,

Close, Adj Close and Vol. As such, I could not retrieve data on metrics like P/E, P/B, P/S and EV/EBITDA

3. Learning Summary

- **How I can improve this project:**
    - **Use a static dataset**: Manually download historical financial metrics for the 2-year period you're interested in, and use this data for the backtest. This data could come from services like Alpha Vantage, Quandl, or other financial data sources that provide historical fundamentals.
    - **Simulate a rolling rebalance based on prices alone**: If you cannot find historical fundamentals, you could adjust your strategy to rely purely on historical prices (and derive ratios or signals from them).