ANALYSIS ON STOCK MARKET BEHAVIOUR USING HARMONIC PATTERNS: THE CASE BULLISH STOCK PATTERN OF *SHARIAH-* COMPLIANT CAPITAL MARKET

Azrul Azim Mohd Yunus[i] Nur Laili Azman [ii] Safwan Ibrahim [iii] & Arif Asraf Mohd Yunus [iv]

[i] (*Corresponding author*). Faculty of Science and Technology, Universiti Sains Islam Malaysia. azrulazim@usim.edu.my

[ii] Faculty of Science and Technology, Universiti Sains Islam Malaysia. nur.laili@raudah.usim.edu.my

[iii] Faculty of Science and Technology, Universiti Sains Islam Malaysia. msafwan@usim.edu.my

[iv] Faculty of Science and Technology, Universiti Sains Islam Malaysia. arifasraf@usim.edu.my

Abstract

In this era of globalization, the investment sector in Malaysia such as investing in stocks is growing rapidly day by day. This involves not only businessmen, but also household investors in the stock market, and it has become very widespread in Malaysia. This is due to the transparency of publicly listed firms' reporting requirements, as well as the most comprehensive and sophisticated technology and software for online trading. The methodology that was used for this study focuses on the second data which is the historical stock price of 3 shariah-compliance companies. Harmonic pattern screening is being used for stock trend indicators. At the same time, Python coding is applied to form the harmonic pattern and compare the pattern with the extremes in real-time. The results demonstrate the behaviour of stock performance on the shariah-compliant capital market in Malaysia by using harmonic pattern analysis. Despite from that, this research uses a Python program to implement a bullish pattern that has five points and reads each of them as the value of an extrema, starting with point X and moving on to points A, B, C, and D. In addition, this analysis found that the most frequent pattern that has a higher possibility of occurring beyond of stock performance is the bullish bat pattern.

Keywords: *Harmonic Pattern, Python, Shariah-Compliance, Stocks, Stock Price.*

INTRODUCTION

The investment sector in Malaysia such as investing in stocks is growing rapidly day by day. This involves not only businessmen, but also household investors in the stock market, and it has become very widespread in Malaysia. This is due to the transparency of publicly listed firms' reporting requirements, as well as the most comprehensive and sophisticated technology and software for online trading. In addition, the benchmark Malaysian stock index has been able to almost completely recover its losses from a sell-off in March because to improvements in retail investor participation, according to data from the FTSE Bursa Malaysia KLCI Index (Lee, 2020). The performance of the Malaysia Stock Index will increase as more retail investors participate in the stock market, according to that article. Gerald Ambrose, chief executive of Aberdeen Standard Islamic Investments in Malaysia, previously stated that the presence of retail investors is actually a good thing. Market forecasting provides excellent profit opportunities. Most researchers either apply technical analysis or fundamental analysis to forecast the market. Fundamental analysis relies on the analysis of unstructured textual data, such as financial news and earnings reports, whereas technical analysis concentrates on analysing price direction to forecast future prices. Important market data is increasingly becoming more widely accessible online. This paints a picture of the importance of text mining techniques for extracting important data to study market behaviours (Alzazah & Cheng, 2020).

Harmonic pricing patterns are which take numerical price patterns to the succeeding level by defining specific turning points using Fibonacci numbers (Dudella, 2010). Harmonic trading, unlike other more frequent trading approaches, aims to forecast future movements. Finding the market's pulse or rhythm, then taking advantage of its trading opportunities, is the process of harmonics. These harmonic sequences give us visual experiences that have a propensity to recur repeatedly. The Fibonacci sequence of numbers is formed by adding the preceding two numbers which are 0, 1, 1, 2, 3, 5, 8, 13, and so on. This pattern could then be divided into ratios, which, according to some, offer hints about the direction a particular financial market will take. The ratio of any number to the next higher number is 0.618, while the ratio of the next lower number is 1.618. In the mathematics world, these values are also known as ϕ (0.618) and Φ (1.618). The ratio of (1.618) is also referred to as the "The Golden Ratio." Stock markets experience selling pressure and extensions so frequently that Fibonacci retracements to ratios like 38.2 percent, 50 percent, or 61.8 percent have become common trading terms. These can be used to enhance entry and exit performance for trading. By applying this concept, a tool for analysing stock performance was developed, namely "harmonic pattern".

HARMONIC PATTERNS

Harmonic stock patterns seem to be ones that are made up of architectural elements toward the next threshold of stock price patterns by defining precise turning points with Fibonacci numbers (Mitchell, 2021). Harmonic trading, which is unlike more different trading approaches, tries to forecast future movements. A precise trading strategy based on the idea that patterns repeat themselves, harmonic trading combines arithmetic and patterns. The main ratio, or a derivation of it, is central to the process (0.618 or 1.618). The ratios 0.382, 0.50, 1.41, 2.0, 2.24, 2.618, 3.14, and 3.618 are complimentary (Mitchell, 2022). The primary ratio is present in almost all man-made structures, as well as in the environments and natural functions and occurrences. The ratio may be observed on the stock prices, that are sometimes stimulated by the surroundings and cultures in which they operate and trade, because the pattern is repeated including both civilization and natural. As a result, among technical traders, the bat, crab, and Gartley harmonic patterns are some of the most well-liked.

The behaviour of financial market time series, particularly the stock market, has posed a difficult study environment in the past few years. Price fluctuations in the stock market have been identified as a complicated system and characterized as a temporally chaotic time series (Souza et al., 2021). To address the cognitive gaps in this crucial field of knowledge, first they define the morphological properties of the most prevalent harmonic patterns, followed by a discrete parameterization that allows any harmonic pattern to be assigned an integer. Then, using a basic method based on a parameter for recognizing peaks and values of price waves, they look for harmonic patterns in various currency zones, taking into account the frequency with which they occur. Their research shows that only one of the popular patterns has a likelihood of occurrence beyond the trivial, while also identifying the most common patterns in the classification they established.

It was stated in the study "Harmonic Pattern Trading" (Duddella, 2010) that financial markets exhibit natural stagnation and flow patterns that relate to the market's expansion and recession stages. These natural cycles correspond to harmonic price behaviour in the financial markets. This harmonic phenomenon occurs practically everywhere in life and is typically caused by particular harmonic patterns. Recognition of the key to price swings is facilitated by ratios of Fibonacci to discover important reversal points and levels in harmonic pattern detection. Each price swing contains of extreme and short prices with some many levels in between, followed by an alteration rotation consisting of the same high and low prices but in the reverse way (Duddella, 2010). If the preceding movement was an upswing, the downswing that follows is known as a reverse swing or retracement. A high movement occurs when the previous high threshold is preceded and followed by a lower-high bar, which leads to a low price (Duddella, 2010). In shorts, figure 1 shows examples on types of harmonic patterns that can be obtained.

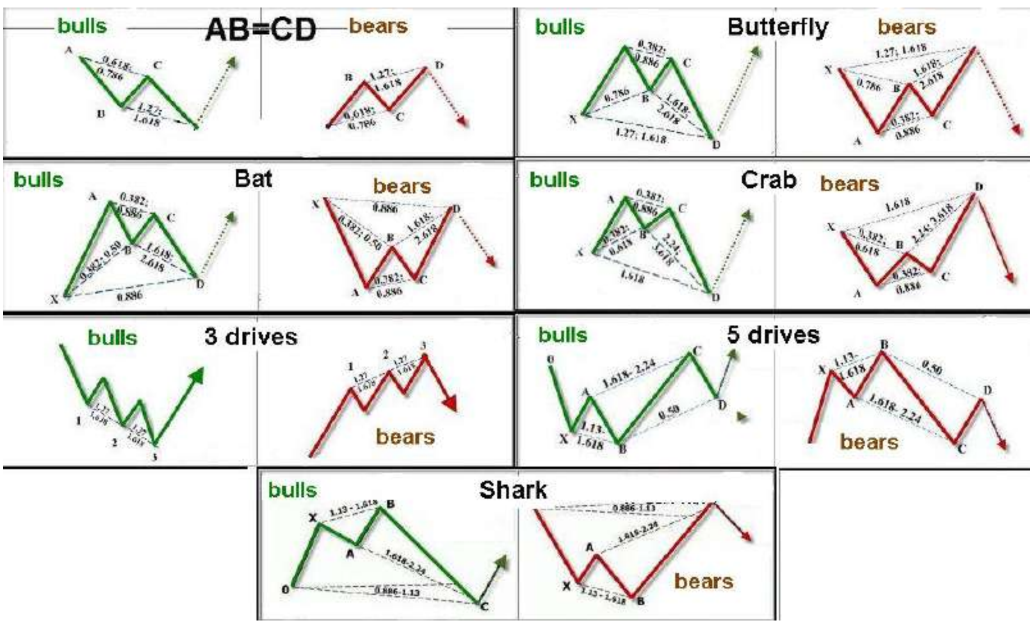

Figure 1: Types of Harmonic Patterns (retrieved from Forex Factory)

FIBONACCI NUMBER AND GOLDEN RATIO

The ratios will be discussed and summarized from the standpoint of stock markets. Keep the 1.618 in mind considering that it is currently the one of the two parameters that this analysis will employ when trading. There are numerous variations of the numbers 1.618 and 0.618. The ratios and their calculations are listed in Table 1.

Table 1: Golden Ratio Calculation

Ratio	Calculation
0.382	$(0.618)^2$
0.500	Half of an observation
0.618	Reciprocal of Fibonacci Golden Ratio
0.786	$\sqrt{0.618}$
0.886	$\sqrt{(\sqrt{0.618})}$
1.130	$\frac{1}{0.886}$
1.618	Fibonacci Golden Ratio
2.240	$1.618 + 0.618$

This study can identify the harmonic pattern from an attempt to find a confluence of perfect ratios based on these ratios. According to this study, many patterns contain ratio intervals, which makes them hazy and overlapping. The only complex pattern that employs only the perfect ratio, with the first leg retracing 61.8 %, the second leg retracing 161.8 %, the third leg retracing 161.8 %, and the final retracement being 224.0 %, which is the sum of the golden ratio (161.8 %) and its reciprocal (61.8 %). To have a solid confidence on the trade, this study like to employ this ratio in conjunction with technical indicators or long-term moving averages.

DATA ANALYSIS USING PYTHON

Stock markets have been working on the digital paradigm since the dawn of Information Technology, according to Vignesh CK (2016) in his study "Applying Machine Learning Models in Stocks Market Prediction." The core of this programme is Artificial Neural Networks, which serve as mathematical function approximators. The feed forward network is a widely used ANN for this purpose. There are also back propagation networks to consider. To modify the weights in the model, they use the backward propagation of errors approach (Vignesh, 2020). His research illustrated how machine learning may be used to solve stock prediction challenges. Past stock data was used to train the model so that it could detect trends and patterns and, as a result, forecast data in the future. As a result, the study concluded that by including all of the parameters that affect stock performance into a neural network with proper data processing and filtering, a model that can more accurately predict stock market values can be constructed (Vignesh, 2020).

McKinney (2010) wrote the following study, "Data Structures for Statistical Computing in Python," which dealt with the practical challenges of working with data sets that are frequent in finance, statistics, and other related subjects. Pandas is a new library that promises to make working with huge data sets easier while also providing a foundation for creating statistical models. Wes McKinney (2010) continues by speculating on the future of statistical computing and data analysis using Python (McKinney, 2010).

According to (Reddy, 2018), it stated that One of the most important activities in the financial sector is stock trading. A form of investment transaction is the performance of trying to predict the future financial performance of the company or other equity securities buy and sell on a financial markets. Their paper explains how Artificial Intelligence (AI) can be used to predict stock prices. When making stock predictions, most stockbrokers use fundamental and technical indicators in conjunction with analyses of time series (Reddy, 2018). Python is the software development language used to apply machine learning to predict the stock market. Throughout their study, they provide a software method that will be employed in order demonstrate how intelligence can be built from publicly available market data and then used to produce precise predictions (Reddy, 2018). Throughout this perspective, their work uses the Support Vector Machine (SVM) machine learning technique to forecast stock values for both small and large common stocks, as well as in three different markets, using daily and present-day prices.

Python is gaining popularity in the quant finance world (Kumar, 2021). Python's availability of adequate scientific libraries makes it simple to develop complicated statistical models. Some popular Python libraries are Pandas, NumPy, Matplotlib, Scikit-learn, Zipline, TA-Lib and more.

Nevertheless, the Python library that were used in this study are Pandas, NumPy, SciPy. Signal, argrelextrema, Matplotlib and pyplot. Python's prominence as a programming language comes in part from its acceptance by some of the domain's giants. Python's functional programming style makes it easy to create and analyse algorithmic trading structures. Python programming may be readily adapted to create dynamic trading algorithms.

PYTHON ALGORITHM

Python library that were used in this study are Pandas, NumPy, SciPy. Signal, argrelextrema, Matplotlib and pyplot. Python's prominence as a programming language comes in part from its acceptance by some of the domain's giants. Python's functional programming style makes it easy to create and analyse algorithmic trading structures. Python programming may be readily adapted to create dynamic trading algorithms. Meanwhile, this study discovered a list of Python code on GitHub which is a for profit website that provides a cloud-based Github repository as shown on sample code below:

```
for i in range(0, len(price)):
```

```
        max_idx = list(argrelextrema(price.values[:i], np.greater, order=10)[0
        ])
        min_idx = list(argrelextrema(price.values[:i], np.less, order=10)[0])
        idx = max_idx + min_idx + [len(price.values[:i]) - 1]
        idx.sort()

if len(idx) >= 5:
        current_idx = idx[-5:]
        start = min(current_idx)
        end = max(current_idx)
        current_pat = price.values[current_idx]
        XA = current_pat[1] - current_pat[0]
        AB = current_pat[2] - current_pat[1]
        BC = current_pat[3] - current_pat[2]
        CD = current_pat[4] - current_pat[3]

if XA > 0 and AB < 0 and BC > 0 and CD < 0:
        err = 0.1
        ABr = np.array([0.618 - err, 0.618 + err]) * abs(XA)
        BCr = np.array([0.382 - err, 0.886 + err]) * abs(AB)
        CDr = np.array([1.27 - err, 1.618 + err]) * abs(BC)

if ABr[0] < abs(AB) < ABr[1] and BCr[0] < abs(BC) < BCr[1] and CDr[0] < abs(
CD) < CDr[1]:
        plt.plot(np.arange(start, end+100), price.values[start:end+100])
        plt.plot(current_idx, current_pat, c="r")
        plt.show()
```

RESULTS AND DISCUSSIONS

This paper will focus on the data of Malaysia stocks from FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI) and Shariah Advisory Council (SAC) of the Securities Commission (SC). These data consist of daily closing stock prices of ten top companies from 1st January 2017 to 31st December 2021. The data was collected from yahoo finance. The data will be used to construct the performances of the stock prices. This study also presents the interpretation data by using python in order to see the trend of harmonic patterns of the 10 stocks market with different sectors in Malaysia. Each type of pattern has their own Fibonacci ratio to determine and decide the stop loss especially when to hold or sell the stock.

Figure 2a shows stock price of AEON Co. Bhd went up from index 575 to 638 which is from 1.44 to 1.8. After that, the price gradually dropped. This called bullish performance of AEON Co. Bhd stock price. Meanwhile, figure 2b shows a bullish bat Harmonic pattern which is the red line and there have 5 points that Python program read them as values of extrema. Denoted as first point is point X, second point is point A, third point is point B, fourth point is point C and the last point is point D.
At the beginning, point X were rise to A, point B retrace 0.382 ratio to 0.50 ratio of line XA. Line BC retrace 0.382 to 0.886 of line AB. Then, line CD is 1.618 to 2.618 extension of AB. Point D is at 0.886 which is retracement of XA.

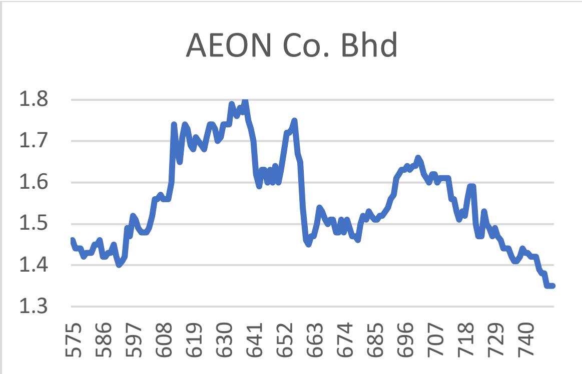

Figure 2a: Graph of Close price AEON Co. Bhd from index 575 to 740

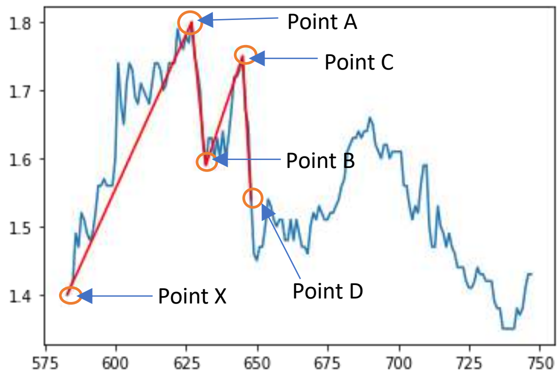

Figure 2b: Output Graph of Close price AEON Co. Bhd from index 575 to 750 from Python

Figure 3a shows the stock price of Petronas Chemical's Group Bhd gradually rose then it declined from index 650 to 845. Meanwhile, figure 3b shows a bullish crab Harmonic pattern which is the red line indicator. At the beginning, point B will pullback ratio of 0.382 to 0.618 of line XA. Line BC will retrace 0.382 to 0.886 of line AB. Then, line CD extends ratio 2.618 to 3.618 of AB. Point D is a 1.618 extension of XA.

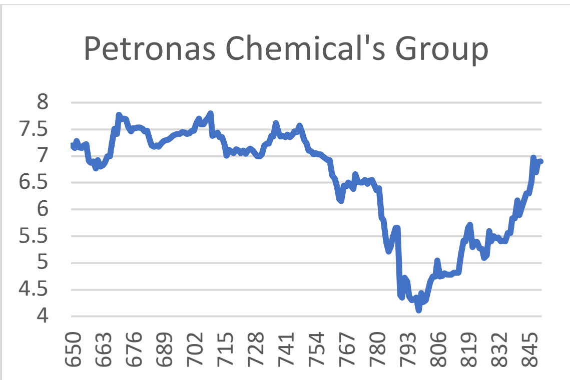

Figure 3a: Graph of Close price Petronas Chemical's Group Bhd from index 650 to 845

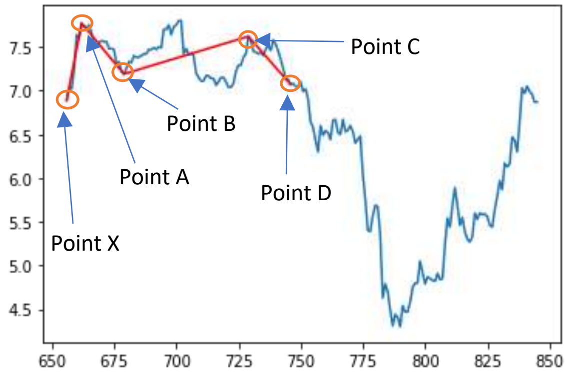

Figure 3b: Output Graph of Close price Petronas Chemical's Bhd from index 650 to 850 from Python

Lastly, Figure 4a displays Ranhill Utilities Bhd's stock price progressively growing until decreasing from index 50 to 245. Figure 4b demonstrates a bullish Gartley Harmonic pattern with red line markers. Price rises to point A, then corrects, with point B being a 0.618 retracement of line A. Price rises along line BC, which is a retracement of line AB from 0.382 to 0.886. The next stage is a down through line CD expansion of AB from 1.13 to 1.618. The 0.786 retracement of XA is shown by Point D. Line CD will attempt to increase the length of line AB from 1.27 to 1.618.

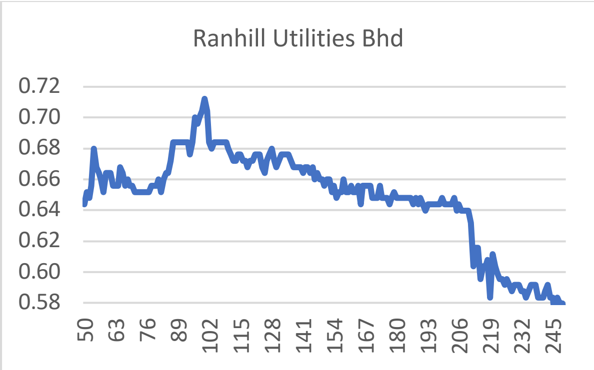

Figure 4a: Graph of Close price Ranhill Utilities Bhd from index 50 to 245

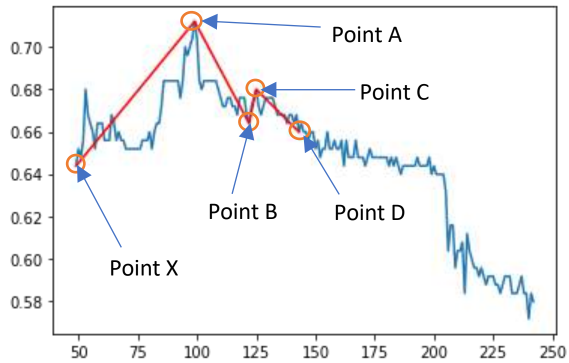

Figure 4b: Output Graph of Close price Ranhill Utilities Bhd from index 50 to 250

CONCLUSION

This study aims at two objectives which were to execute the special characteristic of stock performance in python and to identify the frequent patterns that has the probability of occurrence beyond the stock performance. As stated before, this research aims 3 *shariah*-compliance companies in a different sector to see their stock performance within 5 years which is from 1st January 2017 to 31st December 2021. From this time frames, we interpret the data by using python on Google Colab with the package that was provided such as matplotlib, Numpy, Scipy.Signal, argrelextrema and pyplot.

Despite from that, this research executes the characteristic of bullish pattern on python program which is there have 5 points and read them as values of extrema starting from point X, point A, point B, point C and lastly point D. Other than that, this study also identified that bullish bat pattern as the most frequent pattern that has greater probability of occurrence beyond the stock performance. Thus, this show that golden ratio can be applied on stock market analysis by applying Harmonic pattern.

For the recommendation for future research, there may have the other method to study the stock performance behaviour such as by using candlestick method, moving average method and more.

REFERENCE

Alzazah, F.S., & Cheng. (2020). *Recent Advances in Stock Market Prediction Using Text Mining: A Survey.* Retrieved from Chapter Metrics Overview: https://www.intechopen.com/chapters/72381

Duddella, S. (2010). Harmonic Pattern Trading. *Surinotes.com*, 236-250.

Lee, Y.N. (2020). *Retail investors with 'money to play with' help Malaysian stocks recoup nearly all losses this year*. Retrieved from CNBC: https://www.cnbc.com/2020/08/26/malaysian-retail-investors-pile-into-stocks-help-market-recoup-losses.html

Kumar, H. (2021). *How is Python Used in Quantitative Finance*. Retrieved from How Is Python Used In Quantitative Finance? (easemybrain.com)

McKinney, W. (2010). *Data Structures for Statistical Computing in Python*. PROC. OF THE 9th PYTHON IN SCIENCE CONF, 56-61.

Mitchell, C. (2021). *Harmonic Patterns in the Currency Markets*. Retrieved from https://www.investopedia.com/articles/forex/11/harmonic-patterns-in-the-currency-markets.asp

Mitchell, C. (2022). *Fibonacci Retracement Levels*. Retrieved from https://www.investopedia.com/terms/f/fibonacciretracement.asp

Reddy, V. K. (2018). *Stock Market Prediction Using Machine Learning*. Academia, 1032-1035.

Souza, L. C., Ribeiro, V. S., Suarez, D. F. (2021). An Analysis of Harmonic Patterns in the Time Series of the Forex Market. *Latin American Journal of Development*, 1688-1704

Vignesh C. K. (2020). *Applying Machine Learning Models In Stock Market Prediction*. EPRA International Journal of Research and Development (IJRD), 395-398.