Executive Summary

For this report, the group chose Triple D, the companies JPM, BAC, and WFC. The price series was loaded into Python and analyzed to measure price performance. Company 10K documents and Yahoo Finance data were analyzed to determine key drivers of performance. With fundamental analysis as a background, the group performed statistical treatments to identify cointegration and correlation, serving as indicators for the pair trade selection. The buy and sell signals were set up by calculating the spread and plotting its mean, enclosed by upper and lower bounds that are standard deviations away from the mean. With signals ready, the arbitrage trades from the price series 2020-2021 were generated by the program. A cumulative PnL chart is generated from the inputted capital amount.

Performance

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[0.29594607172474163, 0.6388395133131276, 0.5139179685761484]
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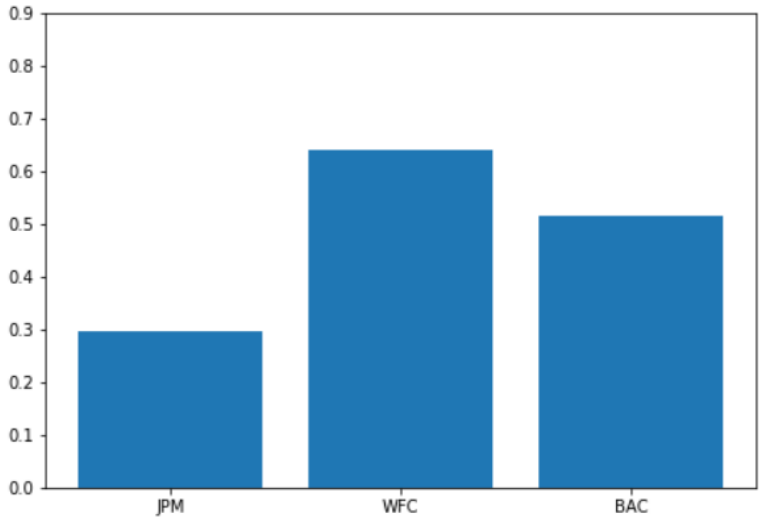


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WFC performed the highest with 63.88% gain, followed by BAC with 51.39% and JPM at 29.59%
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WFC outperformed JPM and BAC by a 63.88% gain over the year of 2021. Main drivers for growth were its Trust Fees by Commissions (+283.39%) and Trading Gains (+251.43%), contributing to big gains on its Net Income (+548.02%). It is worth noting that among the three, WPC has the smallest market cap at 189.571 billion, versus JPM's 388.383 billion and BAC's 331.595 billion, which may influence greater percentage gains from a low base effect. BAC grew a considerable amount at 51.39% gain, propping its Net Income (+78.71%) up with Non-Interest Income (+9.51%) which makes 51.82% of its Net Income. JPM came in last at 29.59%, whose losses in Net Interest Income (-4.13%) were propped up by Non-Interest Income (+6.87%), ending the year with a strong Net Income (+65.92%).

Arbitrage Opportunities

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Visual test between 3 stocks show positive correlation for all 3 possible pairs.
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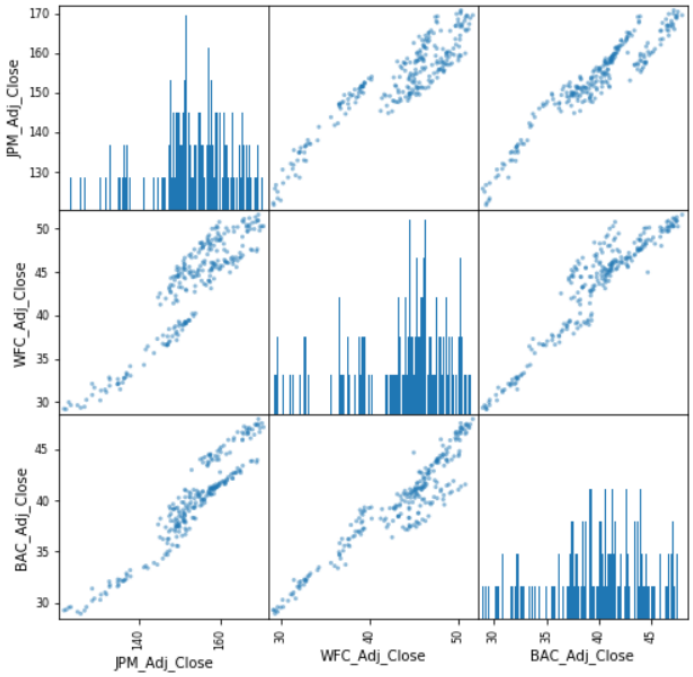

The price series for JPM, BAC, and WFC were plotted in a scatter plot matrix, revealing the positive correlation for all three stocks. A Pearson R calculation revealed that JPM and BAC had the strongest correlation at 0.9502.

Next, a cointegration test was conducted using the coint() function, which uses the augmented Engle-Granger two-step cointegration test to test for no-cointegration. Out of the three stocks, the JPM-BAC pair had a p-value of 0.0930, suggesting that the pair is likely cointegrated. This suggests that the JPM-BAC spread is mean-reverting, which may be examined for arbitrage opportunities.

After, a test for stationarity was conducted using the adfuller() function, which uses the augmented Dickey-Fuller to test the unit root of the series, an indication that the series is non-stationary. With a p-value of 0.0323, JPM fails the non-stationarity test, suggesting that its price series is likely stationary and predictable throughout.

The JPM-BAC pair was picked for arbitrage trading for its strong correlation, cointegration, and the stationarity of JPM.

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When z_s = -1, buy the spread. Unwind at z_s = 0
When z_s = +1, short-sell the spread. Unwind at z_s = 0
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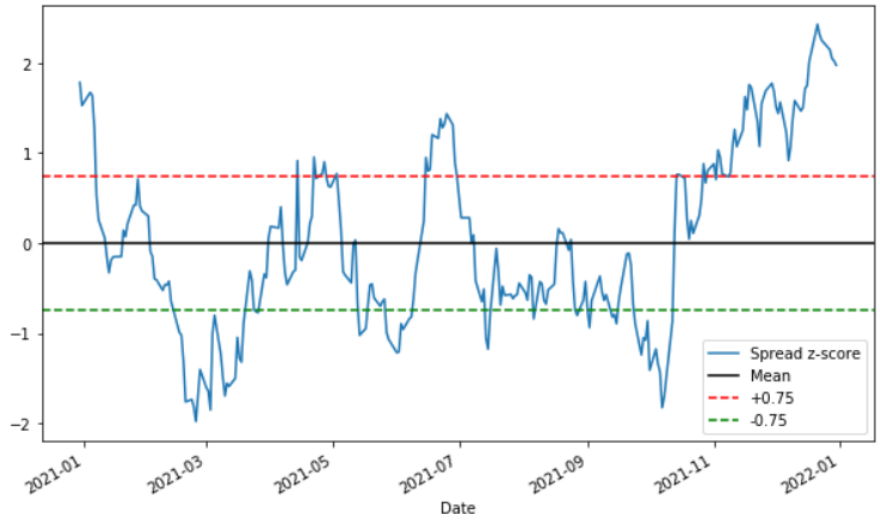

The JPM-BAC spread is generated from statsmodels.regression.linear_model.OLS(), which uses the Ordinary Least Squares method to estimate the spread between the two price series. The zscore() function was used to generate the z-score of the spread, which is plotted in the figure above. The mean and its standard deviations are used as critical points for trading signals.

The pair-trade system signals rely on the upper and lower bounds for entry and the mean for unwinding.

When the spread intercepts the upper bound from the top, a “Sell” order is ensued, where the program is ordered to Short JPM and Long BAC.
When the spread intercepts the lower bound from the bottom, a “Buy” order is ensued, where the program is ordered to Long JPM and Short BAC.
When the program has a pair-trade position in its code, it will keep from placing any orders until it unwinds its position at the mean.

Arbitrage Trades

```
Input your capital here: 100000
```

Out[11]:

Date	Step	JPM	BAC	% Gain	$ Gain	PnL	Port
2021-02-12	0	Buy Long 50000.0	Sell Short 50000.0		0	0	100000
2021-03-30	1	Close Long 50000.0	Close Short 50000.0	6.08	6080	6080	106080
2021-04-13	2	Sell Short 53040.0	Buy Long 53040.0		0	6080	106080
2021-04-14	3	Close Short 53040.0	Close Long 53040.0	6.08	6449	18609	118609
2021-04-21	4	Sell Short 59304.5	Buy Long 59304.5		0	18609	118609
2021-05-05	5	Close Short 59304.5	Close Long 59304.5	6.08	7211	38349	138349
2021-05-13	6	Buy Long 69174.5	Sell Short 69174.5		0	38349	138349
2021-06-11	7	Close Long 69174.5	Close Short 69174.5	6.08	8411	66500	166500
2021-06-14	8	Sell Short 83250.0	Buy Long 83250.0		0	66500	166500
2021-07-08	9	Close Short 83250.0	Close Long 83250.0	6.08	10123	104774	204774
2021-07-13	10	Buy Long 102387.0	Sell Short 102387.0		0	104774	204774
2021-08-17	11	Close Long 102387.0	Close Short 102387.0	6.08	12450	155498	255498
2021-08-26	12	Buy Long 127749.0	Sell Short 127749.0		0	155498	255498
2021-10-12	13	Close Long 127749.0	Close Short 127749.0	6.08	15534	221756	321756
2021-10-13	14	Sell Short 160878.0	Buy Long 160878.0		0	221756	321756

The following arbitrage table for the year 2021 was generated with the specified trading rules. The program asks for the capital input, which is split 50/50 to a long and short position for each pair-trade. In the example above, the inputted capital was 100,000, which denoted the trades to 50,000 long and 50,000 short. The following trades will then take the growing portfolio value as its new capital for reinvestment.

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Total $ Profit: 221756
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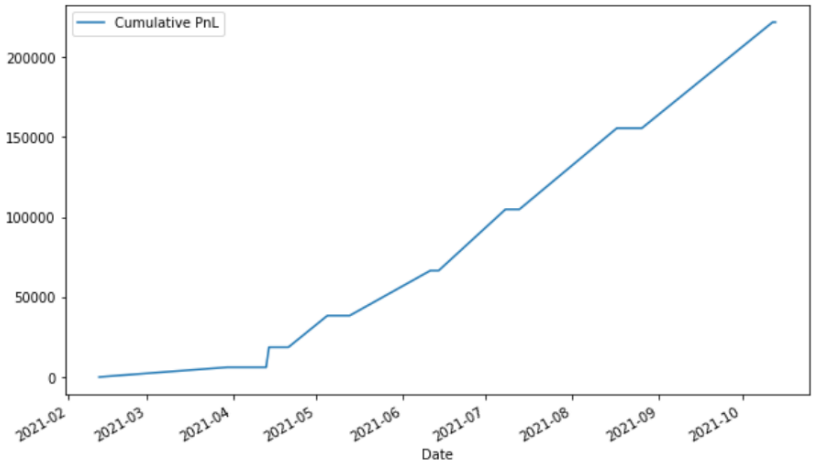

From the arbitrage trades, the cumulative PnL is calculated and plotted above. In our simulation, the trader will achieve a profit of 221,756 over the year from a capital of 100,000.

Risks

The simulation above rarely ever happens in real-life market conditions. The following profit return was generated with perfect information at hand, the ability to predict the stock prices within the year. As such, the system had 100% accuracy rate, with the spread reverting back to its mean. In reality, there are various macro and industry trends that may disrupt the cointegration of the pair-trade, thus nullifying the assumptions of the system. In such cases, the trader must take care to exit the position and find another pair suitable for pair-trade arbitrages.