PAIR TRADING STRATEGY

Author's Name: Tin Hang

Course Name: Trading Strategies in Emerging Markets Specialization

Course Name: Design your own Trading Strategy – Culminating Project

Course Number: Course 5

Instructor's Name: Ramabhadran Thirumalai

Indian School of Business

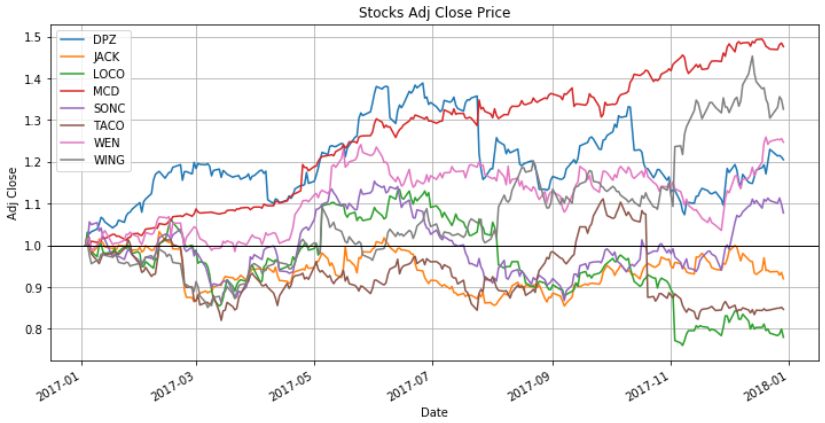
Trading strategy is a profitable strategy design that is long or short in the stock markets. For instance, pair trading is the most popular strategy. Pair trading is a market-neutral trading strategy and two stocks that has relationship; as a result, they both moved together that is correlated. In addition, the strategy determines the direction of the relationship of both stocks. However, buying 2 stocks, they both need to be in the same industry or relate to it. You go long on the loser and the other stock you short the winner, if history repeats itself. Then the pair trading strategy will be profitable.

In the paper, “Pairs Trading: Performance of a Relative Value Arbitrage Rule”, it says find two stocks that moved together historically. Therefore, short the winner and buy the losers, if history repeats itself. Then the pair trading will be profitable. Pairs trading is also called “statistical arbitrage”.

The main industry I choose is restaurants as main industry such as fast food. The alternate related industry would be food because food and beverage have relationship; as a result, people usually buy food and drinks together.

For “Data Collection,” I got the data in yahoo and 1-year historical price. I collected the data from January 1, 2017 to January 1, 2018. Therefore, I wrote the codes in Python for stock analysis. I have chosen ‘Services Industry – Restaurants.’

Main Industry: ['JACK', 'MCD', 'WING', 'WEN', 'LOCO', 'SONC', 'TACO', 'DPZ']



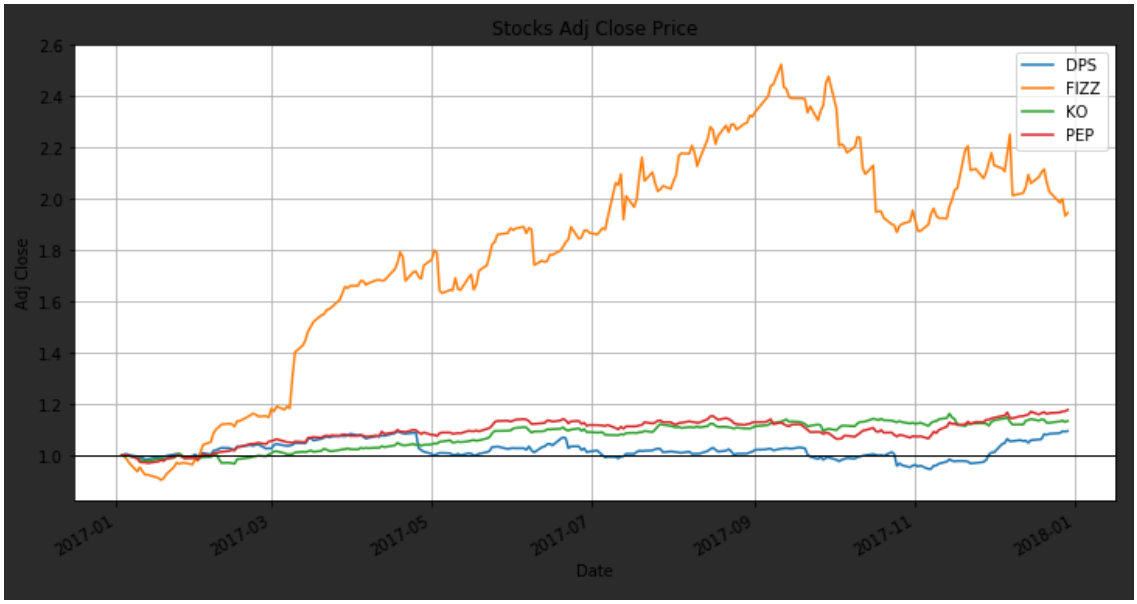
Out of eight stocks, DPZ seem to have potential and growing. While LOCO is decreasing in, and LOCO would be good to short. This table on the bottom shows the correlations.

	DPZ	JACK	LOCO	MCD	SONC	TACO	WEN	WING
DPZ	1.000000	-0.177830	0.529861	0.323936	0.359472	0.166470	0.662502	-0.035356
JACK	-0.177830	1.000000	0.113475	-0.222812	0.561154	0.119632	-0.119355	0.014036
LOCO	0.529861	0.113475	1.000000	-0.409517	0.376515	0.361454	0.147109	-0.623277
MCD	0.323936	-0.222812	-0.409517	1.000000	0.123659	-0.164916	0.737902	0.852372
SONC	0.359472	0.561154	0.376515	0.123659	1.000000	-0.054906	0.476119	0.139746
TACO	0.166470	0.119632	0.361454	-0.164916	-0.054906	1.000000	0.055567	-0.210342
WEN	0.662502	-0.119355	0.147109	0.737902	0.476119	0.055567	1.000000	0.490340
WING	-0.035356	0.014036	-0.623277	0.852372	0.139746	-0.210342	0.490340	1.000000

This is a heatmap of correlations.

For related industry I choose ‘Beverages industry,’ because restaurants need to buy soft drinks and they have relationship. Related Industry:

stocks = ['DPS', 'KO', 'PEP', ‘FIZZ’]



The top chart shows FIZZ is doing well compare to other beverage stocks.

	DPS	FIZZ	KO	PEP
DPS	1.000000	-0.081569	-0.199423	0.246290
FIZZ	-0.081569	1.000000	0.890800	0.824940
KO	-0.199423	0.890800	1.000000	0.820491
PEP	0.246290	0.824940	0.820491	1.000000

For trading rules, I calculated Z-score of spread. The first is "Entry:" When the absolute value of Z-Score more than 1, enter a position by buying stock with lower price and selling the higher one. Next is the "Exit:" When the absolute value of Z-Score less than -1, exit the position by selling the stock with lower price and buying the higher one.

First pair, I picked "FIZZ & TACO" because they have the lowest correlations. The lower correlation, they tend to have better performance. Second pair, I picked "SONC & WEN" because they have the highest correlations. Therefore, they both tend move together. For this part, I calculated the

beta, alpha, r-squared, p-value, and standard error to see if each stock correlates with the overall market (SPY).

For each with the market:

```
FIZZ and SPY
Beta: 0.032692
Alpha: 0.000668
R-Squared: 0.181872
p-value: 0.003910
Standard Error: 0.011224

TACO and SPY
Beta: 0.039957
Alpha: 0.000783
R-Squared: 0.181933
p-value: 0.003898
Standard Error: 0.013713

SONC and SPY
Beta: 0.071605
Alpha: 0.000734
R-Squared: 0.271895
p-value: 0.000013
Standard Error: 0.016093

WEN and SPY
Beta: 0.123758
Alpha: 0.000643
R-Squared: 0.411162
p-value: 0.000000
```

```
Standard Error: 0.017423
```

For this part, I used the two pair with the highest and lowest correlations. I calculated the beta, alpha, r-squared, p-value, and standard error.

```
# First Pair
FIZZ and TACO
Beta: 0.005201
Alpha: -0.000487
R-Squared: 0.006355
p-value: 0.920365
Standard Error: 0.051971

# Second Pair
SONC and WEN
Beta: 0.405163
Alpha: 0.000809
R-Squared: 0.463075
p-value: 0.000000
Standard Error: 0.049243
```

The risk & return measurement, I calculated the Sharpe ratio for individual stocks that I used for the pair. Each of them came out negative because excess return was negative.

Sharpe Ratio:

FIZZ -0.639064

TACO -0.958080

SONC -1.092976

WEN -1.209724

The beta for each of the stock is very low and is lower than 1 with low risk and low returns. On the other hands, the stocks move less than the market.

```
Beta:
FIZZ 0.00429292208976
TACO 0.00351474002374
SONC 0.00438048968516
WEN 0.00579579645188
```

FIZZ have the highest alpha and it has outperformed its benchmark index by 1 percent and it produce positive returns. However, TACO have negative alpha and it means it underperformance of 1 percent and it failed to generate returns.

```
Alpha:
FIZZ 0.00294242315751
TACO -0.000474669048799
SONC 0.000423021347473
WEN 0.000977256390184
```

FIZZ has the highest unsystematic risk; however, WEN have the lowest unsystematic risk.

```
Unsystematic Risk:
FIZZ 21.178130
TACO 0.903511
SONC 1.682423
WEN 0.886908
```

Each of the stock have the same ‘Treynor ratio’ as negative. As a result, the stocks had performed worse than a risk-free instrument.

```
Treynor Ratio:
```

```
FIZZ -1.65179587378
TACO -1.65179587378
SONC -1.65179587378
WEN -1.65179587378
```

All of the stock has negative Modigliani ratio; therefore, they all have negative returns. In addition, it explains why Sharpe ratio is negative.

```
Modigliani Ratio:
FIZZ -0.0214488043924
TACO -0.00843439573472
SONC -0.00947503066558
WEN -0.0138059078363
```

FIZZ have the highest Information ratio, and it was able to produce excess returns. However, TACO has the lowest Information ratio because it was not able to have any excess returns.

```
Information Ratio:
FIZZ 0.0943539543431172
TACO -0.06530184581164493
SONC -0.02189382146988838
WEN 0.016850157738546315
```

FIZZ have the highest omega ratio and TACO have the lowest. As a result, FIZZ will have better return than the rest of the stocks.

```
Omega Ratio:
FIZZ 1.446551739669144
TACO 0.9273885187410763
SONC 1.0738465468702205
WEN 1.1952659485877963
```

FIZZ have the highest Sortino ratio, and TACO has the negative ratio. FIZZ has better returns; on the other hand, TACO has many negative returns.

```
Sortino Ratio:
FIZZ 2.93755846397
TACO -0.36647073254
SONC 0.444302443031
WEN 1.25611257733
```

All of the stocks have negative Calmar ratio and it means the returns has a drawdown risk. The stocks' drawdowns between the peak and trough and is consider a loss or decline.

```
Calmar Ratio:
FIZZ -0.00348049218034
TACO -0.00117483523457
SONC -0.00401896039492
WEN -0.00278806444436
```

FIZZ has higher Sterling ratio, and it means the stock is receiving higher return relative to risk. The rest of the stock is negative Sterling ratio because is producing negative or low returns.

```
Sterling Ratio:
FIZZ 0.0209499110485
TACO -0.00568401908389
SONC -0.00729925148088
WEN -0.00985960424356
```

WEN has the highest appraisal ratio and TACO has lowest. Since WEN has the highest, it means produces positive alpha with low risk. Then, TACO have negative because the stock produces alpha to the benchmark and have high level of risk in relation to the returns.

```
Appraisal Ratio:
FIZZ 0.000139
TACO -0.000527
SONC 0.000251
WEN 0.001102
```

Each of the stock have negative Burke ratio. While WEN have the lowest, have the maximum drawdowns.

```
Burke Ratio:
FIZZ -0.00797046986352
TACO -0.0058070850214
SONC -0.00723603659796
WEN -0.00957730435271
```

All of the stock has positive Martin ratio while WEN have the highest and TACO have the lowest. This indicate that WEN have the highest drawdown over that period and TACO has the lowest drawdown over that period in 14 days.

```
Martin Ratio:
FIZZ 0.000221
TACO 0.000187
SONC 0.000230
WEN 0.000337
```

Every stock has negative pain ratio. Therefore, WEN have the most losses in the investment with the lowest pain ratio in that time period of 14 days.

```
Pain Ratio:
FIZZ -0.000268
```

```
TACO -0.000220

SONC -0.000268

WEN -0.000396
```

Overall, FIZZ is the better choice to buy for long because it has better ratios than the other stocks.

However, WEN should be short since it had the worse ratio comparing to other stocks.

Definition for each term:

Alpha: A positive alpha of 1.0 means the fund or stock has outperformed its benchmark index by 1 percent. A similar negative alpha of 1.0 would indicate an underperformance of 1 percent. A beta of less than 1 means that the security will be less volatile than the market. (https://www.cnbc.com/id/45777498)

Beta: Beta is a measure of a stock's volatility in relation to the market. By definition, the market has a beta of 1.0, and individual stocks are ranked according to how much they deviate from the market. ... If a stock moves less than the market, the stock's beta is less than 1.0. (https://www.investopedia.com/investing/beta-know-risk/)

R-Squared: R-squared is a statistical measure that represents the proportion of the variance for a dependent variable that's explained by an independent variable. In investing, R-squared is generally considered the percentage of a fund or security's movements that can be explained by movements in a benchmark index. (https://www.investopedia.com/terms/r/r-squared.asp)

p-value: One commonly used p-value is 0.05. If the investor concludes that the p-value is less than 0.05, there is strong evidence against the null hypothesis. (*https://www.investopedia.com/terms/p/p-value.asp*)

Standard Error (Volatility): The greater the standard deviation of a security, the greater the variance between each price and the mean, which shows a larger price range. For example, a volatile stock has a high standard deviation, while the deviation of a stable blue-chip stock is usually rather low. (https://www.investopedia.com/terms/s/standarddeviation.asp)

Sharpe Ratio: The *Sharpe ratio* is the average return earned in excess of the risk-free rate per unit of volatility or total risk. Subtracting the risk-free rate from the mean return, the performance associated with risk-taking activities can be isolated. The **Sharpe ratio** is a well-known and well-reputed measure of risk-adjusted return on investment, developed by William **Sharpe**. The **Sharpe ratio** can be used to evaluate the total performance of an investment portfolio or the performance of an individual **stock**. (https://www.investopedia.com/terms/s/sharperatio.asp)

Unsystematic risk: **Unsystematic risk**, also known as "specific **risk**," "diversifiable **risk**" or "residual **risk**," is the type of uncertainty that comes with the company or industry you invest in. **Unsystematic risk** can

be reduced through diversification. (https://www.investopedia.com/walkthrough/corporate-finance/...risk/systematic-risk.aspx)

Treynor ratio: The **Treynor ratio** does just that. It calculates an investment's performance per unit of risk. The **Treynor ratio** uses a portfolio's "beta" as its risk. Beta measures the volatility of an investment relative to the **stock** market, generally the S&P 500 index, which is given a beta of one. (https://www.fool.com/investing/general/2015/06/09/use-the-treynor-ratio-to-measure-your-portfolio-pe.aspx)

Modigliani ratio: **Modigliani risk-adjusted performance** (also known as M^2, M2, **Modigliani–Modigliani** measure or RAP) is a measure of the risk-adjusted returns of some investment portfolio. It measures the returns of the portfolio, adjusted for the risk of the portfolio relative to that of some benchmark (e.g., the market). (https://en.wikipedia.org/wiki/Modigliani_risk-adjusted_performance)

Information ratio: The *information ratio* (IR) is a measure of portfolio returns above the returns of a benchmark, usually an index, to the volatility of those returns. (https://www.investopedia.com/terms/i/informationratio.asp)

Omega ratio: The **Omega ratio** is a risk-return performance measure of an investment asset, portfolio, or strategy. It was devised by Keating & Shadwick in 2002 and is defined as the probability weighted **ratio** of gains versus losses for some threshold return target. (https://en.wikipedia.org/wiki/Omega_ratio)

Sortino ratio: The **Sortino ratio** is the excess return over the risk-free rate divided by the downside semi-variance, and so it measures the return to "bad" volatility. (Volatility caused by negative returns is considered bad or undesirable by an investor, while volatility caused by positive returns is good or acceptable.) (www.morningstar.com/InvGlossary/sortino_ratio_definition_what_is.aspx)

Calmar ratio: The **Calmar ratio** is a formula used to measure a hedge fund's performance relative to its risk. It's calculated by taking a hedge fund's average annual rate of return, typically over a three-year period, and dividing it by the fund's maximum drawdown. (https://www.fool.com/knowledge-center/what-is-a-calmar-ratio.aspx)

Sterling ratio: Sterling ratio is a risk-adjusted return measure that uses compounded annual return over average maximum drawdown. (https://www.investopedia.com/terms/s/sterlingratio.asp)

Appraisal ratio: The appraisal ratio is a ratio used to measure the quality of a fund manager's investment-picking ability. It compares the fund's alpha to the portfolio's unsystematic risk or residual standard deviation. The fund's alpha is the amount of excess return the manager has earned over the benchmark of the fund. It is the portion of the return that the portfolio manager's active management is responsible for. The ratio shows how many units of active return the manager is producing per unit of risk. (https://www.investopedia.com/terms/a/appraisalratio.asp)

Burke ratio: Similar to the Sterling *ratio*, the *Burke ratio* discounts the expected excess return of the security by the square root of the average of the worst expected maximum drawdowns squared for that portfolio. (*https://wootrader.com/screeners/stock-burke-ratio/*)

Martin ratio: Martin introduced the Ulcer Performance Index (UPI), or Martin Ratio. This is simply total return less the risk-free return divided by the Ulcer Index. The goal is to find securities (funds) with the

highest UPI, which means the highest risk-adjusted return.
(https://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:ulcer_index#risk-adjusted_return)

Pain ratio: A proprietary return-versus-risk trade-off metric, the pain ratio compares the added value over the risk-free rate against the depth, duration, and frequency of losses.
(http://www.styleadvisor.com/resources/statfacts/pain-ratio)