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Verification of Technical Analysis Rules Applicability

Ověření aplikovatelnosti pravidel technické analýzy

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2. Description of Financial Markets
3. Description of Technical Analysis
4. Verification of Technical Analysis
5. Conclusion

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List of Abbreviations

Declaration of Utilisation of Results from the Diploma Thesis

List of Annexes

Annexes

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
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The declaration

"I hereby declare that I have elaborated the entire thesis including annexes myself."

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1. Introduction

Technical analysis refers to the sum of the methods of conducting market and all financial derivative trading decisions by taking market behavior as the research object, judging the market trend and following the cyclical changes of the trend. At the same time, technical analysis is more and more important for the investors, it can help them to choose the right trading time.

The goal of the thesis is to make the verification of the technical analysis based on the historical data, we select six stocks to analyze from Hang Seng Index.

This thesis is divided to five chapters. The first chapter is introduction, we introduce the structure of this thesis.

In the second chapter, we make the description of the financial market. Firstly, we introduce the classification of the financial market, the economic function of the financial market, new trends in the financial market which include the globalization, financial innovations and securitization. The last part is the description of analytical approaches of the financial market, it includes the fundamental analysis, psychological analysis and the technical analysis.

In the three chapter, we make the description of the technical analysis. Firstly, we introduce the history of the technical analysis, it has the history more than two hundred years. Secondly, we describe the methods of the technical analysis, it includes the trend analysis, support and resistance, chart, chart patterns and the technical indicators. Finally, we introduce the automated trading systems.

In the fourth chapter, we apply theory we have mentioned in chapter three into practice. At the beginning, we make the data description of six stocks which are from July 29th, 2009 to December 31th, 2018. Then we make the verification of the technical analysis by using the moving average, Bollinger bands and the relative strength index. In the practice, we use the widely used parameters, two assumptions of transaction costs, one is set to 0.25% when we buy and sell orders, and the other one is set 0% which means there is no transaction costs when we buy and sell the orders. Then we verify whether the technical analysis works or not based on some given conditions.

The last chapter is conclusion, we summarize that what we have done in this thesis. Also, we show the results about the thesis.

2. Description of Financial Market

A financial market is a market in which people trade financial securities and derivatives at low transaction costs. The combination of direct financial market and indirect financial market constitutes the financial market as a whole. In this chapter, we introduce the classification of the financial market, economic function of financial market, new trends in financial market and others.

2.1 Classification of financial market

The financial markets can be classified from different angles. In this thesis, we introduce the classification of financial market by maturity of claim, nature of claim, season of claim and immediate or future delivery.

2.1.1 By maturity of claim

According to classification by maturity of claim, financial market can be divided into money market and capital market.

Money market is called short-term financial market and used to promote the transfer of short-term funds from individuals, corporations, or governments with excess funds to those with deficient funds, typically no more than one year. The main purpose of money market is to maintain the liquidity of the financial assets and transfer it to real money. And the money market has the following characteristics:

1. maturity of one year or less,
2. money market instruments have low risk,
3. high liquidity,
4. in general, money market instruments are sold in large denominations.

In the money market, the most popular money market securities are treasury bills, commercial papers, negotiable certificates of deposit, repurchase agreements, federal funds and banker's

acceptances. For the investors who are interested in the money market, the easiest way to gain access to the money market is with the money market mutual funds.

Capital market is a financial market in which long-term debt (typically more than one year) or equity-backed securities are bought and sold. And the companies, municipalities and the government can raise funds for long-term investments by capital market. Compared with the money market, the main characteristics of capital market are the following:

1. maturity of more than one year,
2. capital market instruments have various risk, it depends on the issuer and the type of the instrument,
3. in general, capital market securities are expected to generate a higher annualized return to investors,
4. capital market instruments can be sold in different denominations.

The participants of capital market are national banks, commercial banks, brokers and dealers. The capital market includes stock market and bond market.

2.1.2 By season of claim

According to classification by season of claim, financial market can be divided into primary market and secondary market. Whether referring to money market securities or capital market securities, it is very important to distinguish between transactions in the primary and the transactions in the secondary market.

Primary market is the market where facilitates the issuance of new securities.

Secondary market is the market where facilitates the trading of existing securities, which allows for a change in the ownerships of the securities.

The primary market transaction can provide the funds to initial issuer of the securities, but secondary market transaction cannot do this. The very important feature of the securities that are traded in secondary market is liquidity, which is the degree to which securities can easily be

liquidated (sold) without a loss of value.¹ the investors prefer liquid securities, because they can sell easily the securities whenever they want.

There's strong connection between primary market and secondary market. Primary market is the foundation of secondary market while secondary market is very important for the existence and development of primary market. primary market is affected by secondary market in terms of both price and liquidity.

2.1.3 By nature of claim

According to classification by nature of claim, financial markets can be divided into debt market and equity market.

Debt market, also known as bond market, is the financial market in which bonds are issued and traded. Most transactions are made by individual investors or large institutions, or between the brokers. Investing in debt securities offer a lower potential return on investment.

Equity market, also known as stock market, is the market in which stocks are issued and traded. The equity market is unstable, it can experience significant price volatility. In general, investing in debt securities has the lower risk than equity investments.

2.1.4 By immediate or future delivery

According to classification by immediate or future delivery, financial market can be divided into spot market, future market and the derivatives market.

Spot market is a public financial market in which financial instruments are traded for immediate delivery. The Spot trading is a very common trading method in financial markets. In the spot market, settlement usually happens in the T+2 working days.

Future market is an auction market in which participant buy or sell future contracts delivery on a

¹ Source: Madura (2011, p.3)

specified future date. In general, large future market has their own clearinghouses, in which they make benefits from trading itself and from processing of trades after the fact.

Derivatives market is a market where various derivative financial instruments are traded. The derivatives market can be divided into two types which are exchange-traded derivatives and over-the-counter derivatives. Due to the advantages of fast transaction speed, strong liquidity, high transparency and strict risk monitoring system, the derivatives market plays an important role in attracting investors and preventing financial risks.

2.2 Economic function of financial market

Nowadays, with the development of the economy, financial markets occupy an increasingly important role. In this thesis, we introduce the main economic functions of financial markets.

Motivation function. The financial market can motivate investors to invest their money through financial markets.

Possibility to obtain funds. The deficit units can borrow money in the financial market not only from the bank.

Price information. Periodic trading of a security reveals the consensus price which an asset commands on the market. Then a prospective issuer of new securities knows his costs or at what price level he must set his new bonds or stocks.

Reduced search and transactions cost. Financial market can provide a place for buyers and sellers to trade. Through brokers and dealers, it can reduce the search costs. With the large trading, transactions costs may be kept low.

Liquidity. It can provide the investor with an opportunity to reverse his trade. Without the ability to sell the financial assets investors would not be willing to purchase them in the first place.

Reduction of risk. Investors can invest in lots of various financial instrument. Diversified investments can help investors to reduce investment risk.

2.3 New trends in financial market

After entering the 1980s, the world financial market developed rapidly. The financial markets of many developed countries gradually changed from a single market to an integrated market. Financial instruments have been innovated quickly, and various types institutional investors have begun to appear quickly. This series of changes has made the development of financial markets show a new trend.

2.3.1 Globalization

The globalization of financial markets has become an important trend in the world. Globalization means the integration of the financial market throughout the world into an international financial market. With the increasingly close economic exchanges between countries, the financial market has gradually become a close-knit overall market. The ever-increasing flow of cross-border traffic in terms of money, technology, people and information will not stop. And the reason of the globalization of the financial market is that technological advances for monitoring world markets, deregulation and liberalization of markets and institutionalization of financial markets.

2.3.2 Financial innovations

Financial innovations have been enabled by technological advances which is an important guarantee for improving market efficiency and competitiveness. The development of electronic technology and electronic networks has facilitated the instant transfer of information and the updating of technology. And the main trends of financial innovations are development of banking operations and development of derivative markets. The development of banking operations means using cards firstly, and then using the different ways of communication with the bank, such as home banking, internet banking and so on. As for development of derivative markets, it is typical for financial markets since eighty years of the last century and its value is since that time bigger and

bigger. And the main reasons of using of derivative instruments are hedging and speculations.

2.3.3 Securitization

Securitization is that the phenomenon of borrower prefers issuing securities than borrowing directly from banks. And it is the process of taking an illiquid asset, or group of assets, and through financial engineering, transforming them into a security. The main feature is the increase in the proportion of marketable securities in financial assets. Mortgage-backed security is a typical example of securitization. For companies, there are many advantages to raise funds in the market through the direct issuance of securities. Firstly, financing is very convenient; and then the cost is low; finally, there are many benefits from issuing securities itself. For the public, marketable securities are more attractive than bank deposits in terms of liquidity and profitability.

2.4 Analytical approaches of financial market

In the financial markets, there are mainly three analytical approaches which are fundamental analysis, psychological analysis and technical analysis. And these three analytical approaches can help the investors mark the best investment decisions.

2.4.1 Fundamental analysis

Fundamental analysis is a method of evaluating a security in an attempt to assess its intrinsic value, by examining related economic, financial, and other qualitative and quantitative factors. So, it includes macroeconomic analysis, industry analysis and business analysis. Fundamental analysis is performed on the historical and present data with goal of making financial forecasts.

When we want to analyze a stock, currency and others, there are two basic methods which can be used: bottom up analysis and top down analysis. And these two analyses can be used to distinguish the fundamental analysis from other types of analysis, such as the psychological analysis and

technical analysis.

Fundamental analysis involves analyzing the characteristics of a company in order to estimate its intrinsic value which can indicate whether the stock is undervalued or overvalued. And also, the fundamental analysis can help the managers to do the management decisions.

2.4.2 Technical analysis

Technical analysis is a security analysis subject for forecasting the future direction of prices through the study of past market data, mainly price and volume. There are three assumptions of the technical analysis: market action discounts everything, prices move in trends, and history repeats itself.

Market action discounts everything: the statement "market action discounts everything" forms what is probably the cornerstone of technical analysis. Unless the full significance of this first premise understood and accepted, nothing else that follows makes much sense.² This assumption is based on the premise that all related information is already reflected by the prices.

Prices move in trends: price movements are believed to follow the trends which means that when a trend has been established, the future price movement is more likely to be in the same direction as the trend than to be against it. the prices move in trend is shown in figure 2.1.

Figure 2.1 Prices move in trend



Source: Murphy (1999, p.33)

² Source: Murphy (1999, p.33)

History repeats itself: technical analysts think that the history tends to repeat itself. The repetitive nature of price movements is often attributed to market psychology, which tends to be predictable based on emotions like fear or excitement.³

Different with the fundamental analysis which focus on intrinsic value of the stock, the technical analysis does not care about the intrinsic value. The comparison of approaches is shown in the Table 2.1

Table 2.1 Comparison of approaches

	Fundamental analysis	technical analysis
Definition	Calculate stock value using economic factors, known as fundamentals	Uses historical price movement of security to predict future price movements
Data gathered from	Financial statements	Charts
Stock bought	When price falls below intrinsic value	When trader believes they can sell it on for a higher price
Time horizon	Long-term approach	Short-term approach
Function	Investing	Trading

Source: <http://www.investopedia.com>

2.4.3 Psychological analysis

Most conventional economic theories are created and used under the assumption that all individuals taking part in an activity are behaving rationally which means people are not influenced by the emotions, social, cognitive and other extraneous factors when they want to make economic choices.

³ Source: Murphy (1999, p.34)

But in the real world, this assumption does not reflect people's behavior choices. In fact, people often are not very rational, when they make the choices. At the same time, their behavior is challenged by risk aversion, and it belongs to the field of the behavioral finance.

Behavioral finance, a sub-field of behavioral economics, proposes psychology-based theories to interpret stock market anomalies. The typical behavioral characteristics are loss aversion, mental accounting, narrow framing, anchoring and overconfidence. The loss aversion means that when people face the same amount of gains and losses, they think that the losses are even more unbearable. Mental accounting means the propensity for people to allocate money for specific purposes. Narrow framing, also called frame dependence, is based on emotion, not logic, and it can explain why people sometimes make irrational choices. Anchoring is that refers to attaching a spending level to a certain reference, and everybody has their own anchor. As for the overconfidence, when people start investing, they overstate their knowledge, understate the risks, and overstate their ability to control events.

In general, psychology plays an important role in financial decision-making. The aims of psychological analysis aim to track market behavior by accounting for the beliefs, desires and fears of people and groups of investors. The market can be influenced by the behavior of investors for the short time. And in the market, psychological factors do not influence long trend.

3. Description of Technical Analysis

We have already mentioned some information of technical analysis in the second chapter, however, we focus on technical analysis in more details in this chapter, such as the history of technical analysis, methods of technical analysis and others.

3.1 History of technical analysis

Understanding the history of technical analysis helps investors to understand the nature of technical analysis more accurately. The history of technical analysis has more than two hundred years. It seems that the oldest known clew of technical analysis appeared in Asia and it was used to forecast price of rice in 18th century. Technical analysis begun to develop form the end of the 19th century in the USA.

The biggest influence on today's technical analysis has American named Charles Dow, who was the originator of the Dow-Jones financial news services and the 1st editor of the Wall Street Journal. His basic views and understanding of the market have formed a Dow Jones Theory. The Dow Jones Theory appeared around 1890. It is because of its appearance that the concept and the way of thinking of technical analysis has been spread and developed.

After Dow Theory, there have appeared many analytical masters who have had a major impact on the history of technical analysis, such as W.D.Gann, R.N.Elliott and so on. And their genius ideas and unique observations of the market have a profound influence on technical analysis up to now. These analytical masters have enriched and perfected the technical analysis methods and played a very important role in spreading and developing technical analysis. After the 1970s, the development of computer technology provided the basis for the development of technical indicators.

3.2 Methods of technical analysis

The technical analysis includes a lot of methods. And in this part, we describe the methods of

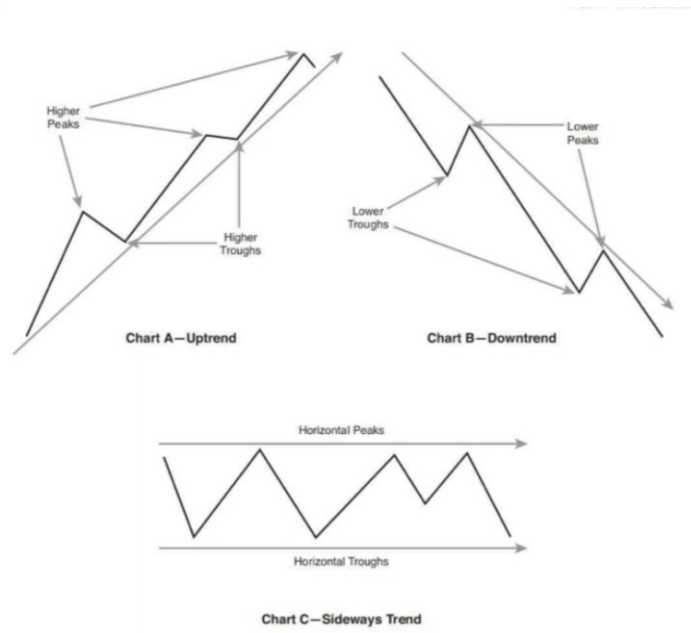
technical analysis which are the most widely used to describe, it includes trend analysis, support and resistance, chart and chart patterns and technical indicators.

3.2.1 Trending analysis

Technical analysis is based on a major assumption which is the trend. Traders and investors hope to buy a security at the beginning of an uptrend at the low price, ride the trend, and sell the security when the trend ends at a high price.⁴ So trending analysis is very important for us to know a security.

We show the trend in figure 3.1.

Figure 3.1 Simple trends



Source: Kirkpatrick and Dahlquist (2010,p.12)

In general, an uptrend appears when the prices reach higher troughs and higher peaks; a downtrend has the opposite direction with the uptrend, it appears when the prices reach lower troughs or lower

⁴ Source: Kirkpatrick and Dahlquist (2010, p.9)

peaks; and a sideways trend appears when the prices trade in a range without significant downward upward and underlying movement.

Dow theory has identified three concomitant trends within the market: primary, secondary and minor trend. Next, we introduce them in more details.

Primary trend is overall direction of market and it is the longest lasting trend. It can last for many years, and move down and up with economic cycles, so it is most predictable. And the primary trend just has two trends which uptrend or downtrend. Because the sideways trend is temporary and secondary. And the primary uptrend means that there exists “bull market”, primary uptrend can be characterized by three phases:

1. In the first phase, main characteristic is that buyers are buying, the main reason is that the price is low.
2. In the second phase, it starts when economy begins to boom, and the company can attract more stock buying.
3. In the third phase, the speculation constitutes the third phase.

As for the primary downtrend, it means that there exists “bear market”, and the primary market can also be characterized by three phases:

1. In the first phase, the economy moves down, and people start selling stocks.
2. In the second phase, selling is increased, the main reason is that business starts to suffer decreased earnings.
3. In the third phase, market has declined so much that people see out of despair.

Secondary trend, also known as medium-term trend, lasts between several weeks and several months, while the retracement of secondary trend ranges between one-third to two-third of primary trends’ movement. The price movement of secondary trend is the opposite direction of primary trend. Dow thought that it is risky to make profits based on the secondary trend, because it is unpredictable and has short time frame.

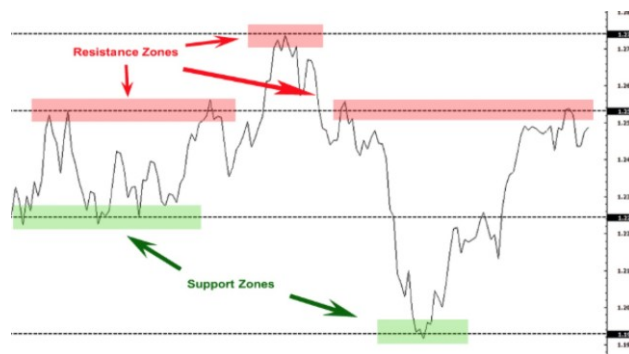
Minor trend can last less than three weeks, and it is the daily and weekly fluctuations that result from the imbalance of demand and supply over short term period.

3.2.2 Support and resistance

The trough is called support. the term indicate that support is level where the price tends to find support as it falls. This means the price is more likely to “bounce” off the level rather than break through it. But when the price has breached the level, by an amount exceeding some noise, it’s likely to maintain falling until the it meets another support level.

Resistance is the opposite of support. And a resistance level is the level where the price tends to find resistance as it rises. and it means that the price is more likely to "bounce" off this level rather than break through it. But when the price has breached this level, by an amount exceeding some noise, it is likely to maintain rising until it meets another resistance level. In general, a resistance level can be identified by a previous peak. An example of support level and resistance level is shown in figure 3.2

Figure 3.2 An example of support level and resistance level



Source: Murphy (1999, p.230)

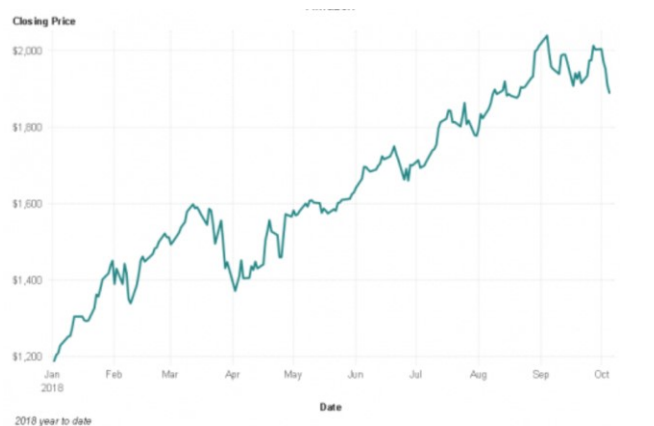
3.2.3 Charts

Charts are fundamental to analysis. There have four main types of charts which are line chart, bar chart, candlestick chart, and point and figure chart.

A. Line chart

The line chart or line graph is a basic type of chart which displays information as a series of data points named “markers” connected by straight line segments. And in line chart, only closing prices are plotted for each successive day. Many people think that line chart is very important measure of price activity, because the closing price is the most critical price of the trading day. We give an example of line chart.

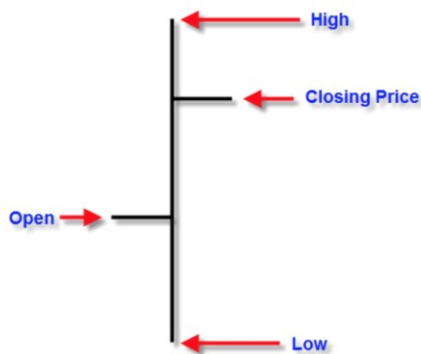
Figure 3.3 An example of line chart



Source: www.stockcharts.com

B. Bar chart

Figure 3.4 An example of single bar



Source: Murphy (1999, p.222)

Bar chart also named as open-high-low-close chart or OHLC chart. In the bar chart, top of the

vertical line indicates the highest price a security traded at a given day, the bottom means the lowest price. And the opening price is shown on the left side of the bar, the closing price is shown on the right side of the bar. We show a single bar which represents one day of trading in figure 3.4, and an example of bar chart in figure 3.5.

Figure 3.5 An example of bar chart



Source: www.stockcharts.com

C. Candlestick chart

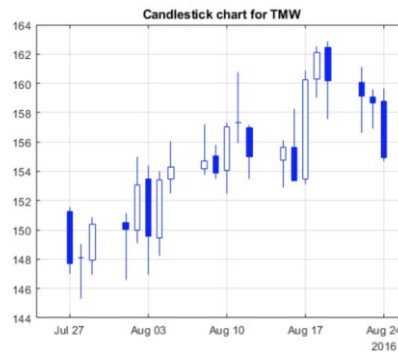
The candlestick chart is also called Japanese candlestick chart and has been developed in 18th century. It is a type of financial chart to describe the price movements of a security. The candlesticks are composed of the body, an upper and a lower shadow. When the closing price is lower than the opening price, color of the body is red or black. When the closing price is higher than the opening price, color of the body is green or white. And the area between the opening price and closing price is called real body. We can get some important information from the length of the body. The longer the body is, the more intense the selling and buying stress. Also, the short candlestick means small price changes and represents consolidation. Moreover, candlestick charts contain all the information that a bar chart contains, so all of the technical tools that are used with bar charts can also be used with candlestick charts. Here, we show an example of a single candlestick in figure 3.6, and an example of candlestick chart in figure 3.7.

Figure 3.6 An example of a single candlestick



Source: Murphy (1999, p.233)

Figure 3.7 An example of candlestick chart



Source: www.stockcharts.com

D. Point and figure chart

Point and figure chart, also known as P&F chart, has a long history. Point and figure chart focuses on pure price movements, and it reduces the importance of time in the chart. Point and figure chart is made up of X's and O's, X means that the price is increasing, and the O represents the price is decreasing. Here, an example of point and figure chart is shown in figure 3.8.

Figure 3.8 An example of figure chart

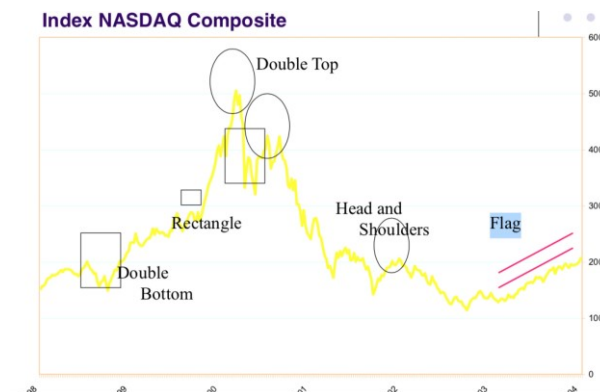


Source: www.stockcharts.com

3.2.4 Chart patterns

Chart pattern is a method analysis of technical analysis used to analyze a stock's price action according to the shape its price chart creates. Using patterns can identify the current trends and the trend reversals and trigger sell and buy signals. There are two types of patterns which are reversal pattern and continuation pattern. Here, we show an example of a chart pattern in figure 3.9.

Figure 3.9 An example of a chart pattern



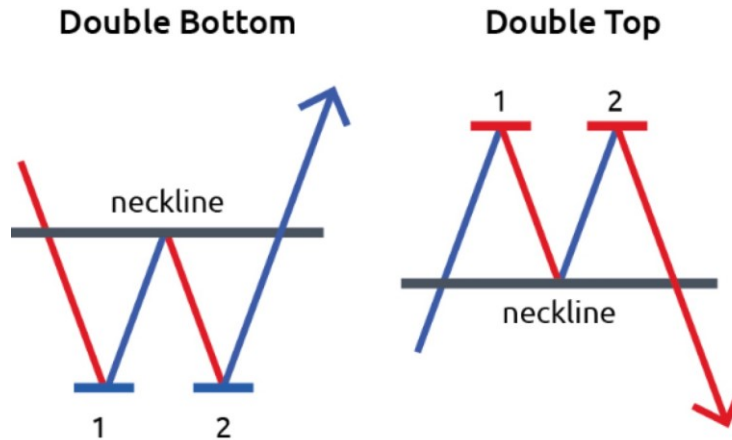
Source: www.stockcharts.com

In the figure 3.9, we can find that there are double bottom and top, rectangle and head and shoulders on the chart. Double bottom, double top and head and shoulders belong to reversal pattern which signals that a prior trend will reverse upon completion of pattern. Rectangle and flag belong to continuation pattern which signals the trend will go on once pattern is completed. We describe them separately.

A. Double top and bottom

The Double Top (bottom) Reversal is a bearish (bullish) reversal pattern. They can be typically found on bar charts, candlestick charts, and others. And the pattern is composed by a moderate trough (peak) in-between, and two connected peaks (troughs) that are basically same. In a word, the double bottom is the mirror image of the double top. Here, we show an example of the double top and bottom in figure 3.10.

Figure 3.10 An example of the double top and bottom



Source: Murphy (1999, p.251)

B. Head and shoulders

The head and shoulders are a kind of reversal chart pattern. It appears when the market trend is in the process of reversal either from a bearish or a bullish trend. This type of chart pattern consists of a left shoulder, a head, a right shoulder and a neckline. Head and shoulders top include three successive peaks, the middle peak is the highest one which is called head, the others are lower than the head and roughly equal, they called shoulders. The neckline means the key support level. As for the head and shoulders bottom, it represents an inverse of head and shoulders top. Here, two examples of head and shoulders top and bottom are shown in figure 3.11 and figure 3.12

Figure 3.11 An example of head and shoulders top



Source: Murphy (1999, p.260)

Figure 3.12 An example of head and shoulders bottom

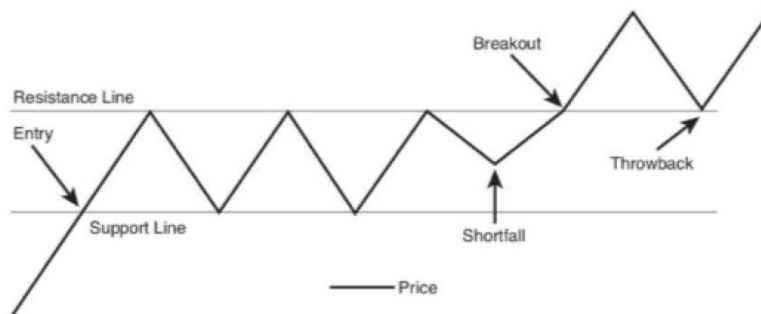


Source: Murphy (1999, p.261)

C. Rectangle

A rectangle is a continuation pattern, which forms as a trading range during a pause in the trend. The rectangle can be identified by two comparable lows and two comparable highs. The pattern consists of a resistance line above and a support line. Each resistance or support line must also be a trend line, which means that it must touch roughly the same price reversal at least twice.⁵ Here, we show an example of rectangle in figure 3.13.

Figure 3.13 An example of rectangle



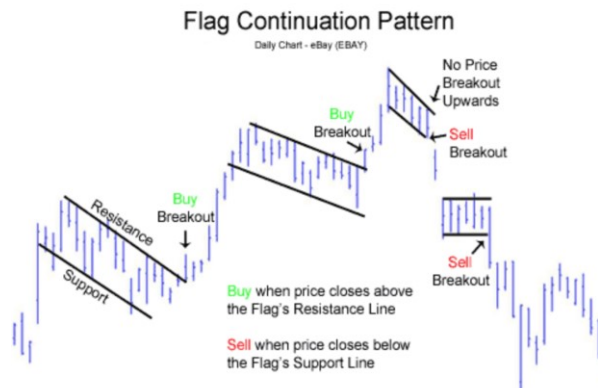
Source: Kirkpatrick and Dahlquist (2010, p.311)

⁵ Source: Kirkpatrick and Dahlquist (2010, p 310)

D. Flag and pennants

The flags and pennants are short-term continuation patterns which mean a small consolidation before the previous movement resumes. Here we show an example of flag in figure 3.14.

Figure 3.14 An example of flag



Source: <https://commodity.com/technical-analysis/flag/>

These patterns usually are preceded by a sharp advance or decline with heavy volume and mark a midpoint of the move.

3.2.5 Technical indicators

Technical indicators are very important for technical analysis, they are a fundamental part of technical analysis and typically plotted as a chart pattern to try to predict market trend. And in this part, we choose three popular technical indicators to describe. They are moving average, relative strength index and Bollinger bands and CR indicator.

(1) Moving average (MA)

The moving average is one of the most versatile and widely used of all technical indicators. Moving Average is a good method to measure momentum as well as to confirm trends and define areas of support and resistance. Essentially, Moving Averages smooth out the “noise” when trying to

explain the charts. What deserves our attention is that moving average is the basis for other indicators, such as the Bollinger bands and the MACD. Here, we choose the typical types of the moving average to describe, they are simple moving average and exponential moving average.

A. Simple moving average (SMA)

The simple moving average, or the arithmetic mean, is the type used by the most technical analysts. A simple moving average is the calculation of the sum of the prices of a security divided by a number of time periods. The formula of simple moving average is shown as follows:

$$SMA = \frac{P_1 + P_2 + P_3 + \dots + P_n}{N}, \quad (3.1)$$

where P means the closing price of a security, and N is a number of time period.

B. Exponential moving average (EMA)

The exponential moving average is also known as the exponentially weighted moving average. In order to avoid the lag, the exponential moving average applies greater weight to the recent prices. And compared with a simple moving average, an exponentially weighted moving average reacts more significantly to recent price changes. There are three basic steps to calculate EMA: the first step is to determine the initial value of EMA, which equals to value of initial price. The second step is to calculate the multiplier for weighting the EMA. And the third step is to calculate the current EMA. The formulas of multiplier and the current EMA are shown as follows:

$$K = \frac{2}{N+1}, \quad (3.2)$$

$$EMA_n = P_n * K + EMA_{n-1} * (1 - K). \quad (3.3)$$

In these two formulas, N is a number of time period, K means the multiplier, and P means the closing price of a security. We show an example of the simple moving average and the exponential

moving average in figure 3.15.

Figure 3.15 An example of SMA and EMA



Source: www.stockcharts.com

(2) Bollinger bands (BB)

The Bollinger bands were developed by John Bollinger in the 1980s. Bollinger Bands are displayed as a single moving average line, with two evenly spaced standard deviation lines (one on each side of the moving average line). Standard deviation is a statistical concept that describes how the prices are dispersed around an average value. And the volatility is based on standard deviation, which changes as volatility increases and decreases. Bollinger bands are used in different ways by the different traders, some of them make trades when price moves above or below Bollinger bands, and some of them make trades near the moving average. In general, when market fluctuates greatly, the bands widen, and when the market is less volatile, the bands contract. One thing worthy of our attention, if the price fluctuations cross the zone, it means that the price fluctuations may be abnormal. We show an example of Bollinger bands in figure 3.16.

Figure 3.16 An example of Bollinger bands



Source: www.stockcharts.com

The formulas of Bollinger bands are shown as follows:

$$\text{middle band} = SMA_{20}, \quad (3.4)$$

$$\text{upper band} = SMA_{20} + \sigma_{20} \cdot 2, \quad (3.5)$$

$$\text{lower band} = SMA_{20} - \sigma_{20} \cdot 2, \quad (3.6)$$

where SMA_{20} represents 20-day simple moving average, σ_{20} means 20-day standard deviation of the price.

(3) Relative strength index (RSI)

The relative strength index is a popular momentum oscillator developed in 1978 by J.Wells.Wilder. It is a momentum indicator that measures the magnitude of recent price changes to evaluate overbought or oversold conditions in the price of a security. In generally, signals are thought overbought when RSI is above 70, and oversold when RSI is below 30. The formula of relative strength index is shown as follows:

$$RSI_t = 100 \cdot \frac{AG_t}{AG_t + AL_t}, \quad (3.7)$$

where the AG_t means average gain at the t time, the AL_t means average loss at the t time. What's more, the average loss is expressed as positive values. Here we show an example of RSI in figure 3.17

Figure 3.17 An example of RSI



Source: <https://www.investopedia.com/terms/r/rsi.asp>

(4) CR indicator

The CR indicator is also called the intermediate willing indicator and the price momentum indicator. The CR indicator compares the buying power with the selling power in relation to its previous mid-price. It is a medium-long term technical analysis instrument to grasp the timing of buying and selling the stocks. The formulas are shown as follows:

$$M = \frac{close+high+low}{3}, \quad (3.8)$$

$$CR(t) = \frac{\sum(high_t - M_{t-1})}{\sum(M_{t-1} - low_t)} \cdot 100, \quad (3.9)$$

Where M means the middle price, YM means the middle price of the previous trading day. In the process of calculations, if $(M_{t-1} - low_t)$ is equal to minus, we use 0 to represent its value.

3.3 Automated trading system

Automated trading system (ATS), also known as algorithmic trading, is a computer program that generates the orders automatically based on predefined rule set. And in technical analysis, it is a well-defined procedure that indicates whether a purchase, sale, or no action on an asset is made at a particular time. In this part, we introduce the automated trading system based on the trading rules of various technical indicators which we have already mentioned before.

3.3.1 Trading rules

The trading rules are essentially mechanical trading methods. A rule is a function that transforms one or more items of information, referred to as the rule's input, into the rule's output, which is a recommended market position, such as long, short and neutral position. In this part, according to trading rules of the moving average, Bollinger bands and relative strength index, we set automated trading system. Next, we introduce them one by one.

(1) The trading rule of moving average

The trading rule of moving average is that when the price of the security rises above its moving average, a buy signal is generated, and when the price of a security falls below its moving average, a sell signal is generated. The most famous method is the golden cross and the death cross. When the gold crosses, it should be bought. When the death crosses, it should be sold. Trading rule is defined as follows:

$$position_t = \begin{cases} \text{buy, if } MA(f)_t > MA(s)_t \text{ and } MA(f)_{t-1} \leq MA(s)_{t-1} \\ \text{sell, if } MA(f)_t < MA(s)_t \text{ and } MA(f)_{t-1} \geq MA(s)_{t-1} \\ \text{otherwise do nothing,} \end{cases} \quad (3.10)$$

where the $MA(f)$ means the fast moving average, the $MA(s)$ is slow moving average. One thing that needs our attention is that the fast moving average is relates to the prices over a short term period. As for the slow moving average, it is related to the prices over a long term period. What's more, the formula above means a simple automated trading system.

(2) The trading rules of Bollinger bands

In this part, we introduce two trading rules of Bollinger bands, which are below-above system and crossover system. Each formula below means a simple automated trading system.

A. Below-above system

The trading rule of below-above system is that when price of security goes up over the upper bands, it is a selling opportunity. When the price of security goes down over the lower bands, it is a buying opportunity.⁶ Trading rule is defined as follows:

$$position_t = \begin{cases} \text{buy, if } P_t < LB_t \\ \text{sell, if } P_t > UB_t \\ \text{otherwise do nothing,} \end{cases} \quad (3.11)$$

⁶ Source: Li (2015, p.286)

where the *LB* means lower band, and *UB* means upper band.

B. Crossover system

The trading rule of the crossover system is that when the price of the security is higher than the lower band and the price of the previous trading day is lower than the lower band, it is a buying opportunity. When the price of the security is lower than the upper band and the price of the previous trading day is higher than the upper band, it is a selling opportunity. Trading rule is fined as the follows:

$$\text{position}_t = \begin{cases} \text{buy, if } P_t > LB_t \text{ and } P_{t-1} > LB_t \\ \text{sell, if } P_t < UB_t \text{ and } P_{t-1} \geq UB_t \\ \text{otherwise do nothing,} \end{cases} \quad (3.12)$$

(3) Trading rules of relative strength index

In this part, the trading rules of relative strength index include two systems, which are below-above system and crossover system. Each formula below means a simple automated trading system.

A. Below-above system

The theory of RSI believes that price of any market rise or fall is between 0-100. According to the normal distribution, the RSI value is expected to vary between 30-70. In general, RSI is considered overbought when RSI is above 70, and oversold when RSI is below 30, at the same time, it generates signals to buy or sell. The formula for trading rules means a simple automated trading system. The formula is as follows:

$$\text{position}_t = \begin{cases} \text{buy, if } RSI_t < 30 \\ \text{sell, if } RSI_t > 70 \\ \text{otherwise do nothing,} \end{cases} \quad (3.13)$$

B. Crossover system

The trading rules of the crossover system is that when RSI is lower than 70 and RSI of previous trading day is higher than 70, it means that it is a buying opportunity. When RSI is higher than 30 and RSI of previous trading day is lower than 30, it means that it is a selling opportunity. The formula is as follows:

$$position_t = \begin{cases} \text{buy, if } RSI_t < 70 \text{ and } RSI_{t-1} \geq 70 \\ \text{sell, if } RSI_t > 30 \text{ and } RSI_{t-1} \leq 30 \\ \text{otherwise do nothing,} \end{cases} \quad (3.14)$$

(4) Trading rules of CR indicator

In this part, we also introduce two systems of CR indicator, it includes below-above system and crossover system. Each formula below means a simple automated trading system.

A. Below-above system

The trading rule of the below-above system is that when CR is lower than 40, it means signals are thought oversold, when CR is higher than 300, it means that signals are thought overbought. In general, the lower the value of CR, the safer it is to buy.

$$position_t = \begin{cases} \text{buy, if } CR_t < 40 \\ \text{sell, if } CR_t > 300 \\ \text{otherwise do nothing,} \end{cases} \quad (3.15)$$

B. Crossover system

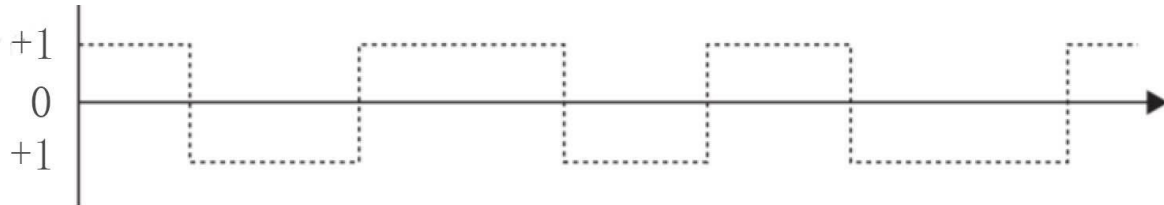
The trading rule of crossover system is that when CR is higher than 40 and CR of previous trading day is lower than 40, it is a buying opportunity. When CR is lower than 300 and CR of previous trading day is higher than 300, it is a selling opportunity. The formula is as follows:

$$position_t = \begin{cases} \text{buy, if } CR_t > 40 \text{ and } CR_{t-1} < 40 \\ \text{sell, if } CR_t < 30 \text{ and } CR_{t-1} > 300 \\ \text{otherwise do nothing,} \end{cases} \quad (3.16)$$

3.3.2 Setting automated trading systems

An investment strategy is always in either a long or short position in the market being traded. Rules of this type are referred to as reversal rules because signals call for a reversal from long to short or short to long. Over time a reversal rule produces a time series of +1's and -1's that represent an alternating sequence of long and short positions. Also, the neutral position should be considered. We show an example of the long position, short position and neutral position in figure 3.18.

Figure 3.19 An example of positions



Source: Li (2015, p. 355)

The long position (+1) means when we buy the security, short position (-1) means when we sell the security, and the neutral position (0) is when we neither buy nor sell. The formula is shown as follows:

$$position_t = \begin{cases} 1, \text{ if long position} \\ -1, \text{ if short position} \\ 0, \text{ otherwise,} \end{cases} \quad (3.17)$$

3.3.3 Profitability of Automated Trading System

In this part, the main process is to verify whether traders can make the profits if they follow automated trading system. Here, we describe the steps of calculating profits that are created during

the trading. First step is that we calculate the returns, and it is shown as a percentage changes of the price. And the second step is that we compute wealth the traders would have owned at t time, if they followed the automated trading system. The formulas are shown as follows:

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1, \quad (3.18)$$

$$w_t = w_{t-1} * \prod_{i=1}^t [(1 + position_i * r_i) * (1 - fee * |position_i - position_{i-1}|)], \quad (3.19)$$

where the r_t means the return at the t time, w_{t-1} means the wealth of previous trading day. *Position* is position taken based on the formula (3.17) we have mentioned before, r represents the return based on formula (3.18). As for the *fee*, it means the transaction costs expressed as the percentage, it is incurred on selling and buying orders.

4. Verification of Technical Analysis

In the previous chapter, we have mentioned some basic information of the technical analysis and introduced several technical indicators. In this chapter, we make the verification of technical analysis based on the historical data. We do the verification of technical analysis by using the moving average, Bollinger band RSI and CR indicator.

4.1 Data description

It has lots of different types of assets in the financial market. In this part, we choose the historical stock data to analysis. As for the data acquisition, we choose 6 stocks from hangseng Index. Our selection of data is from July 29th, 2009 to December 31th, 2018, which is the daily data. We download all the data in the website www.investing.com. Table 4.1 lists the names of the stock that we choose.

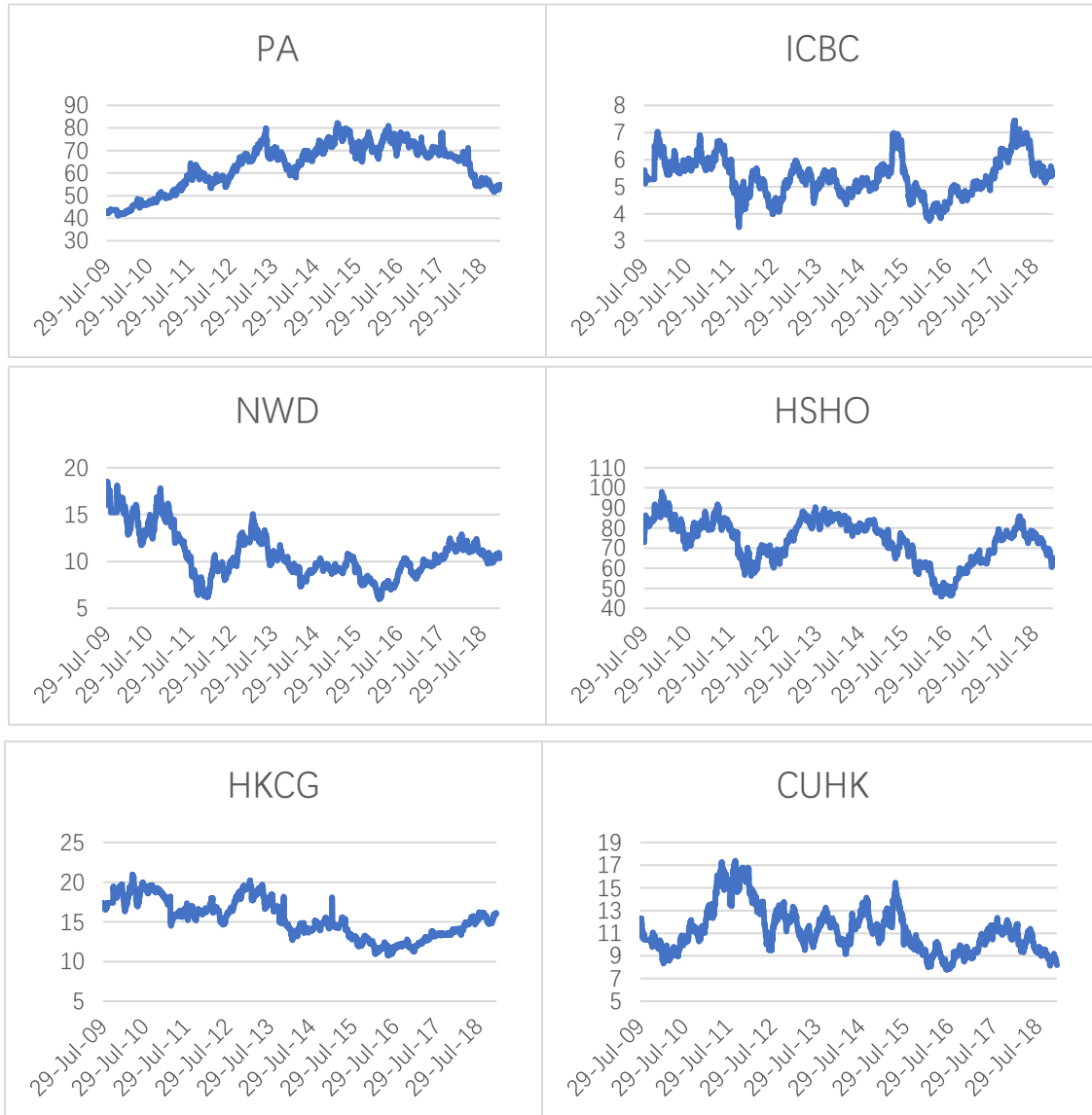
Table 4.1 List of companies

Name	Abbreviations
Power assets	PA
Industrial and Commercial Bank of China	ICBC
New World Development. Co ltd	NWD
HSBC Holdings PLC	HSBC
HK&China Gas	HKCG
China Unicom Hong Kong Ltd	CUHK

The Hang Seng Index is an index compiled by Hang Seng Index Company, a wholly-owned subsidiary of Hong Kong Hang Seng Bank. Its sample stocks are listed in 33 listed companies in the Hong Kong stock market, with a weighted average stock price index based on circulation. The

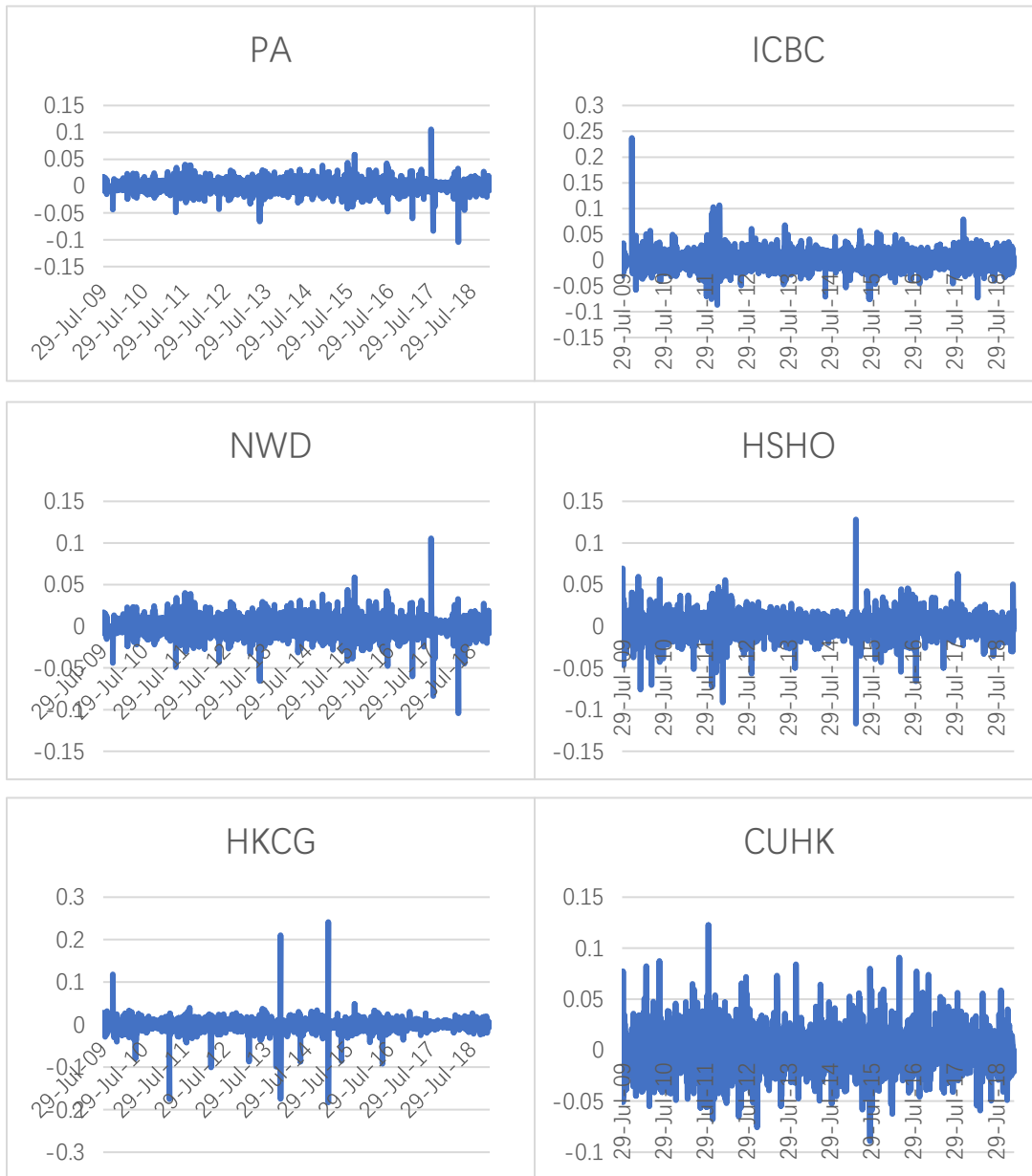
Hang Seng Index is the most influential index in the Hong Kong stock market. The figure 4.1 shows the stock prices, the returns are shown in figure 4.2.

Figure 4.1 The closing prices of stocks



From the figure 4.1, we can find that all the stocks have been fluctuating so many years. It is particularly obvious about PA and HSHO, which changed a lot at the analytical period. But for ICBC, NWD, HKCG and CUHK, although the prices have been floating for many years, the change are not very big. From the figure 4.2, we can find that the return of the stock have been floating for many years, but the change are not very big.

Figure 4.2 Calculation of returns



4.2 Assumptions in verification

We assume that the initial wealth is equal to 1HKD. When we trade, the transaction costs are definitely different, the reason is that the brokers are different. In general, the transaction costs are within the range of 0.1% to 0.3% based on the Hong kong stock market. The table 4.2 is shown the transaction costs are form different brokers.

Table 4.2 Transaction costs

	Transaction costs
Futu	0.15%
Guotai junan	0.25%
Huili	0.25%
Haitong international	0.2%

Source: www.investing.com

According to table 4.2, we make two assumptions of the transaction cost in our verification, the first one is set the transaction cost which equals to 0.25% (buying and selling the orders), the other one is set the transaction cost which equals to 0% (it means that no transaction cost).

4.3 Verification of technical analysis by using Moving average

In this part, we verify the technical analysis based on application of Moving average. We use the widely used parameters for fast moving average and slow moving average, which are 20 days for fast moving average and 120 days for slow moving average.⁷ We apply this fast moving average (20) and the slow moving average (120) in calculations. Then we can get the signals based on the formula that we have mentioned in chapter 3. When the signal is generated, we can get the value of the positions, which are long position, short position and neutral position. The long position means we buy a security, the short position means we sell a security, and the neutral position means we neither buy nor sell. Then we calculate the final wealth that the traders have owned at the end of period, we calculate the average annual return based on the final wealth (when the final wealth is higher than the initial wealth, the average annual return would be positive, when the average annual return is negative, which means that the final wealth is lower than the initial wealth). Finally, we compare the final wealth and the initial wealth and confirm whether the average annual return is a positive or not, we verify that we can make the profits or not if we follow the signals it generates.

⁷ Source: Liu (2011, p.39)

According to the process we mentioned above, we can make the conclusion.

We have already introduced the detailed process above, now we start to verify. We apply the Auto Trading System which fast moving average equals to 20 days, and slow moving average equals to 120 days in the analytical period. We get the value of position based on the signals it generated. Then we calculate the wealth evolution in the analytical period when the transaction costs equal to 0.25% and 0%. Because the wealth evolutions are very similar when transaction costs equal to 0.25% and 0%, in the figure 4.3, we just show the wealth evolutions when transaction costs equal to 0.25%. When it equals to 0%, the wealth evolutions are shown in Annex 5.

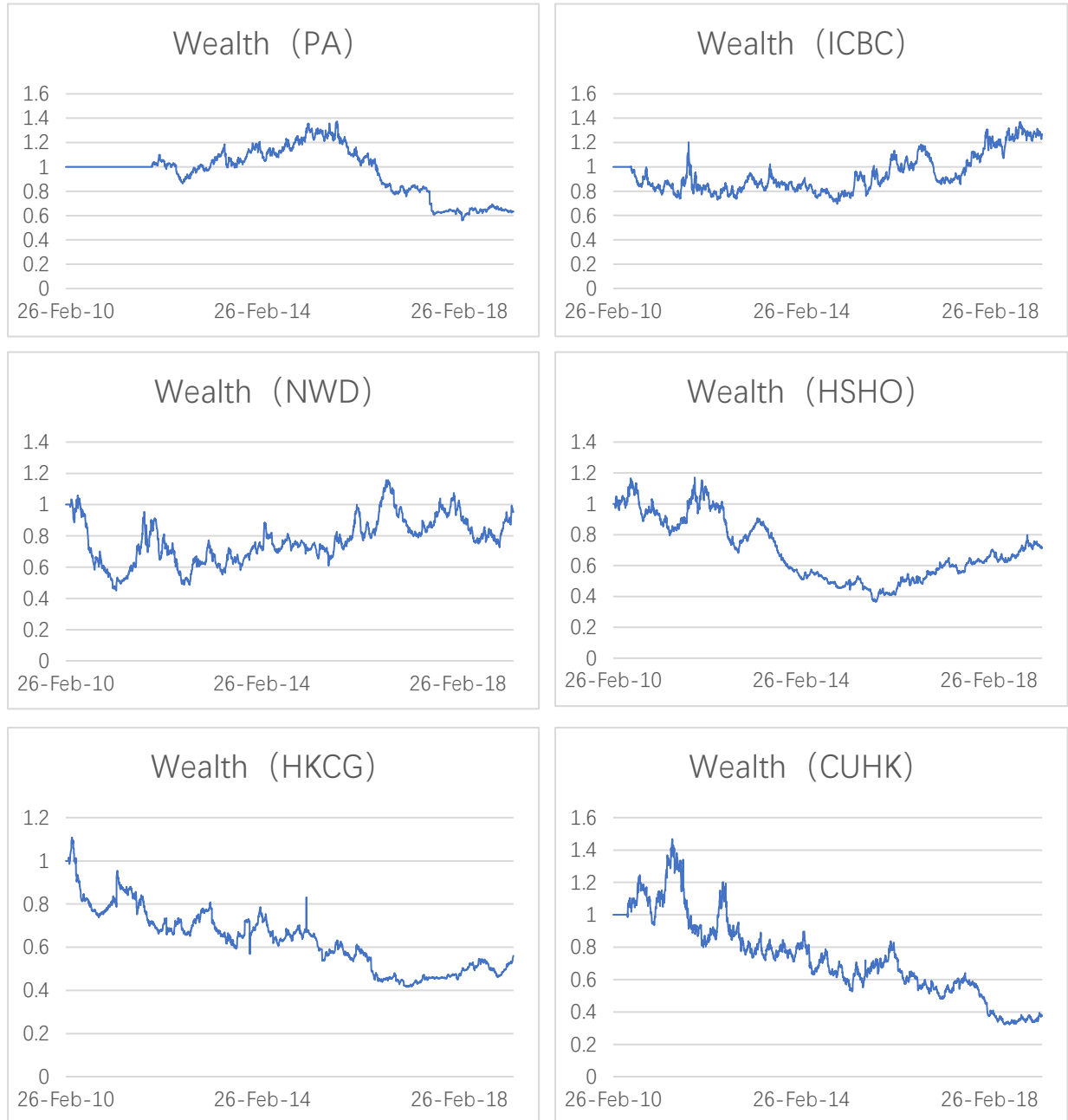
From the figure 4.3, we can find that the final wealth PC, ICBC, NWD, HSHO, HKCG and CUHK are lower than 1 HKD at the end of the analytical period, which means the value of the final wealth traders have owned are lower than the initial wealth. We show the average annual return on table 4.3 when transaction costs equal to 0.25% and 0%.

Table 4.3 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	-4.5	-3.5
ICBC	-0.1	1
NWD	-5	-3.8
HSHO	-5.2	-3.3
HKCG	-13.1	-11.8
CUHK	-12.5	-11.3

From the table 4.3, we can find when the transaction costs equal to 0.25%, the value of average annual return is negative for PA, ICBC, NWD, HSHO, HKCG and CUHK. When the transaction costs equal to 0%, we can find that all the value of average annual return is negative except for the value of ICBC. From all the results we have got, we can make the conclusion that when the transaction costs are 0.25%, we can not get the profits based on the application of moving average, the technical analysis does not work. When the transaction costs are 0%, the technical analysis does not work except for ICBC.

Figure 4.3 Wealth evolutions (transaction costs of 0.25%)



4.4 Verification of technical analysis by using Bollinger band

We use the widely used parameters for the multiple of standard deviation and the periods of moving

average, which are equal to 2 and 20 days.⁸ We apply this multiple of standard deviation (2) and periods of moving average (20) in calculations. Then we get the signals based on the formula we have mentioned in chapter 3. When signal is generated, we get the value of the positions. We calculate the final wealth that the traders have owned at the end of analytical period, then we calculate the average annual return. Finally, we compare the final wealth and the initial wealth and confirm that the average annual return is positive or not. We verify that we can make the profits or not if we follow the signals it generates. According to the process we mentioned above, we can make the conclusion. As we mentioned in chapter three, we have two trading systems of Bollinger bands, so we verify it separately.

4.4.1 Below-above system

We apply the Auto Trading System which the multiple of standard deviation equals to 2 and the periods of moving average equals to 20 in the analytical period. We show the wealth evolutions are shown in figure 4.4, we just show the wealth evolutions when transaction costs equal to 0.25%. When it equals to 0%, the wealth evolutions are shown in Annex 5.

Table 4.4 Average annual return (unit: %)

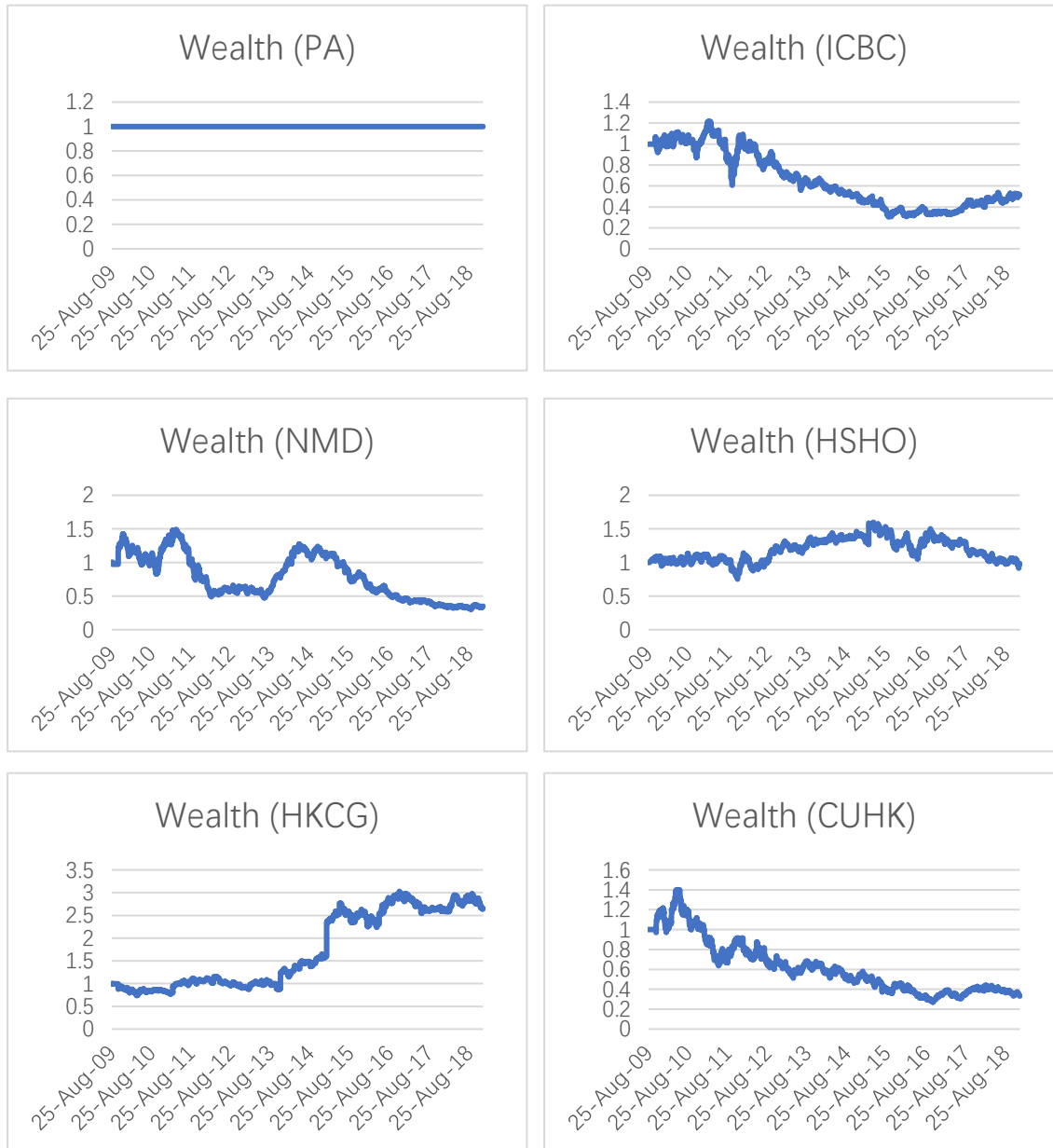
	ARR(0.25)	ARR(0)
PA	0	0
ICBC	-6.2	-4.2
NWD	-9.7	-7.4
HSHO	-0.1	2.2
HKCG	9.8	12.8
CUHK	-10	-8.1

From the figure 4.4, we can find that the value of the final wealth for ICBC, NWD, HSHO and CUHK are lower than 1 HKD which is the initial wealth we set. Only HKCG is higher than 1 HKD.

⁸ Source: Li (2015, p.286)

For PA, the value of wealth that traders would have owed is always 1 HKD in the analytical period, which means there is no trading action. We calculate the average annual return in the analytical period. We show them in table 4.4 when transaction costs equal to 0.25% and 0%.

Figure 4.4 Wealth evolutions (transaction costs of 0.25%)



From the table 4.4, we can find that the value of average annual return is negative for ICBC, NWD, HSHO and CUHK, the value of average annual return is positive for HKCG when the transaction costs equal to 0.25%. When the transaction costs equal to 0%, we find that the value of average

annual return is positive for HSHO and HKCG, and it is negative for ICBC, NWD and CUHK. Thus, according to the application of Bollinger bands in our analysis, we can make the conclusion that when the transaction costs are 0.25%, the technical analysis works well for HKCG, but it does not work for ICBC, NWD, HSHO and CUHK. When the transaction costs equal to 0%, technical analysis works for HSHO and HKCG and it does not work for the others.

4.4.2 Crossover system

In this part, conditions are same with the below-above system. We apply the Auto Trading System (multiple of standard deviation = 2, periods of moving average = 20 days) in the analytical period. We show the wealth evolutions when the transaction costs equal to 0.25% in figure 4.5. when the transaction costs equal to 0%, we show it in Annex 5.

From the table 4.5, we can find that all the final wealth is higher than the initial wealth which we assume it equals to 1 HKD except for ICBC and PA. From the table 4.5, we can find that when the transaction costs equal to 0.25%, the average annual return of NWD, HSHO, HKCG and CUHK are positive. As for ICBC, the value of average annual return is negative. When the transaction costs equal to 0%, we can find the average annual return of NWD, HSHO, HKCG and CUHK are positive and it is negative value for ICBC.

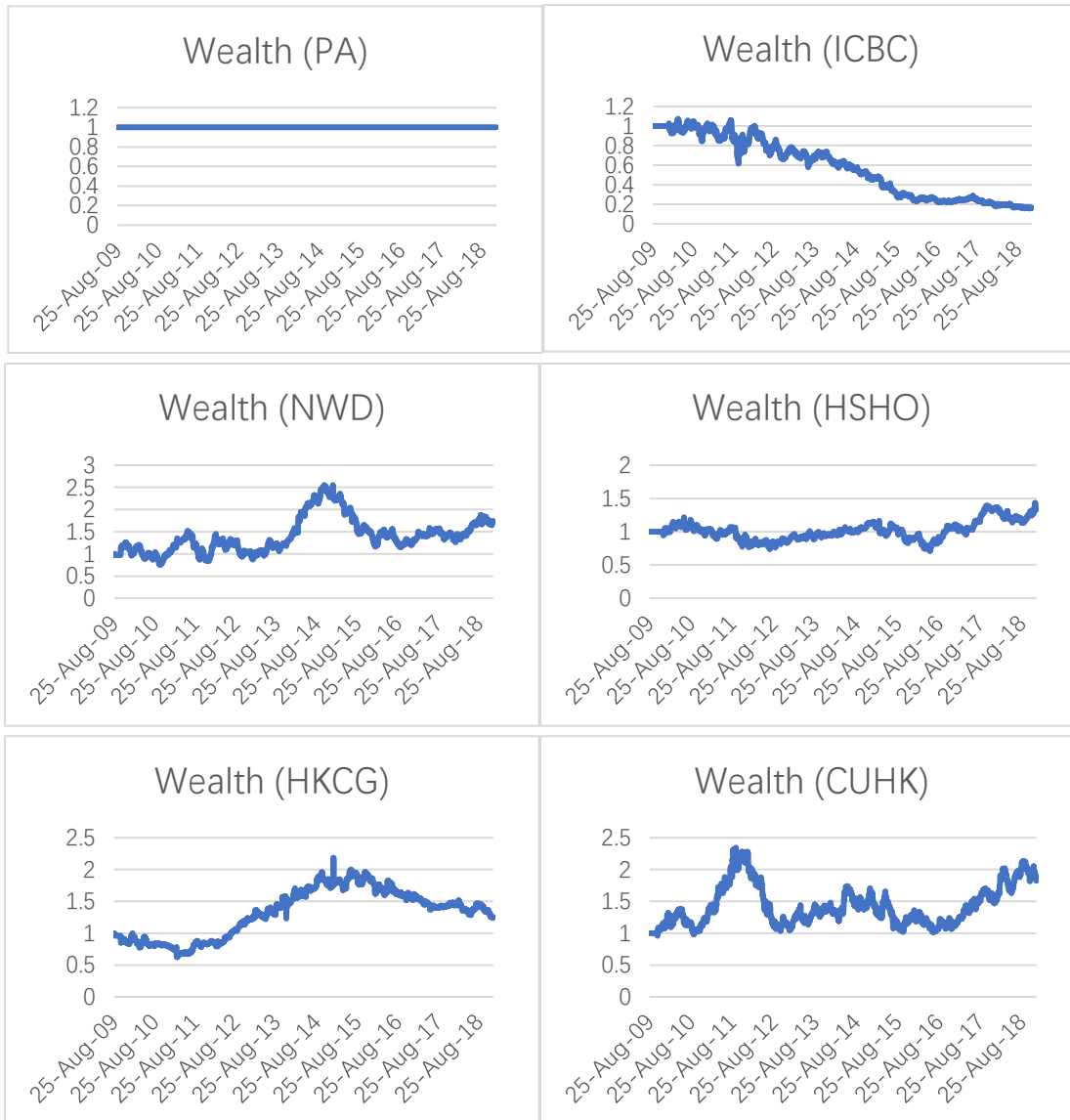
Table 4.5 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	0	0
ICBC	-16	-15.3
NWD	12.7	14
HSHO	9.8	11.3
HKCG	2.2	3.4
CUHK	6	7.3

From the results we have got, we can make the conclusion that the technical analysis works for

NWD, HSHO, HKCG and CUHK with the application of Bollinger bands, as the same time, technical analysis does not work for ICBC and PA (no trading action) when the transaction costs equal to 0.25%. When the transaction costs equal to 0%, the technical analysis works for NWD, HSHO, HKCG and CUHK, as for PA and ICBC, technical analysis does not work based on the application of Bollinger bands.

Figure 4.5 Wealth evolutions (transaction costs of 0.25%)



4.5 Verification of technical analysis by using Relative Strength Index

In this part, we apply the RSI to verify the technical analysis. We use the widely used parameters which is that the period of Relative Strength Index is equal to 14 days (based on Welles Wilder). We apply this period of RSI which equals to 14 days in calculation. According the formula we have introduced in chapter 3, we can get the signals. Then we calculate the value of the positions when the signal is generated, there are short position, long position and neutral position. We can get the final wealth that the traders would have owned at the end of the analytical period and we calculate the average annual return. Then comparing the final wealth and the initial wealth and confirming the value of average annual return, we verify that if we follow the signal it generated, we can make profits or not. Finally, we make the conclusion based on the process we mentioned above when the transaction costs are set to 0.25% and 0%. We have two trading systems of RSI, so we verify it separately.

4.5.1 Below-above system

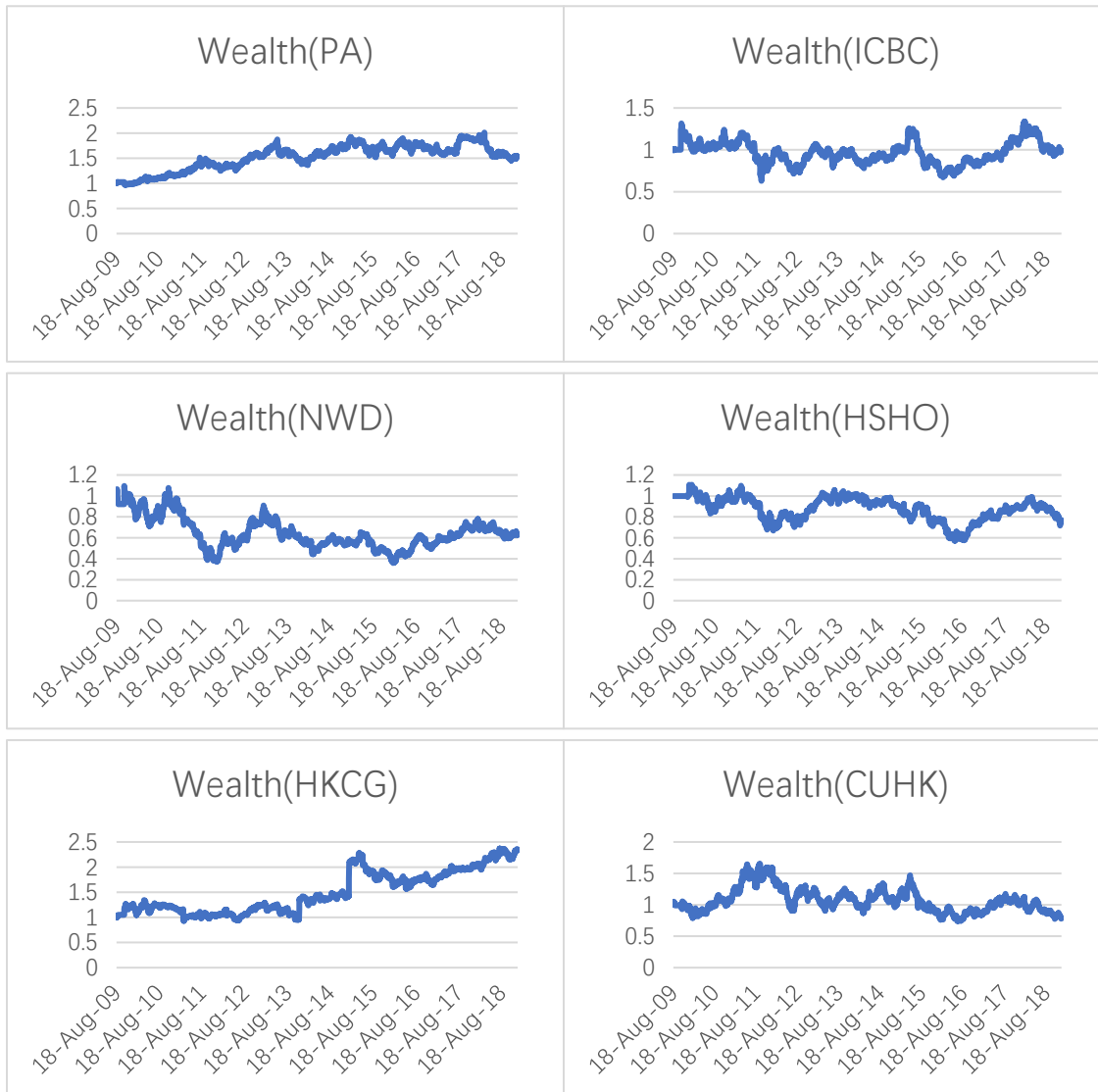
Table 4.6 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	4.2	4.3
ICBC	-0.1	-0.02
NWD	-4.4	-4.4
HSHO	-2.5	-1.9
HKCG	8.5	8.8
CUHK	-2.4	-2.4

In this part, we apply the auto trading system which the period of RSI equals to 14 days in this analytical period. We can get the value of the positions, then we calculate the final wealth at the end of analytical period and calculate the average annual return. We show the wealth evolutions when the transaction costs equal to 0.25% in figure 4.6. Because the wealth evolutions are roughly

the same when the transaction costs equal to 0.25% and 0%, we show the wealth evolutions when the transaction costs equal to 0% in Annex 5.

Figure 4.6 Wealth evolutions (transaction costs of 0.25%)



From the figure 4.6, we can find the final wealth of the PA and HKCG is higher than the initial wealth which we set to 1 HKD, it means that the final wealth of the traders would have owned is higher than 1HKD at the end of the analytical period. But the final wealth of ICBC, NWD, HSHO, and CUHK are lower than the initial wealth. Also, we show the average return when the transaction costs equal to 0.25% and 0% in table 4.6. we can find that no matter the transaction costs are, all values are negative except PA and HKCG.

From the results that we have got, we can make the conclusion that the technical analysis works for PA and HKCG based on the application of the Relative Strength Index when transaction costs equal to 0.25%. As for ICBC, NWD, HSHO and CUHK, the technical analysis does not work by the application of Relative Strength Index when the transaction costs equal to 0.25%. When the transaction costs equal to 0%, the technical analysis works for PA and HKCG. For ICBC, NWD, HSHO and CUHK, technical analysis does not work when the transaction costs are 0%.

4.5.2 Crossover system

In this part, we also apply the Auto Trading System which the period of RSI equals to 14 days in this analytical period. All the steps are same with sub-chapter 4.5.1. We show the wealth evolutions in figure 4.7 when the transaction costs equal to 0.25%. When the transaction costs are 0%, we show the wealth evolutions in Annex, because they are very similar.

From the figure 4.7, we can find that the value of final wealth for PA, ICBC, NWD, HSHO and CUHK is lower than the initial wealth which we set to 1 HKD, the value of final wealth for HKCG is higher than the initial wealth when the transaction costs equal to 1 HKD. We also calculate the average annual return, we show it when the transaction costs equal to 0.25% and 0% in the table 4.7.

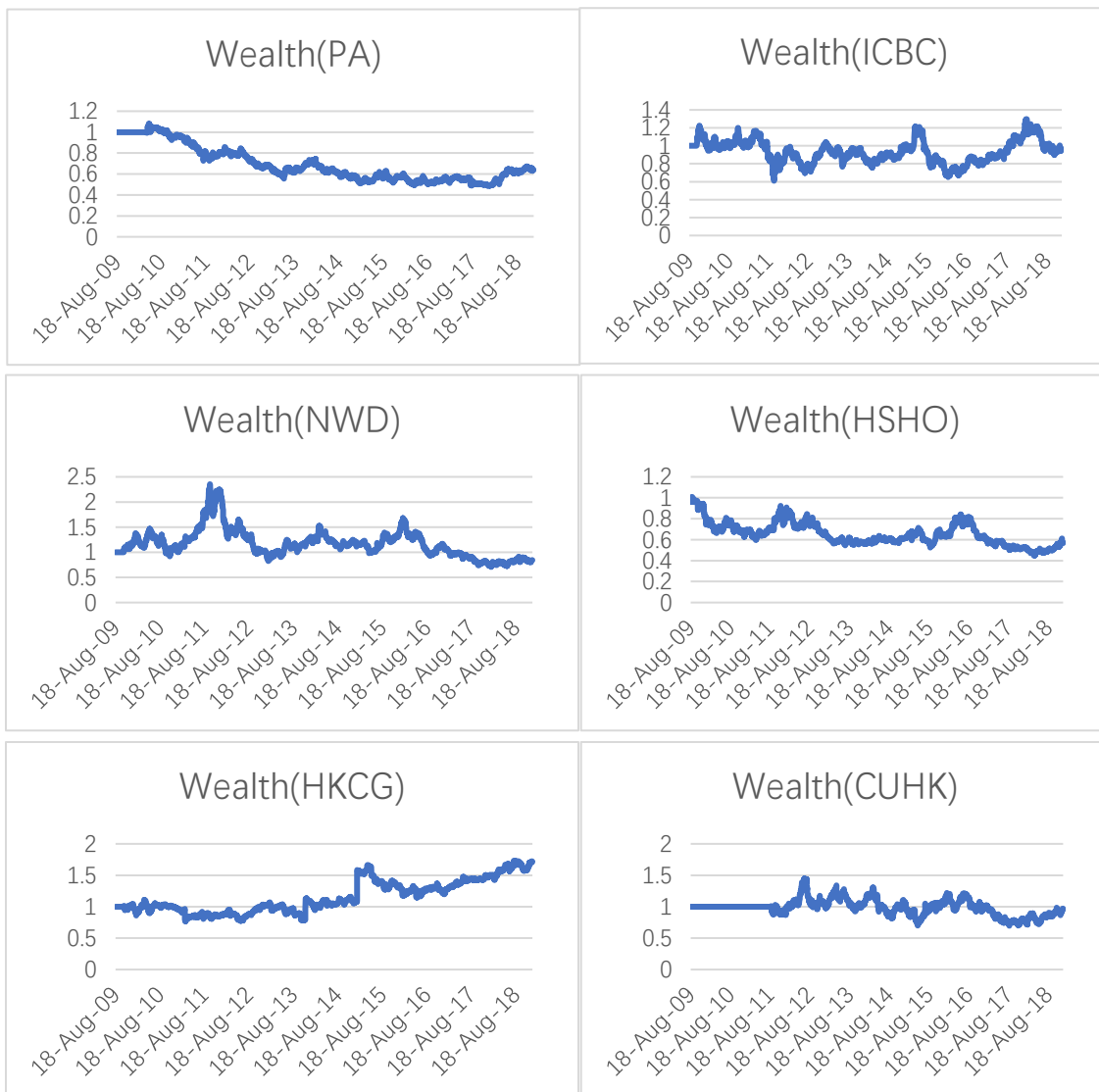
Table 4.7 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	-4.2	-4.1
ICBC	-0.4	-0.3
NWD	-1.6	-1.6
HSHO	-5.3	-4.8
HKCG	5.3	5.6
CUHK	-0.3	-0.2

From the table 4.7, we can find that when the transaction costs are 0.25%, the value of average

annual return for PA, ICBC, NWD, HSHO and CUHK are negative, which are -4.2%, -0.4%, -1.6%, -5.3% and -0.3%. But it is positive for HKCG. When transaction costs equal to 0%, we can find only the value of average annual return for HKCG is positive. Thus, we can make the conclusion that technical analysis of PA, ICBC, NWD, HSHO, and CUHK does not work efficiency by the application of RSI, when the transaction costs equal to 0.25%. As for HKCG, the technical analysis works when the transaction costs equal to 0.25%. When the transaction costs equal to 0%, the same situation as when the transaction costs equal to 0.25%, only for HKCG, technical analysis works well with the application of RSI.

Figure 4.7 Wealth evolutions (transaction costs of 0.25%)



4.6 Verification of technical analysis by using CR indicator

In this part, we make the verification of technical analysis by using CR indicator. The parameter of CR indicator we set is equal to 26 days.⁹ It is popular at present.

We apply the period of CR indicator which equal to 26 days in calculation. We get the signals based on the formula we have mentioned in chapter 3. Then we start calculating the value of the positions, after that, we can calculate the wealth, and we can find the final wealth which the traders would have owned at the end of the analytical period and we calculate the average annual return. We verify that if we follow the signal, we can make the profit or not by comparing the final wealth and the initial wealth. Finally, we can have the conclusion based on the process we mentioned above. We have mentioned in chapter three, we have two trading system of CR indicator, so we verify it one by one.

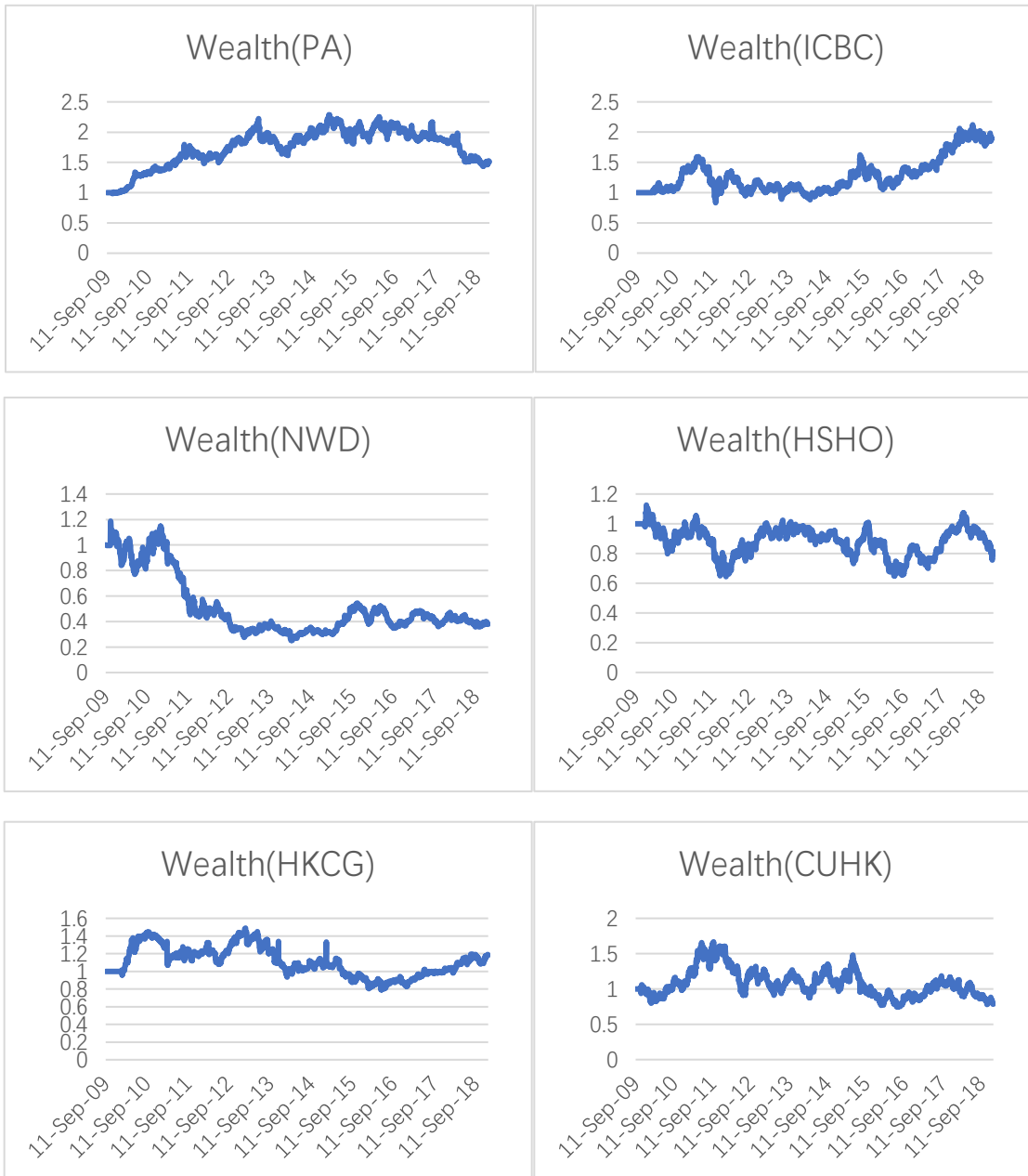
4.6.1 Below-above system

In this part, we apply the Auto Trading System which the period of CR indicator equals to 26 days in this analytical period. We can get the value of the positions, then we calculate the wealth during the analytical period. We show the wealth evolutions when the transaction costs equal to 0.25% in figure 4.8. When transaction costs equal to 0%, the wealth evolutions are shown in Annex 5

From the figure 4.8, we can find that the final wealth of PA, ICBC and HKCG are higher than the initial wealth we assume it equals to 1 HKD. As for the NWD, HSHO and CUHK, they are obviously lower than 1HKD. We also calculate the average annual return, we show it in table 4.8 when the transaction costs equal to 0.25% and 0%. From the table 4.8, we can find that the value of average return for PA, ICBC and HKCG are positive, but the value of average annual return for NWD, HSHO and CUHK are negative whether the transaction costs equal to 0.25% or 0%.

⁹ Source: Li (2015, p.259)

Figure 4.8 Wealth evolutions (transaction costs of 0.25%)



From the results we have got, we can make the conclusion that technical analysis works by the application of CR indicator whether the transaction costs equal to 0.25% or 0% for PA, ICBC and HKCG. As for NWD, HSHO and CUHK, technical analysis does not work with the application of CR indicator when the transaction costs are 0.25% or 0%.

Table 4.8 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	4.1	4.2
ICBC	6.3	6.7
NWD	-8.9	-8.5
HSHO	-2	-1.5
HKCG	1.6	1.8
CUHK	-2.3	-2.3

4.6.2 Crossover system

In this part, we apply the auto trading system which the period of CR indicator equals to 26 days in the analytical period. Then we show the wealth evolution when the transaction costs equal to 0.25% in figure 4.9. because they are very similar, when the transaction costs equal to 0%, we show them in the Annex.

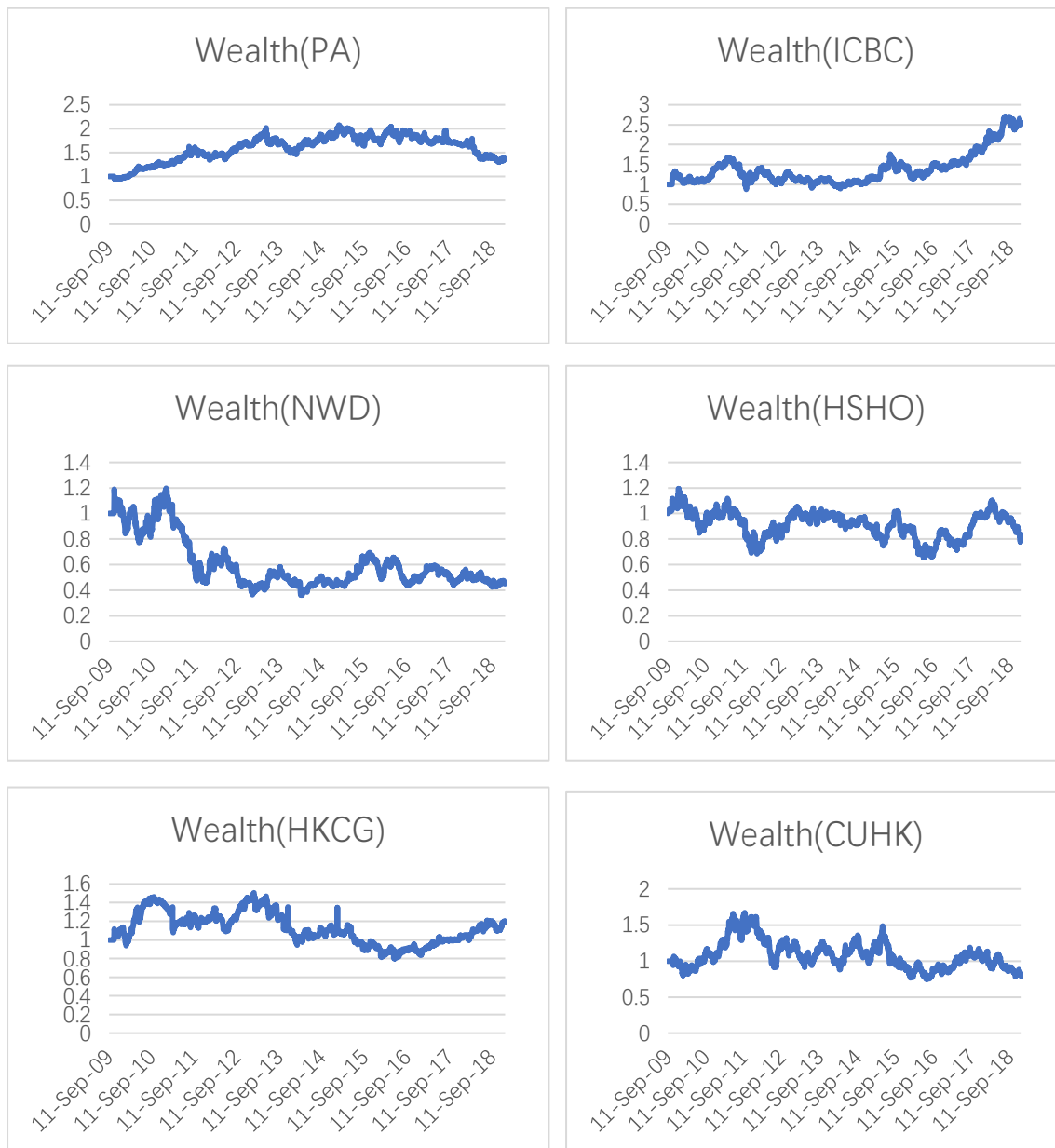
Table 4.9 Average annual return (unit: %)

	ARR(0.25)	ARR(0)
PA	3.1	3.2
ICBC	9.3	9.7
NWD	-7.4	-6.9
HSHO	-1.7	-1.2
HKCG	1.7	1.9
CUHK	-2.2	-2.2

From the figure 4.9, we can find the value of the final wealth for PA, ICBC, and HKCG are higher than the initial wealth which equals to 1HKD. As for the NWD, HSHO and CUHK, we can find the final wealth of them are lower than 1HKD. Then we calculate the average annual return of them when the transaction costs equal to 0.25% and 0%. We show the average annual return in the table

4.9.

Figure 4.9 Wealth evolutions (transaction costs of 0.25%)



From the table 4.9, we can find the value of average annual return of PA, ICBC, and HKCG are positive whether the transaction costs equal to 0.25% and 0%. As for NWD, HSHO and CUHK, we can find that the value of the average annual return is negative when the transaction costs equal to 0.25% and 0%. Thus, we can make the conclusion that the technical analysis works well for PA, ICBC and HKCG based on the application of CR indicator. As for the NWD, HSHO and CUHK,

the technical analysis does not work when the transaction costs equal to 0.25% and 0%.

5. Conclusion

Technical analysis refers to predicting price trends and strategies for determining investments by studying information from past financial markets. Firstly, we talk about what we have done in this thesis.

The goal of the thesis is to make the verification of the technical analysis based on the historical data, we select six stocks to analyze from Hang Seng Index.

In the first chapter, we introduce the structure of our thesis. In the second chapter, we introduced the classification of the financial market, economic function of the financial market, new trend in the financial market and the analytical approaches of the financial market. In the third chapter, we focused on the theory of technical analysis. We introduced the history and methods of technical analysis, then we introduced the automated trading system. In the fourth chapter, we combined the financial data of six stocks during July 29th, 2009 to December 31th, 2018 with certain theoretical analysis we mentioned in the third chapter to verify the technical analysis. We used four indicators which are moving average, Bollinger bands, relative strength index and CR indicator. We use the widely used parameters to analyze and our calculations are based on the two assumptions which are transaction cost is set to 0.25% and 0%. And now, we summarize the results we have got.

We find that technical analysis does not work for five stocks in verification by using moving average, the transaction costs have little effect on the results. For Bollinger bands, we can find that when we use crossover system to verify, technical analysis works better than below-above system. But in general, we can not get profit if we follow the signal its generates. For RSI, the below-above system is better than crossover system. But technical analysis does not work well for RSI. For the CR indicator, the situation is much better than the previous indicators for below-above system and crossover system, because technical analysis works for 3 stocks in 6 stocks, but it is still not enough. In a word, we can make the conclusion that these indicators are not suitable for the stocks we choose, because we can not get the profit when we follow the signal its generates, most time we loss.

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8. [http:// investing.com](http://investing.com)
9. <http://stockcharts.com>

List of Abbreviations

AG - Average gain

AL - Average loss

BB - Bollinger Bands

CR – CR indicator

CUHK – China Unicom Hong Kong Ltd

EMA - Exponential Moving Average

HSHO – HSBC Holdings PLC

HKCG – HK&China Gas

ICBC – Industrial and Commercial Bank of China

MA - Moving Average

MACD - Moving Average Convergence Divergence

NWC – New World Development. Co Ltd

PA – Power Assets

RSI - Relative Strength Index

SMA - Simple Moving Average

σ – Standard deviation

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Limin Shi

Student's name and surname

List of Annexes

Annex 1 Moving average

Annex 2 Bollinger bands

Annex 3 RSI

Annex 4 CR indicator

Annex 5 Wealth evolution when transaction cost equal to 0%

Annex 1 moving average

Date	Price	MA(20)	MA(120)	SIGNAL	Position	RETURN	WEALTH	AAR(0.25%)		AAR(0)
29-Jul-09	16.77					0.028026237		-0.132962755		-0.117581846
19-Aug-09	16.57					0.003017502				
20-Aug-09	16.62					-0.006016847				
21-Aug-09	16.52					0.016343826				
24-Aug-09	16.79					-0.004764741				
25-Aug-09	16.71	16.8575				-0.004189108				
26-Aug-09	16.64	16.851				0.021634615				
4-Nov-09	18.13	17.9325				-0.01103144				
5-Nov-09	17.93	17.9585				0.005577245				
6-Nov-09	18.03	17.99				0.016638935				
10-Nov-09	18.33	18.0365				0.008183306				
11-Nov-09	18.48	18.0905				0.008116883				
9-Dec-09	18.69	18.6005				0.008560728				
10-Dec-09	18.85	18.619				0.010079576				
11-Dec-09	19.04	18.6395				0.011029412				
14-Dec-09	19.25	18.672				0.008311688				
15-Dec-09	19.41	18.725				0.000515198				
16-Dec-09	19.42	18.777				-0.01184346				
17-Dec-09	19.19	18.805				-0.004168838				
18-Dec-09	19.11	18.826				-0.004709576				
21-Dec-09	19.02	18.839				-0.014721346				
5-Feb-10	16.3	17.953				0.019631902				
8-Feb-10	16.62	17.7955				0.027075812				
9-Feb-10	17.07	17.678				-0.007029877				
20-Dec-16	11.69	11.852	11.99083333	0	-1	-0.007698888	0.218610894		0.25600202	
21-Dec-16	11.6	11.8405	11.99525	0	-1	0	0.218610894		0.25600202	
10-Feb-17	12.13	11.861	11.9965	0	-1	-0.009068425	0.210594795		0.246614851	
13-Feb-17	12.02	11.8935	11.99641667	0	-1	0.006655574	0.209193166		0.244973487	
15-Feb-17	12.15	11.966	11.9985	0	-1	0.008230453	0.206614091		0.241953289	
16-Feb-17	12.25	12.006	12.00041667	1	1	0.008979592	0.207427054		0.244125931	
17-Feb-17	12.36	12.044	12.00283333	0	1	-0.004045307	0.206587948		0.243138366	
24-Nov-17	13.47	13.4575	13.45091667	0	1	-0.002227171	0.225551749		0.265457323	
27-Nov-17	13.44	13.455	13.45275	0	1	0.000744048	0.22571957		0.265654836	
28-Nov-17	13.45	13.45	13.453	-1	-1	-0.005204461	0.225759847		0.267037426	

29-Nov-17	13.38	13.4425	13.44975	0	-1	0.002989537	0.22508493		0.266239108	
30-Nov-17	13.42	13.441	13.44658333	0	-1	0.002235469	0.224581759		0.265643938	
1-Dec-17	13.45	13.4425	13.44366667	0	-1	0.005947955	0.223245957		0.2640639	
4-Dec-17	13.53	13.447	13.44116667	1	1	0.005173688	0.223278957		0.265430084	
5-Dec-17	13.6	13.4525	13.43925	0	1	0.011029412	0.225741592		0.268357622	
15-Oct-18	14.92	15.605	15.46641667	0	1	0	0.24495015		0.291192416	
16-Oct-18	14.92	15.557	15.46783333	0	1	-0.001340483	0.244621798		0.290802078	
18-Oct-18	14.9	15.513	15.46925	0	1	0	0.244621798		0.290802078	
19-Oct-18	14.9	15.47	15.471	-1	-1	0.008053691	0.241438431		0.288460047	
22-Oct-18	15.02	15.439	15.47375	0	-1	-0.013315579	0.244653324		0.29230106	
29-Nov-18	15.28	15.011	15.43025	0	-1	0.001308901	0.236409595		0.282451814	
30-Nov-18	15.3	15.035	15.42941667	0	-1	0.011764706	0.233628305		0.279128851	
11-Dec-18	15.78	15.283	15.43333333	0	-1	0.00887199	0.226928817		0.271124597	
12-Dec-18	15.92	15.332	15.43816667	0	-1	0.005025126	0.225788471		0.269762162	
13-Dec-18	16	15.383	15.44483333	0	-1	-0.005	0.226917414		0.271110972	
14-Dec-18	15.92	15.437	15.4525	0	-1	0.002512563	0.226347269		0.270429789	
17-Dec-18	15.96	15.489	15.46166667	1	1	-0.001253133	0.224933308		0.270090905	
18-Dec-18	15.94	15.545	15.47033333	0	1	-0.003764115	0.224086633		0.269074251	
19-Dec-18	15.88	15.59	15.48066667	0	1	0	0.224086633		0.269074251	
21-Dec-18	15.88	15.67	15.4975	0	1	0.005037783	0.225215533		0.270429789	
24-Dec-18	15.96	15.7	15.506	0	1	0.006265664	0.226626658		0.272124211	
27-Dec-18	16.06	15.744	15.51333333	0	1	0.00622665	0.228037783		0.273818633	
28-Dec-18	16.16	15.788	15.52083333	0	1	-0.006188119	0.226626658		0.272124211	
31-Dec-18	16.06	15.827	15.5285	0	1	0	0.226626658		0.272124211	

Annex 2 Bollinger bands

Date	Price	SMA(20)	UPPER	LOWER	signal	position	return	wealth	ARR(0.25%)		0
29-Jul-09	16.77		2	2			0.028026237		0.098288613		0.127507035
30-Jul-09	17.24						0.00812065				
31-Jul-09	17.38						-0.008055236				
3-Aug-09	17.24						-0.019721578				
4-Aug-09	16.9						-0.013017751				
5-Aug-09	16.68						0.011390887				
6-Aug-09	16.87						-0.003556609				
7-Aug-09	16.81						0.011302796				
10-Aug-09	17						-0.001764706				
11-Aug-09	16.97						-0.011785504				
12-Aug-09	16.77						0.010733453				
13-Aug-09	16.95						0.004719764				
14-Aug-09	17.03						-0.028772754				
17-Aug-09	16.54						0.015114873				
18-Aug-09	16.79						-0.013103038				
19-Aug-09	16.57						0.003017502				
20-Aug-09	16.62						-0.006016847				
21-Aug-09	16.52						0.016343826				
24-Aug-09	16.79						-0.004764741				
25-Aug-09	16.71	16.8575	17.32065764	16.39434236	0	0	-0.004189108	1		1	
26-Aug-09	16.64	16.851	17.32246156	16.37953844	0	0	0.021634615	1		1	
27-Aug-09	17	16.839	17.28157881	16.39642119	0	0	0.011176471	1		1	
28-Aug-09	17.19	16.8295	17.23151866	16.42748134	0	0	-0.023269343	1		1	
31-Aug-09	16.79	16.807	17.16225202	16.45174798	0	0	0.031566409	1		1	
1-Sep-09	17.32	16.828	17.24674097	16.40925903	-1	-1	0.005196305	0.992316686		0.994803695	
2-Sep-09	17.41	16.8645	17.34759316	16.38140684	-1	-1	-0.000574383	0.992886655		0.995375093	
11-Sep-09	17.4	16.891	17.42757805	16.35442195	0	-1	0	0.992886655		0.995375093	
18-Sep-09	17.4	16.9205	17.49923915	16.34176085	0	-1	0	0.992886655		0.995375093	
24-Aug-10	19.02	19.224	19.72942655	18.71857345	0	1	-0.01787592	0.826512294		0.849612727	
25-Aug-10	18.68	19.187	19.73607559	18.63792441	0	1	-0.006423983	0.821202793		0.84415483	
3-Sep-10	19.02	18.942	19.46090654	18.42309346	0	1	0.002103049	0.843325713		0.86689607	
7-Sep-10	19.44	18.929	19.42304048	18.43495952	-1	-1	0.004115226	0.852316468		0.880540814	
8-Sep-10	19.52	18.941	19.47832299	18.40367701	-1	-1	-0.00102459	0.853189743		0.881443007	
9-Sep-10	19.5	18.952	19.5244893	18.3795107	0	-1	-0.004102564	0.856690008		0.885059184	
10-Sep-10	19.42	18.972	19.57947346	18.36452654	0	-1	0.001029866	0.855807732		0.884147691	

15-Sep-10	19.49	19.0325	19.74532186	18.31967814	0	-1	-0.004617753	0.857491404		0.885887118	
17-Sep-10	19.5	19.1005	19.82907326	18.37192674	0	-1	0.004102564	0.849571566		0.877705015	
22-Sep-10	19.4	19.1985	19.91550139	18.48149861	0	-1	0	0.857396022		0.885788577	
27-Sep-10	19.5	19.2865	19.87926555	18.69373445	0	-1	-0.004102564	0.856475846		0.884837929	
13-Oct-10	19.02	19.4155	19.71392755	19.11707245	1	1	0.011566772	0.863531081		0.896609846	
14-Oct-10	19.24	19.3985	19.69624318	19.10075682	0	1	-0.003118503	0.860838156		0.893813766	
19-Oct-10	18.9	19.336	19.72517348	18.94682652	1	1	0.012698413	0.859042873		0.891949712	
20-Oct-10	19.14	19.314	19.69517712	18.93282288	0	1	-0.003134796	0.856349949		0.889153631	
22-Oct-10	19.02	19.278	19.68373883	18.87226117	0	1	-0.006309148	0.848271176		0.88076539	
25-Oct-10	18.9	19.253	19.68627128	18.81972872	0	1	0.001058201	0.849168817		0.881697417	
17-Dec-10	18.58	18.8755	19.13980853	18.61119147	1	1	0.010764263	0.842885327		0.875173228	
7-Mar-11	17.9	17.539	17.96934405	17.10865595	0	1	-0.007821229	0.797105613		0.827639858	
31-Aug-12	16.58	16.579	16.94923776	16.20876224	0	-1	0.002412545	0.969348908		1.042423253	
3-Sep-12	16.62	16.599	16.93071675	16.26728325	0	-1	0	0.969348908		1.042423253	
4-Sep-12	16.62	16.6155	16.91539832	16.31560168	0	-1	-0.010830325	0.979847271		1.053713036	
28-Jan-16	11.95	12.2285	12.68083947	11.77616053	0	1	-0.031799163	2.37585297		2.867164883	
28-Apr-16	12.45	11.909	12.45069733	11.36730267	0	-1	-0.030522088	2.310049023		2.80176189	
4-May-16	12.07	11.9695	12.50273447	11.43626553	0	-1	-0.001657001	2.313074218		2.805431023	
23-May-16	10.85	12.0145	12.64845505	11.38054495	1	1	-0.008294931	2.511110293		3.060925326	
24-May-16	10.76	11.9385	12.76278818	11.11421182	1	1	0.000929368	2.513444038		3.063770052	
1-Jun-16	10.76	11.5025	12.67264315	10.33235685	0	1	0.011152416	2.53911524		3.095062039	
6-Jun-16	10.98	11.333	12.45546336	10.21053664	0	1	0.010018215	2.588123898		3.154801288	
20-Jun-16	11.72	11.096	11.76486172	10.42713828	0	1	-0.015358362	2.693142451		3.282813965	
21-Jun-16	11.54	11.1305	11.81602097	10.44497903	0	1	-0.024263432	2.627797574		3.203161633	
12-Oct-16	12.1	12.1395	12.39574012	11.88325988	0	1	0.002479339	2.892898641		3.561836685	
3-Nov-16	12.43	12.211	12.41446007	12.00753993	-1	-1	-0.002413516	2.956742744		3.658737436	
11-Nov-16	12.68	12.31	12.69899871	11.92100129	0	-1	-0.011829653	2.923694374		3.617842668	
14-Nov-16	12.53	12.3305	12.72049872	11.94050128	0	-1	-0.003990423	2.935361151		3.63227939	
17-Nov-16	12.61	12.3945	12.77399835	12.01500165	0	-1	-0.008723236	2.930236751		3.625938346	
18-Jan-17	11.6	11.4335	11.74309813	11.12390187	0	1	0.030172414	2.980621465		3.706819579	
23-Jan-17	11.9	11.47	11.91654227	11.02345773	0	-1	0.006722689	2.958048535		3.69723315	
27-Jan-17	12.02	11.57	12.17890065	10.96109935	0	-1	-0.004159734	2.960439644		3.700221772	
1-Feb-17	11.97	11.6005	12.22517512	10.97582488	0	-1	0	2.960439644		3.700221772	
3-Feb-17	11.97	11.6645	12.29627449	11.03272551	0	-1	0.004177109	2.948073564		3.68476554	
15-Feb-17	12.15	11.966	12.28932027	11.64267973	0	-1	0.008230453	2.89192073		3.614580715	
5-May-17	12.69	12.8725	13.20715654	12.53784346	0	-1	0.001576044	2.779607412		3.474201504	
8-May-17	12.71	12.8715	13.20796842	12.53503158	0	-1	0.005507474	2.764298796		3.455067428	

9-May-17	12.78	12.874	13.20695045	12.54104955	0	-1	0	2.764298796		3.455067428	
10-May-17	12.78	12.874	13.20695045	12.54104955	0	-1	0.004694836	2.751320867		3.438846454	
18-May-17	12.94	12.8585	13.17901677	12.53798323	0	-1	0	2.729600395		3.411698269	
19-May-17	12.94	12.851	13.15614914	12.54585086	0	-1	0.00309119	2.721162681		3.401152061	
19-Dec-18	15.88	15.59	16.21756673	14.96243327	0	-1	0	2.682829431		3.525606168	
20-Dec-18	15.88	15.631	16.2207084	15.0412916	0	-1	0	2.682829431		3.525606168	
21-Dec-18	15.88	15.67	16.21560059	15.12439941	0	-1	0.005037783	2.669313918		3.507844928	
24-Dec-18	15.96	15.7	16.24007407	15.15992593	0	-1	0.006265664	2.652588893		3.48586595	
27-Dec-18	16.06	15.744	16.24974302	15.23825698	0	-1	0.00622665	2.63607215		3.464160683	
28-Dec-18	16.16	15.788	16.27747319	15.29852681	0	-1	-0.006188119	2.652384478		3.48559732	
31-Dec-18	16.06	15.827	16.2704907	15.3835093	0	-1	0	2.652384478		3.48559732	

Annex3 RSI

Date	Price	change	gain	loss	aveg gian	aveg loss	rs	RSI	singal	position	return	wealth	arr(0.25)		
29-Jul-09	11.04										0.008152174		-0.023572024		-0.023572024
30-Jul-09	11.13	0.09	0	0							0.005390836				
31-Jul-09	11.19	0.06	0	0							0.00178731				
3-Aug-09	11.21	0.02	0	0							-0.002676182				
4-Aug-09	11.18	-0.03	0	0.03							0.02236136				
5-Aug-09	11.43	0.25	0	0							0.076990376				
6-Aug-09	12.31	0.88	0	0							-0.051177904				
7-Aug-09	11.68	-0.63	0	0.63							0.016267123				
10-Aug-09	11.87	0.19	0	0							-0.02021904				
11-Aug-09	11.63	-0.24	0	0.24							-0.044711952				
12-Aug-09	11.11	-0.52	0	0.52							0.01620162				
13-Aug-09	11.29	0.18	0	0							-0.012400354				
14-Aug-09	11.15	-0.14	0	0.14							-0.039461883				
17-Aug-09	10.71	-0.44	0	0.44							0.000933707				
18-Aug-09	10.72	0.01	0	0	0	0.142857143	0	0	1	1	-0.019589552	1		1	
19-Aug-09	10.51	-0.21	0	0.21	0	0.147653061	0	0	1	1	0.034253092	1.034253092		1.034253092	
20-Aug-09	10.87	0.36	0	0	0	0.137106414	0	0	1	1	-0.009199632	1.024738344		1.024738344	
21-Aug-09	10.77	-0.1	0	0.1	0	0.134455956	0	0	1	1	0.025998143	1.051379638		1.051379638	
24-Aug-09	11.05	0.28	0	0	0	0.124851959	0	0	1	1	-0.016289593	1.034253092		1.034253092	
19-Jan-11	11.56	-0.1	0	0.1	0	0.042176674	0	0	1	1	0.032871972	1.136060894		1.136060894	
20-Jan-11	11.94	0.38	0	0	0	0.039164054	0	0	1	1	0.010050251	1.147478592		1.147478592	
21-Jan-11	12.06	0.12	0	0	0	0.036366622	0	0	1	1	0.023217247	1.174119886		1.174119886	
24-Jan-11	12.34	0.28	0	0	0	0.033769006	0	0	1	1	-0.006482982	1.166508088		1.166508088	
25-Jan-11	12.26	-0.08	0	0.08	0	0.03707122	0	0	1	1	-0.003262643	1.162702188		1.162702188	
26-Jan-11	12.22	-0.04	0	0.04	0	0.037280419	0	0	1	1	0.022913257	1.189343482		1.189343482	
2-Feb-11	12.96	0.08	0	0	0	0.03369615	0	0	1	1	0	1.233111323		1.233111323	
7-Feb-11	12.96	0	0	0	0	0.031289283	0	0	1	1	-0.021604938	1.206470029		1.206470029	
8-Feb-11	12.68	-0.28	0	0.28	0	0.049054334	0	0	1	1	0.047318612	1.263558516		1.263558516	
9-Feb-11	13.28	0.6	0	0	0	0.045550453	0	0	1	1	0.001506024	1.265461465		1.265461465	
10-Feb-11	13.3	0.02	0	0	0	0.042296849	0	0	1	1	-0.006015038	1.257849667		1.257849667	
11-Feb-11	13.22	-0.08	0	0.08	0	0.044989931	0	0	1	1	0.019667171	1.282588011		1.282588011	
14-Feb-11	13.48	0.26	0	0	0	0.041776365	0	0	1	1	0.00148368	1.284490961		1.284490961	
15-Feb-11	13.5	0.02	0	0	0	0.038792339	0	0	1	1	-0.031111111	1.24452902		1.24452902	
30-May-14	11.44	-0.12	0	0.12	6.E-07	0.099579737	6.E-06	0.000601338	1	1	0.01048951	1.099904853		1.099904853	
3-Jun-14	11.56	0.12	0	0	6.E-07	0.092466898	6.E-06	0.000601338	1	1	0.003460208	1.103710752		1.103710752	

4-Jun-14	11.6	0.04	0	0	5.E-07	0.08586212	6.E-06	0.000601338	1	1	-0.024137931	1.077069458		1.077069458
5-Jun-14	11.32	-0.28	0	0.28	5.E-07	0.099729111	5.E-06	5.E-04	1	1	0.024734982	1.103710752		1.103710752
6-Jun-14	11.6	0.28	0	0	4.E-07	0.092605603	5.E-06	5.E-04	1	1	0.006896552	1.11132255		1.11132255
9-Jun-14	11.68	0.08	0	0	4.E-07	0.085990917	5.E-06	5.E-04	1	1	-0.011986301	1.098001903		1.098001903
10-Jun-14	11.54	-0.14	0	0.14	4.E-07	0.089848709	4.E-06	4.E-04	1	1	-0.017331023	1.078972407		1.078972407
11-Jun-14	11.34	-0.2	0	0.2	4.E-07	0.097716658	4.E-06	4.E-04	1	1	0	1.078972407		1.078972407
12-Jun-14	11.34	0	0	0	3.E-07	0.090736897	4.E-06	4.E-04	1	1	0.014109347	1.094196004		1.094196004
13-Jun-14	11.5	0.16	0	0	3.E-07	0.08425569	4.E-06	4.E-04	1	1	0.020869565	1.117031399		1.117031399
23-Jun-14	12.02	0.06	0	0	2.E-07	0.058166887	4.E-06	4.E-04	1	1	-0.001663894	1.141769743		1.141769743
24-Jun-14	12	-0.02	0	0.02	2.E-07	0.055440681	4.E-06	4.E-04	1	1	0.005	1.147478592		1.147478592
25-Jun-14	12.06	0.06	0	0	2.E-07	0.051480632	4.E-06	4.E-04	1	1	0.001658375	1.149381541		1.149381541
26-Jun-14	12.08	0.02	0	0	2.E-07	0.047803444	4.E-06	4.E-04	1	1	-0.011589404	1.136060894		1.136060894
27-Jun-14	11.94	-0.14	0	0.14	2.E-07	0.054388913	3.E-06	3.E-04	1	1	-0.018425461	1.115128449		1.115128449
30-Jun-14	11.72	-0.22	0	0.22	1.E-07	0.066218276	2.E-06	2.E-04	1	1	-0.001706485	1.1132255		1.1132255
2-Jul-14	11.7	-0.02	0	0.02	1.E-07	0.062916971	2.E-06	2.E-04	1	1	-0.006837607	1.105613701		1.105613701
13-Jun-17	11.38	0.16	0	0	7.E-31	0.049387798	1.E-29	0	1	1	0.003514938	1.086584206		1.086584206
16-Jun-17	11.46	0	0	0	5.E-31	0.039542636	1.E-29	0	1	1	-0.012216405	1.077069458		1.077069458
19-Jun-17	11.32	-0.14	0	0.14	5.E-31	0.046718162	1.E-29	0	1	1	-0.01590106	1.059942912		1.059942912
31-Oct-17	11.18	-0.12	0	0.12	5.E-34	0.046980907	1.E-32	0	1	1	0.019677996	1.084681256		1.084681256
1-Nov-17	11.4	0.22	0	0	5.E-34	0.043625128	1.E-32	0	1	1	-0.015789474	1.06755471		1.06755471
2-Nov-17	11.22	-0.18	0	0.18	4.E-34	0.05336619	8.E-33	0	1	1	-0.012477718	1.054234063		1.054234063
3-Nov-17	11.08	-0.14	0	0.14	4.E-34	0.05955432	7.E-33	0	1	1	0.034296029	1.090390105		1.090390105
10-Nov-17	12	0.28	0	0	3.E-34	0.045093603	6.E-33	0	1	1	-0.01	1.130352046		1.130352046
13-Nov-17	11.88	-0.12	0	0.12	3.E-34	0.05044406	5.E-33	0	1	1	0.001683502	1.132254995		1.132254995
14-Nov-17	11.9	0.02	0	0	2.E-34	0.046840913	5.E-33	0	1	1	0.003361345	1.136060894		1.136060894
15-Nov-17	11.94	0.04	0	0	2.E-34	0.043495133	5.E-33	0	1	1	0.020100503	1.158896289		1.158896289
16-Nov-17	12.18	0.24	0	0	2.E-34	0.040388338	5.E-33	0	1	1	-0.022988506	1.132254995		1.132254995
24-Apr-18	10.5	0.24	0	0	9.E-38	0.057521609	2.E-36	0	1	1	-0.00952381	0.989533777		0.989533777
25-Apr-18	10.4	-0.1	0	0.1	8.E-38	0.06055578	1.E-36	0	1	1	0.032692308	1.02188392		1.02188392
26-Apr-18	10.74	0.34	0	0	8.E-38	0.056230367	1.E-36	0	1	1	0.001862197	1.02378687		1.02378687
27-Apr-18	10.76	0.02	0	0	7.E-38	0.052213912	1.E-36	0	1	1	-0.013011152	1.010466223		1.010466223
30-Apr-18	10.62	-0.14	0	0.14	7.E-38	0.058484347	1.E-36	0	1	1	0.001883239	1.012369172		1.012369172
2-May-18	10.64	0.02	0	0	6.E-38	0.054306894	1.E-36	0	1	1	0.026315789	1.039010466		1.039010466
15-May-18	10.68	-0.06	0	0.06	3.E-38	0.068310895	5.E-37	0	1	1	0.020599251	1.037107517		1.037107517
16-May-18	10.9	0.22	0	0	3.E-38	0.063431546	5.E-37	0	1	1	0	1.037107517		1.037107517
24-May-18	11.4	0.08	0	0	2.E-38	0.043790699	5.E-37	0	1	1	-0.014035088	1.069457659		1.069457659
25-May-18	11.24	-0.16	0	0.16	2.E-38	0.052091363	4.E-37	0	1	1	-0.026690391	1.040913416		1.040913416

28-May-18	10.94	-0.3	0	0.3	2.E-38	0.069799123	2.E-37	0	1	1	0.023765996	1.06565176		1.06565176	
29-May-18	11.2	0.26	0	0	2.E-38	0.064813471	2.E-37	0	1	1	-0.007142857	1.058039962		1.058039962	
26-Oct-18	8.84	-0.08	0	0.08	8.E-42	0.063499234	1.E-40	0	1	1	0.003393665	0.843958135		0.843958135	
29-Oct-18	8.87	0.03	0	0	7.E-42	0.058963575	1.E-40	0	1	1	-0.010146561	0.835394862		0.835394862	

Annex 4 CR indicator

Date	Price	Open	High	Low	Vol.	Change %	M	BS	SS	SS'	CR(26)	SIGNAL	POSITION	RETURN	WEALTH	AAR		aar
29-Jul-09	16.77	16.84	16.86	16.51	-	2.76%	16.71							0.03		0.02		0.02
30-Jul-09	17.24	16.96	17.43	16.85	-	2.80%	17.17	0.72	-0.14	0.00				0.01				
31-Jul-09	17.38	17.27	17.49	17.13	-	0.81%	17.33	0.32	0.04	0.04				-0.01				
3-Aug-09	17.24	17.21	17.45	17.03	-	-0.81%	17.24	0.12	0.30	0.30				-0.02				
4-Aug-09	16.9	17.23	17.35	16.9	-	-1.97%	17.05	0.11	0.34	0.34				-0.01				
5-Aug-09	16.68	16.89	17.06	16.64	-	-1.30%	16.79	0.01	0.41	0.41				0.01				
6-Aug-09	16.87	16.59	16.95	16.59	-	1.14%	16.80	0.16	0.20	0.20				0.00				
7-Aug-09	16.81	16.74	16.85	16.61	-	-0.36%	16.76	0.05	0.19	0.19				0.01				
10-Aug-09	17	16.86	17.09	16.85	-	1.13%	16.98	0.33	-0.09	0.00				0.00				
11-Aug-09	16.97	16.91	17.01	16.83	-	-0.18%	16.94	0.03	0.15	0.15				-0.01				
12-Aug-09	16.77	16.71	16.87	16.57	-	-1.18%	16.74	-0.07	0.37	0.37				0.01				
13-Aug-09	16.95	16.82	17.07	16.75	-	1.07%	16.92	0.33	-0.01	0.00				0.00				
14-Aug-09	17.03	17.12	17.13	16.86	-	0.47%	17.01	0.21	0.06	0.06				-0.03				
17-Aug-09	16.54	16.6	16.61	16.51	-	-2.88%	16.55	-0.40	0.50	0.50				0.02				
18-Aug-09	16.79	16.75	16.97	16.61	-	1.51%	16.79	0.42	-0.06	0.00				-0.01				
19-Aug-09	16.57	16.69	16.94	16.5	-	-1.31%	16.67	0.15	0.29	0.29				0.00				
20-Aug-09	16.62	16.69	16.71	16.53	-	0.30%	16.62	0.04	0.14	0.14				-0.01				
21-Aug-09	16.52	16.5	16.63	16.34	-	-0.60%	16.50	0.01	0.28	0.28				0.02				
24-Aug-09	16.79	16.85	16.85	16.72	-	1.63%	16.79	0.35	-0.22	0.00				0.00				
25-Aug-09	16.71	16.59	16.79	16.43	-	-0.48%	16.64	0.00	0.36	0.36				0.00				
26-Aug-09	16.64	16.71	16.76	16.59	-	-0.42%	16.66	0.12	0.05	0.05				0.02				
27-Aug-09	17	16.83	17.09	16.83	-	2.16%	16.97	0.43	-0.17	0.00				0.01				
28-Aug-09	17.19	17.19	17.21	17.01	-	1.12%	17.14	0.24	-0.04	0.00				-0.02				
31-Aug-09	16.79	16.71	16.81	16.63	-	-2.33%	16.74	-0.33	0.51	0.51				0.03				
1-Sep-09	17.32	16.81	17.35	16.81	-	3.16%	17.16	0.61	-0.07	0.00				0.01				
2-Sep-09	17.41	17.35	17.49	17.09	-	0.52%	17.33	0.33	0.07	0.07				0.00				
11-Sep-09	17.4	17.4	17.4	17.4	-	-0.06%	17.40	0.07	-0.07	0.00	85.08	0	0	0.00	1.00		1.00	
18-Sep-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	78.45	0	0	0.00	1.00		1.00	
24-Sep-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	81.55	0	0	0.00	1.00		1.00	
7-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	86.22	0	0	0.00	1.00		1.00	
8-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	97.06	0	0	0.00	1.00		1.00	
15-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	98.43	0	0	0.00	1.00		1.00	
19-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	103.61	0	0	0.00	1.00		1.00	

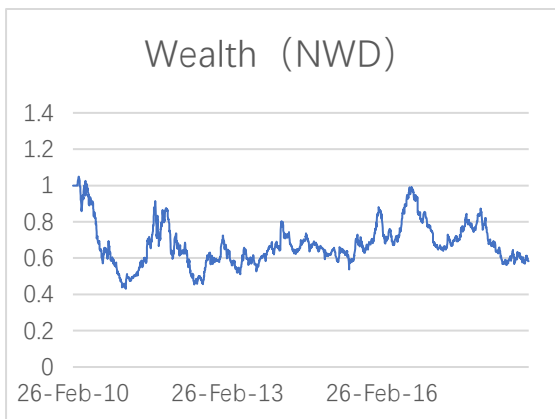
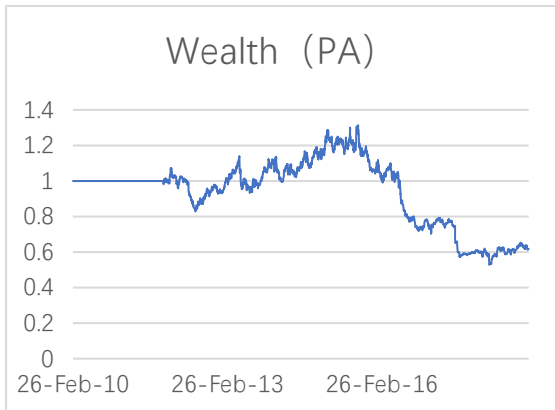
20-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	91.59	0	0	0.00	1.00		1.00	
21-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	95.68	0	0	0.00	1.00		1.00	
22-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	114.18	0	0	0.00	1.00		1.00	
23-Oct-09	17.4	17.4	17.4	17.4	-	0.00%	17.40	0.00	0.00	0.00	99.41	0	0	0.12	1.00		1.00	
26-Oct-09	19.46	19.46	19.46	19.46	-	11.84%	19.46	2.06	-2.06	0.00	186.78	0	0	-0.02	1.00		1.00	
27-Oct-09	19.11	19.31	19.33	19.11	-	-1.80%	19.18	-0.13	0.35	0.35	213.19	0	0	0.00	1.00		1.00	
28-Oct-09	19.11	19.14	19.26	18.99	-	0.00%	19.12	0.08	0.19	0.19	179.61	0	0	-0.01	1.00		1.00	
29-Oct-09	18.84	19.08	19.29	18.77	-	-1.41%	18.97	0.17	0.35	0.35	175.80	0	0	0.00	1.00		1.00	
30-Oct-09	18.85	19.19	19.34	18.73	-	0.05%	18.97	0.37	0.24	0.24	182.61	0	0	-0.02	1.00		1.00	
15-Jan-10	18.53	18.78	18.92	18.53	-	-1.59%	18.66	0.00	0.39	0.39	92.63	0	0	0.00	1.00		1.00	
18-Jan-10	18.61	18.45	18.71	18.34	-	0.43%	18.55	0.05	0.32	0.32	82.22	0	0	-0.01	1.00		1.00	
19-Jan-10	18.51	18.67	18.67	18.41	-	-0.54%	18.53	0.12	0.14	0.14	75.96	0	0	-0.01	1.00		1.00	
20-Jan-10	18.29	18.46	18.55	18.21	-	-1.19%	18.35	0.02	0.32	0.32	68.34	0	0	-0.01	1.00		1.00	
21-Jan-10	18.19	18.28	18.35	18.19	-	-0.55%	18.24	0.00	0.16	0.16	57.26	0	0	-0.02	1.00		1.00	
22-Jan-10	17.85	17.98	18.05	17.51	-	-1.87%	17.80	-0.19	0.73	0.73	46.49	0	0	0.02	1.00		1.00	
25-Jan-10	18.23	17.72	18.23	17.72	-	2.13%	18.06	0.43	0.08	0.08	56.44	0	0	-0.02	1.00		1.00	
26-Jan-10	17.85	18.14	18.15	17.65	-	-2.08%	17.88	0.09	0.41	0.41	52.23	0	0	-0.02	1.00		1.00	
27-Jan-10	17.44	17.84	17.84	17.33	-	-2.30%	17.54	-0.04	0.55	0.55	45.85	0	0	-0.01	1.00		1.00	
28-Jan-10	17.28	17.39	17.5	17.21	-	-0.92%	17.33	-0.04	0.33	0.33	46.72	0	0	-0.02	1.00		1.00	
29-Jan-10	16.95	17.07	17.17	16.87	-	-1.91%	17.00	-0.16	0.46	0.46	38.08	1	1	0.01	1.01		1.01	
1-Feb-10	17.12	16.94	17.17	16.67	-	1.00%	16.99	0.17	0.33	0.33	35.65	1	1	0.01	1.02		1.02	
2-Feb-10	17.25	17.11	17.35	17.03	-	0.76%	17.21	0.36	-0.04	0.00	37.28	1	1	-0.01	1.00		1.01	
11-Feb-10	17.01	17.06	17.15	16.99	-	0.35%	17.05	0.26	-0.10	0.00	25.87	1	1	-0.01	0.99		1.00	
12-Feb-10	16.89	16.94	16.99	16.89	-	-0.71%	16.92	-0.06	0.16	0.16	23.00	1	1	0.01	1.01		1.01	
17-Feb-10	17.13	17.03	17.19	17.02	-	1.42%	17.11	0.27	-0.10	0.00	24.56	1	1	0.01	1.01		1.02	
18-Feb-10	17.22	17.31	17.37	17.15	-	0.53%	17.25	0.26	-0.04	0.00	29.99	1	1	-0.01	1.00		1.00	
19-Feb-10	17.01	17.07	17.08	16.96	-	-1.22%	17.02	-0.17	0.29	0.29	31.35	1	1	0.02	1.02		1.02	
29-May-12	15.14	15.12	15.27	15.07	5.29M	0.00%	15.16	0.14	0.06	0.06	38.05	1	1	0.00	1.12		1.14	
30-May-12	15.16	15.11	15.19	15.09	6.71M	0.13%	15.15	0.03	0.07	0.07	40.28	0	1	-0.01	1.11		1.13	
31-May-12	15.06	15.11	15.21	15.04	13.00M	-0.66%	15.10	0.06	0.11	0.11	43.55	0	1	0.00	1.11		1.13	
26-Oct-12	18.64	18.59	18.68	18.41	4.25M	-0.21%	18.58	0.19	0.08	0.08	179.21	0	1	0.00	1.37		1.40	
1-Nov-12	18.73	18.82	18.82	18.45	5.00M	0.00%	18.67	0.17	0.20	0.20	137.63	0	1	-0.01	1.36		1.39	
3-Jan-13	19.45	19.45	19.5	19.27	5.89M	1.14%	19.41	0.26	-0.03	0.00	130.07	0	1	-0.01	1.42		1.45	
6-Mar-13	17.89	17.85	17.98	17.77	7.49M	0.45%	17.88	0.09	0.12	0.12	45.14	0	1	0.00	1.32		1.35	
7-Mar-13	17.93	17.89	18.02	17.81	7.05M	0.22%	17.92	0.14	0.07	0.07	45.46	0	1	0.02	1.34		1.37	
8-Mar-13	18.22	17.93	18.31	17.93	12.48M	1.62%	18.15	0.39	-0.01	0.00	47.49	0	1	0.01	1.35		1.38	
11-Apr-13	18.76	18.51	18.8	18.51	8.23M	0.91%	18.69	0.15	0.14	0.14	142.05	0	1	0.00	1.38		1.41	

12-Apr-13	18.76	18.84	18.97	18.68	5.87M	0.00%	18.80	0.28	0.01	0.01	154.19	0	1	0.01	1.39		1.42	
15-Apr-13	18.88	18.88	19.01	18.84	4.56M	0.64%	18.91	0.21	-0.04	0.00	164.08	0	1	-0.01	1.38		1.41	
25-Jul-13	18	17.93	18.02	17.8	5.28M	0.39%	17.94	0.24	-0.02	0.00	104.75	0	1	0.00	1.33		1.36	
26-Jul-13	18.02	17.8	18.09	17.8	6.54M	0.11%	17.97	0.15	0.14	0.14	109.49	0	1	0.01	1.33		1.37	
31-Jul-13	18.11	18.09	18.23	17.89	8.31M	1.12%	18.08	0.24	0.10	0.10	141.72	0	1	0.00	1.33		1.36	
8-Oct-13	16.71	16.91	16.91	16.69	11.36M	-1.30%	16.77	0.02	0.20	0.20	122.85	0	1	0.01	1.24		1.27	
9-Oct-13	16.8	16.78	16.96	16.71	9.05M	0.54%	16.82	0.19	0.06	0.06	130.97	0	1	0.00	1.23		1.26	
10-Oct-13	16.73	16.73	16.8	16.71	5.91M	-0.42%	16.75	-0.02	0.11	0.11	108.46	0	1	-0.01	1.23		1.25	
8-Dec-14	14.69	15.04	15.17	14.68	21.02M	-3.29%	14.85	-0.09	0.58	0.58	96.83	0	1	0.02	1.10		1.13	
9-Dec-14	14.98	14.78	15.01	14.66	15.23M	1.97%	14.88	0.16	0.19	0.19	98.19	0	1	-0.01	1.09		1.11	
10-Dec-14	14.76	15.12	15.12	14.73	12.83M	-1.47%	14.87	0.24	0.15	0.15	98.01	0	1	-0.01	1.08		1.11	
11-Dec-14	14.68	14.89	14.89	14.64	11.13M	-0.54%	14.74	0.02	0.23	0.23	88.52	0	1	0.01	1.09		1.12	
22-Dec-14	14.43	14.53	14.53	14.3	8.49M	-0.82%	14.42	-0.06	0.29	0.29	66.40	0	1	-0.01	1.05		1.08	
17-Jan-15	14.48	14.71	14.73	14.46	6.62M	-1.09%	14.56	0.07	0.20	0.20	82.48	0	1	0.00	1.07		1.10	
19-Jan-15	14.55	14.56	14.64	14.46	9.37M	0.48%	14.55	0.08	0.10	0.10	87.90	0	1	0.00	1.07		1.09	
10-Sep-15	11.9	12.12	12.12	11.85	14.63M	-0.25%	11.96	0.10	0.17	0.17	58.58	0	1	0.01	0.88		0.90	
11-Sep-15	11.98	12.18	12.18	11.92	13.31M	0.67%	12.03	0.22	0.04	0.04	63.64	0	1	0.00	0.88		0.90	
23-Sep-15	12.6	12.43	12.66	12.31	13.44M	1.78%	12.52	0.26	0.09	0.09	80.63	0	1	-0.02	0.91		0.93	
24-Sep-15	12.35	12.63	12.63	12.2	17.46M	-1.98%	12.39	0.11	0.32	0.32	72.31	0	1	0.00	0.91		0.93	
25-Sep-15	12.35	12.38	12.51	12.31	13.50M	0.00%	12.39	0.12	0.08	0.08	75.47	0	1	0.00	0.91		0.93	
29-Sep-15	12.35	12.35	12.48	12.28	9.25M	0.00%	12.37	0.09	0.11	0.11	79.11	0	1	0.01	0.92		0.94	
27-Oct-15	12.79	12.61	12.83	12.61	8.67M	0.63%	12.74	0.15	0.07	0.07	105.41	0	1	0.01	0.95		0.97	
28-Oct-15	12.94	12.79	12.96	12.78	11.53M	1.17%	12.89	0.22	-0.04	0.00	125.06	0	1	0.01	0.96		0.98	
28-Jun-16	10.96	11.07	11.09	10.88	14.13M	0.46%	10.98	0.13	0.08	0.08	95.56	0	1	0.01	0.82		0.83	
29-Jun-16	11.07	11.09	11.12	10.91	8.12M	1.00%	11.03	0.14	0.07	0.07	106.98	0	1	0.00	0.82		0.84	
30-Jun-16	11.12	11.14	11.19	11.02	11.29M	0.45%	11.11	0.16	0.01	0.01	115.80	0	1	0.00	0.82		0.84	
11-Jul-16	11.47	11.4	11.54	11.37	13.92M	0.97%	11.46	0.21	-0.04	0.00	130.63	0	1	0.02	0.86		0.88	
12-Jul-16	11.69	11.55	11.7	11.52	27.83M	1.92%	11.64	0.24	-0.06	0.00	135.35	0	1	0.02	0.87		0.89	
20-Jul-16	11.65	11.8	11.8	11.49	13.89M	1.39%	11.65	0.26	0.05	0.05	100.92	0	1	0.00	0.86		0.88	
9-Aug-16	11.97	12.03	12.05	11.92	11.83M	-0.91%	11.98	0.02	0.11	0.11	152.33	0	1	-0.01	0.88		0.90	
23-Aug-16	12.07	12.07	12.08	12.02	9.42M	0.42%	12.06	0.08	-0.02	0.00	119.81	0	1	0.00	0.89		0.91	
24-Aug-16	12.13	12.02	12.17	12.02	11.22M	0.50%	12.11	0.11	0.04	0.04	151.09	0	1	0.00	0.89		0.91	
25-Aug-16	12.07	12.12	12.13	12.02	8.40M	-0.49%	12.07	0.02	0.09	0.09	132.91	0	1	0.00	0.88		0.91	
4-Oct-17	13.36	13.33	13.4	13.33	7.29M	-0.30%	13.36	0.01	0.06	0.06	64.47	0	1	0.00	0.98		1.00	
6-Oct-17	13.33	13.36	13.36	13.31	6.58M	-0.22%	13.33	0.00	0.05	0.05	64.25	0	1	0.01	0.99		1.01	
9-Oct-17	13.4	13.33	13.42	13.31	7.63M	0.53%	13.38	0.09	0.02	0.02	67.34	0	1	0.00	0.99		1.01	
10-May-18	14.95	14.76	14.98	14.73	30.40M	1.49%	14.89	0.26	-0.01	0.00	93.22	0	1	0.01	1.11		1.14	

11-May-18	15.11	14.8	15.11	14.8	19.83M	1.07%	15.01	0.22	0.09	0.09	95.23	0	1	-0.01	1.11		1.13	
16-May-18	15.05	14.98	15.07	14.98	7.17M	0.07%	15.03	0.05	0.04	0.04	119.44	0	1	0.00	1.11		1.14	
6-Jun-18	15.55	15.47	15.6	15.4	13.97M	0.13%	15.52	0.07	0.13	0.13	177.92	0	1	0.00	1.14		1.17	
7-Jun-18	15.49	15.53	15.55	15.45	9.28M	-0.39%	15.50	0.03	0.07	0.07	173.68	0	1	-0.01	1.13		1.16	
8-Jun-18	15.4	15.44	15.49	15.35	21.87M	-0.58%	15.41	-0.01	0.15	0.15	162.86	0	1	0.00	1.14		1.16	
4-Oct-18	15.58	15.76	15.76	15.58	24.94M	-0.64%	15.64	0.05	0.13	0.13	75.47	0	1	0.00	1.14		1.17	
5-Oct-18	15.54	15.58	15.7	15.52	10.68M	-0.26%	15.59	0.06	0.12	0.12	70.15	0	1	0.00	1.15		1.17	
8-Oct-18	15.58	15.7	15.7	15.52	11.02M	0.26%	15.60	0.11	0.07	0.07	73.66	0	1	0.00	1.15		1.17	
12-Oct-18	15.1	15.1	15.18	15.02	20.20M	-0.53%	15.10	-0.11	0.27	0.27	48.02	0	1	-0.01	1.10		1.12	
15-Oct-18	14.92	15.2	15.2	14.92	27.47M	-1.19%	15.01	0.10	0.18	0.18	44.91	0	1	0.00	1.10		1.12	
16-Oct-18	14.92	14.82	14.94	14.8	18.28M	0.00%	14.89	-0.07	0.21	0.21	40.24	0	1	0.00	1.10		1.12	
18-Oct-18	14.9	15	15.1	14.9	11.15M	-0.13%	14.97	0.21	-0.01	0.00	45.27	0	1	0.00	1.10		1.12	
19-Oct-18	14.9	14.9	14.96	14.84	8.82M	0.00%	14.90	-0.01	0.13	0.13	40.08	0	1	0.01	1.11		1.13	
5-Nov-18	14.96	14.78	14.96	14.7	18.11M	0.94%	14.87	0.11	0.15	0.15	54.22	0	1	-0.01	1.10		1.12	
6-Nov-18	14.88	14.92	14.94	14.78	14.19M	-0.53%	14.87	0.07	0.09	0.09	56.20	0	1	0.01	1.10		1.13	
7-Nov-18	14.96	14.86	14.98	14.82	9.90M	0.54%	14.92	0.11	0.05	0.05	57.54	0	1	0.00	1.10		1.12	
6-Dec-18	15.76	15.7	15.8	15.62	12.55M	0.38%	15.73	0.18	0.00	0.00	162.33	0	1	0.01	1.17		1.20	
7-Dec-18	15.9	15.82	15.9	15.74	17.45M	0.89%	15.85	0.17	-0.01	0.00	175.70	0	1	-0.02	1.15		1.17	
10-Dec-18	15.6	15.86	15.9	15.56	11.59M	-1.89%	15.69	0.05	0.29	0.29	160.66	0	1	0.01	1.16		1.19	
11-Dec-18	15.78	15.72	15.86	15.66	26.42M	1.15%	15.77	0.17	0.03	0.03	171.53	0	1	0.01	1.17		1.20	
19-Dec-18	15.88	15.8	15.9	15.74	16.71M	-0.38%	15.84	-0.15	0.31	0.31	156.29	0	1	0.00	1.17		1.20	
20-Dec-18	15.88	15.96	15.96	15.82	14.16M	0.00%	15.89	0.12	0.02	0.02	165.58	0	1	0.00	1.17		1.20	
21-Dec-18	15.88	15.9	16	15.86	14.48M	0.00%	15.91	0.11	0.03	0.03	176.90	0	1	0.01	1.18		1.20	
24-Dec-18	15.96	15.96	15.98	15.9	16.37M	0.50%	15.95	0.07	0.01	0.01	174.65	0	1	0.01	1.18		1.21	
27-Dec-18	16.06	15.92	16.06	15.88	17.16M	0.63%	16.00	0.11	0.07	0.07	186.59	0	1	0.01	1.19		1.22	
28-Dec-18	16.16	16.1	16.16	16.02	13.51M	0.62%	16.11	0.16	-0.02	0.00	189.71	0	1	-0.01	1.18		1.21	
31-Dec-18	16.06	16.16	16.18	16.02	11.57M	-0.62%	16.09	0.07	0.09	0.09	188.52	0	1	0.00	1.18		1.21	

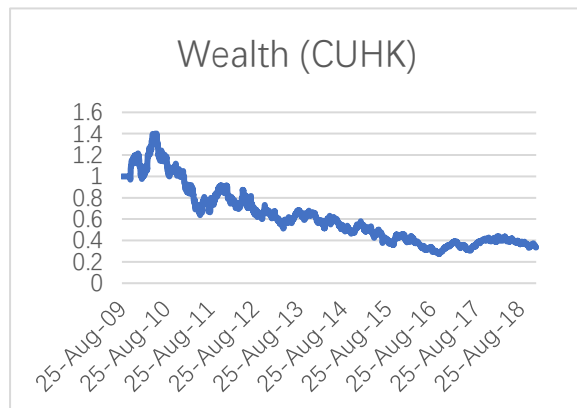
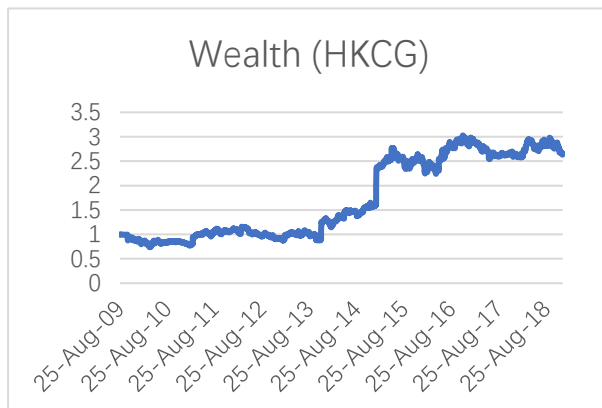
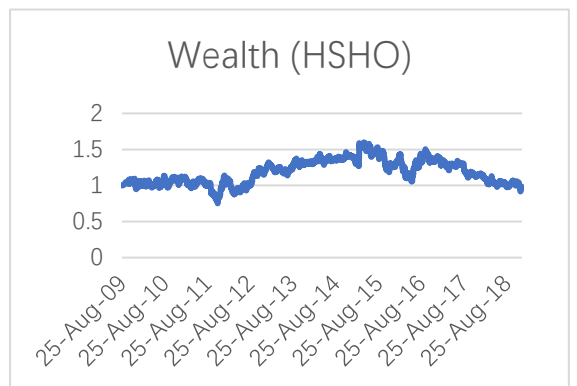
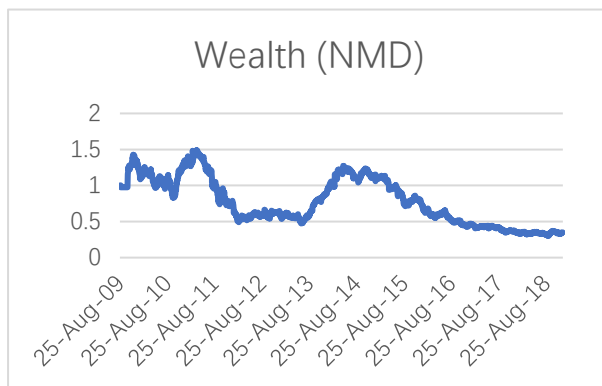
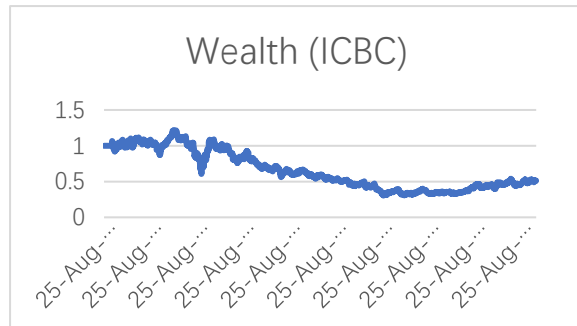
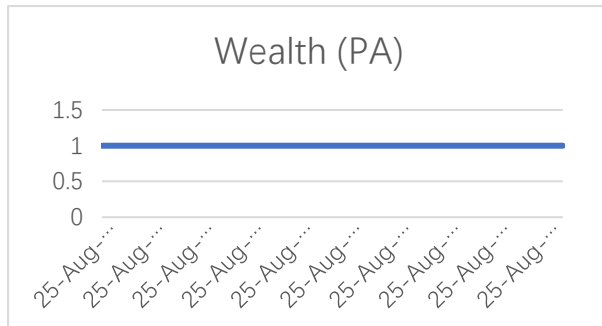
Annex 5 Wealth evolution when transaction cost equal to 0%

Moving average(0.%)

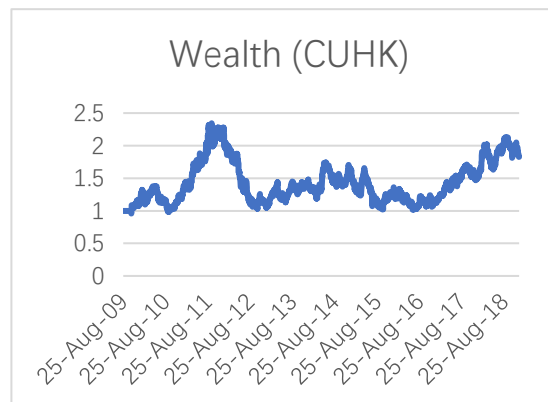
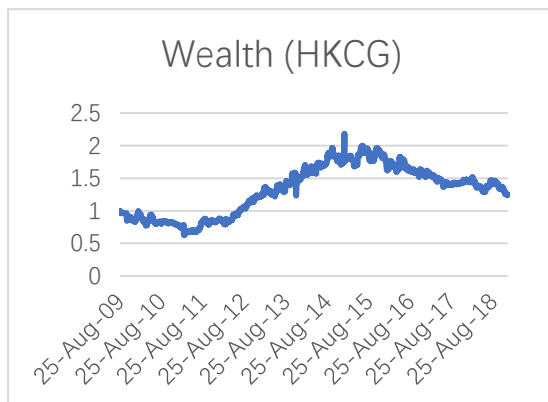
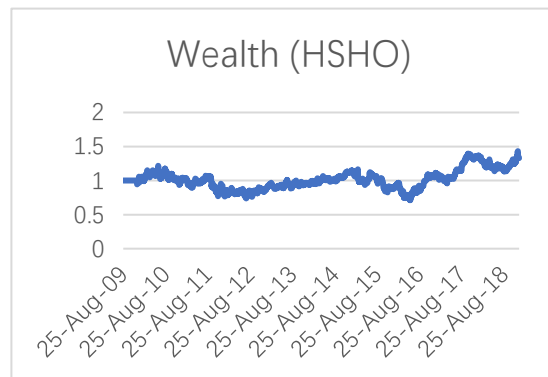
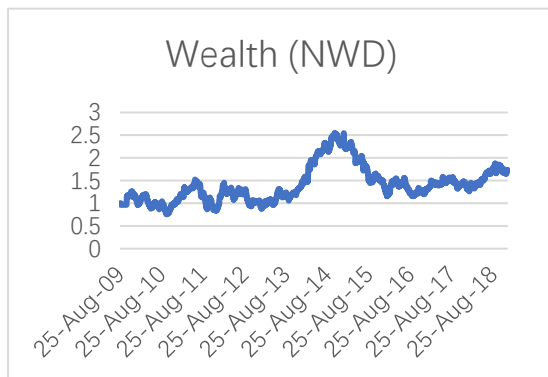
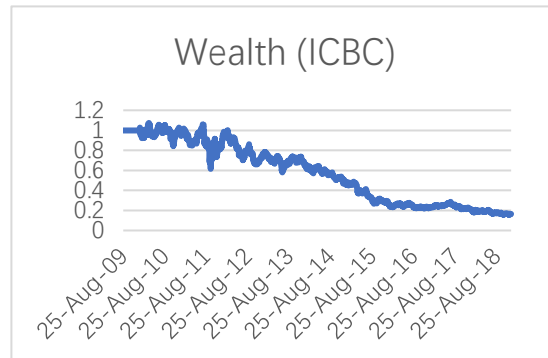
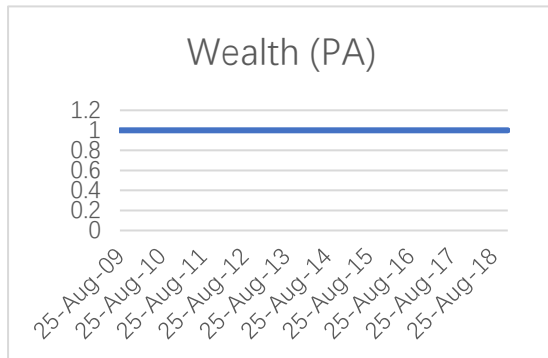


Bollinger bands

Below-above system

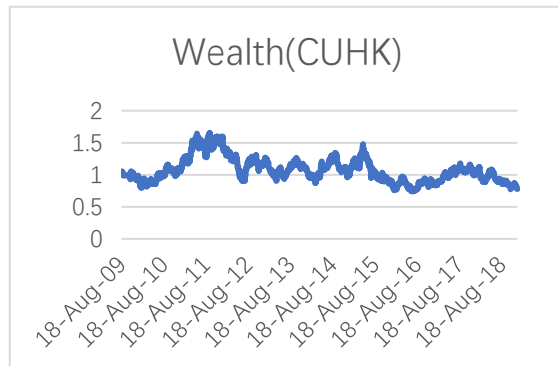
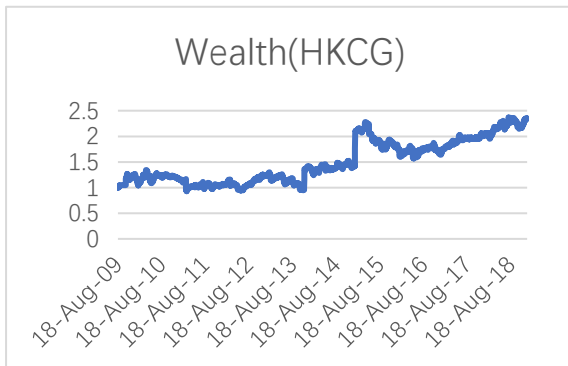
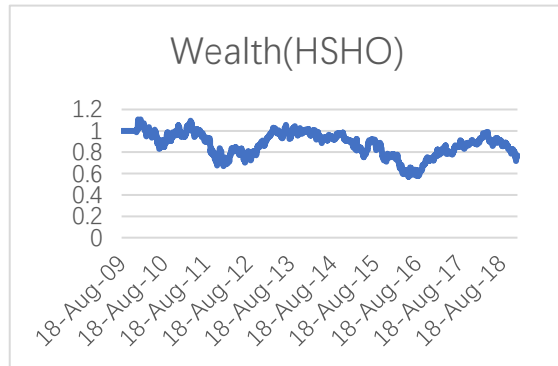
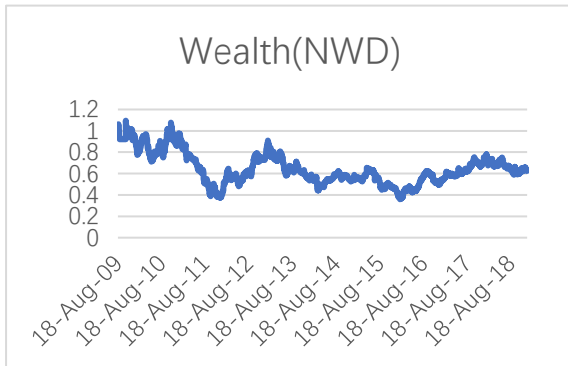
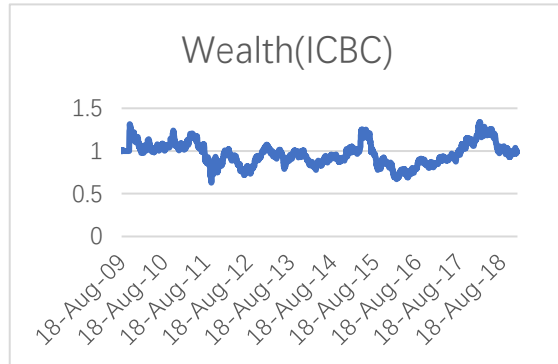
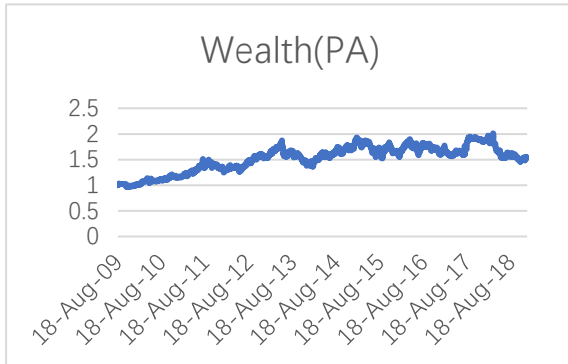


Crossover system

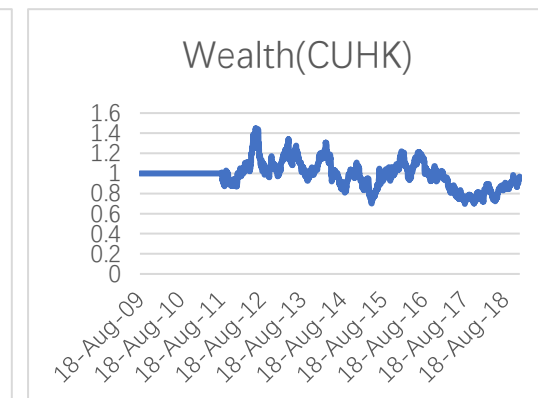
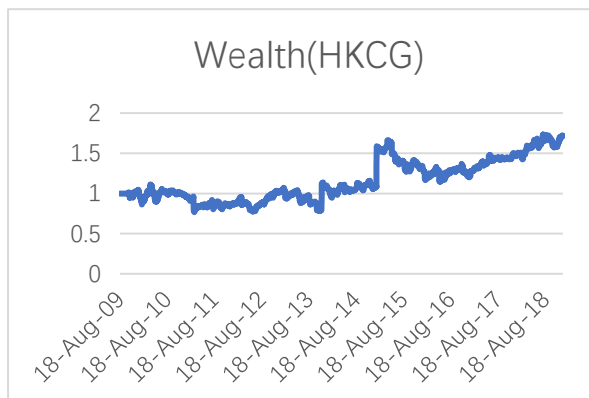
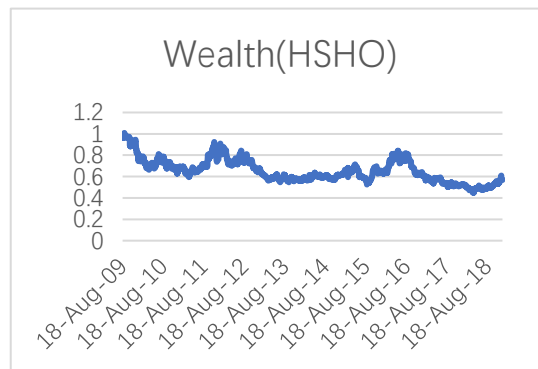
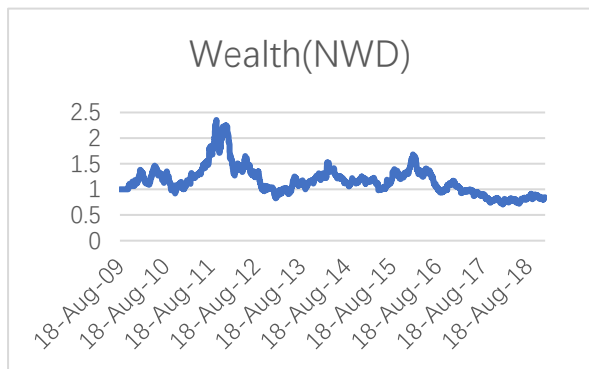
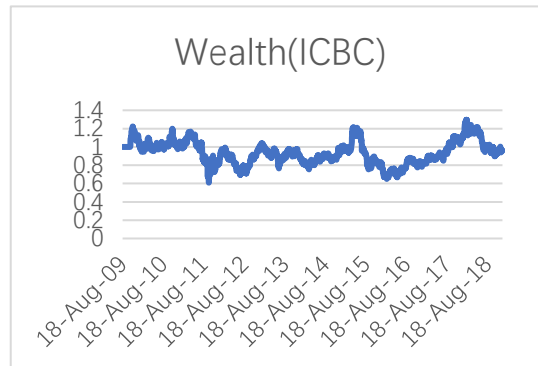
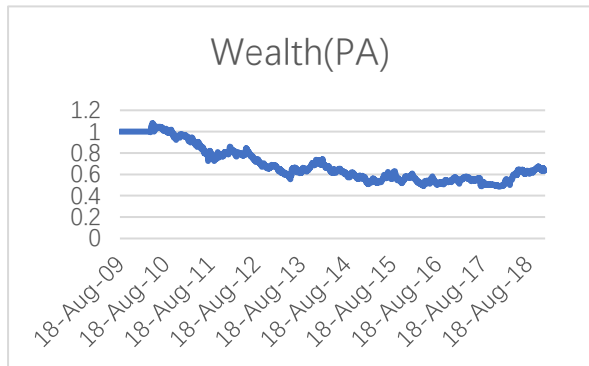


RSI

Below-above system

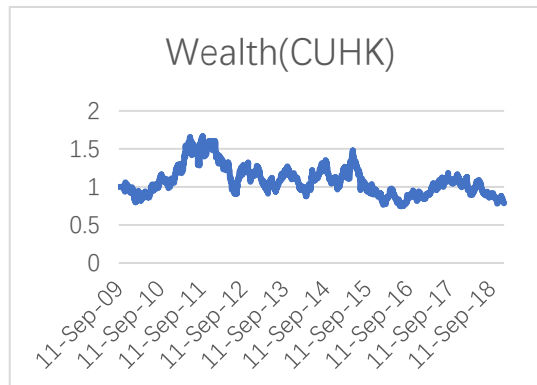
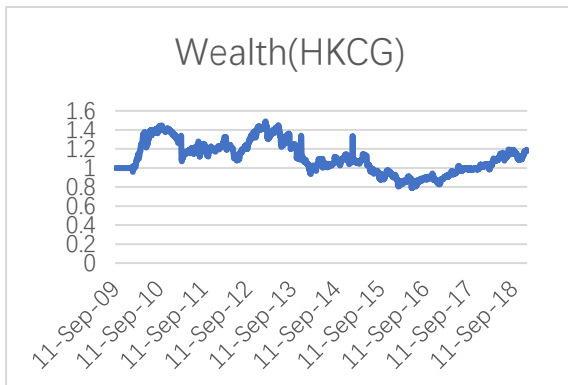
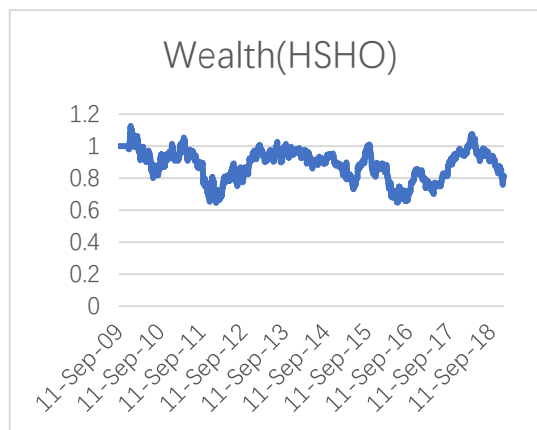
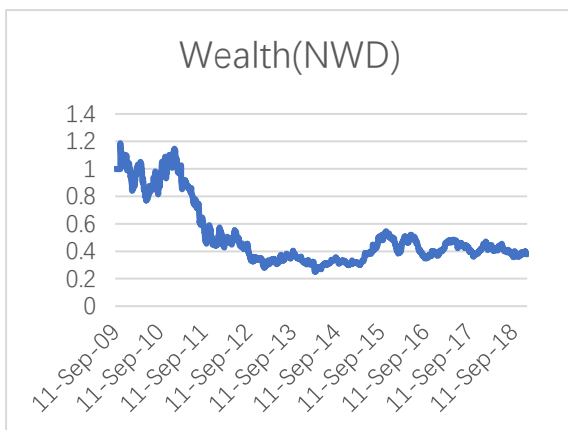
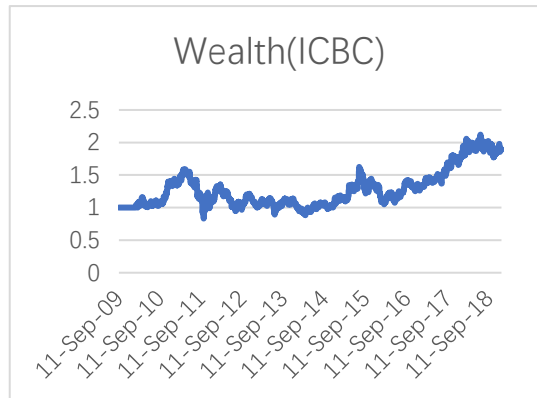
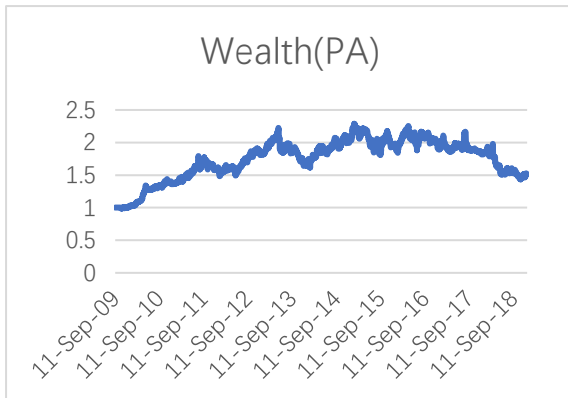


Crossover system



CR

Below-above system



Crossover system

