Cognitive Ability and Psychological Biases
---Perspective from Chinese stock individual investors

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Abstract

The rapid development of Chinese economy stimulates the prosperity of its stock market. Within only 20 years, the scale of capitalization of Chinese stock market has become the second largest in the world, only after USA. However, the stock market and investors are too young that many collective irrational behaviors appear which aggravate market fluctuation. With the development of empirical studies in financial market, more and more systematically irrational behaviors have been proved, which intrigue financial researchers incorporate psychological factors into their studies to analyze market phenomena and investors’ behaviors.

This paper is to study the relationship between cognitive ability and six well-known behavioral biases in the course of investors’ decision making, from the perspective of Chinese individual stock investors. Those six biases are representativeness, availability, herding, regret, anchoring, and framing effect, which systematically violate the assumption of ‘rational person’ in traditional finance studies.

Those six biases are also being called cognitive errors. Meanwhile, people have different cognitive ability, which directly influences their lives. In this paper, we apply a set of scientific methods, such as deductive approach, quantitative strategy, and some critical statistical techniques, to conduct the study. Meanwhile, in order to make it clear about the knowledge of this paper, we conduct a thorough literature review, including ‘rational person’ assumption in traditional finance theories, behavioral finance viewpoints, and some important psychological knowledge.

Through carefully testing and analyzing those collected data from investors, we find investors with high level of cognitive ability can effectively reduce the influence of representativeness and availability heuristics than investors in the group of low cognitive ability level. However, investors in high cognitive reflection test (CRT) group cannot perform better than investors in low CRT group when they encounter the other four cognitive errors.

This study may arouse researchers’ attention on behavior biases, cognitive ability and their relationship, which contribute to the study of how to perform in a more rational way and how to measure these irrational factors for a better pricing model.
Key words:

Behavioral finance; market anomaly; cognitive ability; representativeness; availability; anchoring; framing; herding; regret; expected utility theory; rationality.

Key conceptions:

Weekend effect, in which there appear to be abnormal returns on Fridays and relative falls on Mondays.

January effect refers to the tendency for shares to give excess returns in the first few days of January.

Small-firms effect refers to a number of studies in the 1980s found that smaller firms’ shares outperformed those of larger firms over a period of several decades.

Random walk in financial area stands for prices fluctuate randomly and arbitrage from its intrinsic value.

Cognitive biases stand for deviations in judgment that occur in particular situations, such as herding, representativeness, anchoring, and so on, which lead to behavior distortion, inaccurate judgment, and other irrational activities.

Representativeness is an evaluation of the degree of correspondence between a sample and a population, an instance and a category, or more generally, an outcome and a model.

Availability heuristic is a kind of decision-making heuristic in which people judge the frequency or probability of some events on the basis of how easily examples or instances can be recalled or remembered.

Regret, as a kind of human emotion, which influence people’s decision.

Herding is a kind of phenomenon that many people take the same action.

Anchoring means people usually make their evaluation based on an initial value has been given out.

Framing effect means decision is influenced by the phrasing or frame in which the problem is presented.
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Part 1   Introduction


However, because Chinese stock market started from 1990s, period is not very long. It is still not as mature as some developed markets, such as U.S.A, or Japan. Especially on the aspect of market structure, as reported by CSRC (China Securities Regulatory Commission, 2008), large proportion of market share in Chinese stock market is taken by individual investors, and the percentage is 51.3% at the end of 2007. The proportion of institutional investors’ share is relative low, which affects their function on stabilizing market fluctuation. This kind of investment entity structure is not good for the long-term healthy development of stock market.

In order to reduce the fluctuation of stock market, it is very important to make both institutional investors and individual investors clear about those psychological factors they have in the process of making their investment decision, besides increasing the proportion of institutional investors in stock market. Although traditional finance theories assume financial market participants are rational, more and more studies show some financial market phenomena, such as January effect, weekend effect, etc, can be only explained by loosing this strict assumption.

Behavioral finance integrates psychological factors into the study of financial market. It believes that financial market participants are not perfectly rational, and easily be induced by market information and others’ investment behaviors. It pays attention to the influence of investors’ psychological factors on their investment decision making. This kind of study provides a realistic instruction for investment decision.

According to previous empirical studies on the investors’ behaviors of Chinese stock market, we found out both institutional investors and individual investors have cognition biases, such as herding, loss-aversion, anchoring, etc. Those kinds of cognition biases are not individual phenomena, they systematically occur in financial market. The market would be more fluctuating due to investors’ behavior caused by those systematical biases, which leads investors to expose more investment risk.
How investors conduct their investment, and which kinds of factors affect investors’
decision making? In order to understand human behavior on financial market and
make finance studies be closer to realistic market phenomena, more and more finance
researchers incorporate psychology including heuristics and psychological biases into
their studies.

Behaviors of biases and heuristics are exhibition of people’s psychological activities.
From the perspective of cognitive psychology, they are resulted from cognitive errors.
However, people have different cognitive ability. Higher cognitive ability people may
lead different choices than those with relative low cognitive ability when they face
similar problems. Studies ((Jensen, 1998; Benjamin & Brown, 2006; Oechssler et al.
2008) also show cognitive ability is a very important factor that affects people’s lives
and their achievement. Then, whether or not people with higher cognitive ability
could efficiently avoid or reduce the influence of biases in the course of decision
making? In our research, we will detect the relationship between cognitive ability and
psychological biases from the perspective of Chinese individual stock investors, to
take a look whether Chinese individual stock investors with high cognitive ability
could perform better than those with low cognitive ability.

1.1 Research Background

1.1.1 Chinese stock market background

With the reform and opening policy carried out by the Chinese government, Chinese
economy has kept long-term high speed development in the last 30 years. Total
amount of GDP has grown from 364.5 billion Yuan in 1978 to 33.53 thousand billion
Yuan in 2006, according to comparable price; the average growth rate of GDP is 9.8%
each year. Gross domestic product per capita rise from 381 Yuan in 1978 to 16,165
Yuan in 2006, the average growth rate is 8.5% every year based on comparable price.
Until the end of 2007, aggregate amount of Chinese economy has taken 6% of whole
world’s economy amount, is the fourth largest economy entity of the world. (NBSC,
2010)

Prosperity of economy prompts the development of Chinese stock market, makes
stock market play a more important role in the society, influence operation of the
whole economy. With the establishment of Shanghai Stock Exchange (SSE) and
Shenzhen Stock Exchange (SZSE), Chinese capital market has been developing
rapidly from the early 1990s, total stock market value arises from 104.8 billion Yuan
to 12.1 thousand billion Yuan in 2008(CSRC, 2008). Although there are ups and
downs due to various factors under development, China’s stock market sizes steadily
expands, market mechanisms continuously improves, and investment institutions
become more competitive. Until 2009.07.15, listing companies’ market value in
China achieved 21.93 thousand billion Yuan, became the second largest stock market
of the world. (Chinanews, 2009)

Even though stock market volume has been growing fast, investor structure of Chinese stock market is still immature (CSRC, 2008). According to the data from China Securities Depository and Clearing Corporation Limited (SD&C), until the end of 2008 in Chinese stock market, the number of stock accounts is 123.6 million, while A-share accounts took up to 121.2 million (notes: There are two kinds of stock account in China, A-share is denoted by Chinese currency, Yuan, traded by Chinese; B-share is denoted by foreign currency, mainly for foreign investors), while in those A-share accounts, individual investors had 120.75 million, which takes up to 97.7% of total stock accounts.

In recent years, mainly after 2004, institutional investors especially security investment fund has been developing very fast (Yin, 2005). The structure of investors has been improved a lot (CSRC, 2008). However, the status of unreasonable investor structure and unbalanced development does not change much, the scale of institutional investors is still relative small both in accounts numbers and capital amount (see figure 1). Until the end of 2007, the number of investor accounts is largely made up of small and medium individual investors, whose capital amount below RMB500,000 Yuan (CSRC, 2008).

Due to the large number of individual investors, the capital amount of market share for individual investors is also a big proportion in China’s stock market. Until the end of 2007, individual investors in Chinese stock market take 51.3% of total market share, other institutional investors like securities investment funds, ordinary investment institution, insurance companies, qualified foreign institutional investor(QFII), securities firms, national social security fund and pension funds takes 25.7%, 16.6%, 2.5%, 1.7%, 1.4%, 0.8% and 0.01% , respectively.

Through the picture (figure 1), we can find that there is a capitalization proportion of 3.31% in the institutional investors are taken by national social security fund, insurance companies and pension funds, whose investment orientations are under strict supervision than others. The pure market investment funds only account for 43.7%.
So many individual investors and so large market shares they take in Chinese stock market make stock market more fluctuate. Proportion of institutional investors, especially professional securities investment institutions is relative low compare to some developed markets (see figure 2), which affects their ability to stabilize market. Although according traditional capital market theory, especially efficient market hypothesis (EMH), investors’ irrational behavior will be finally balanced each other through random walk, and even they cannot be cancel out totally, arbitrage can balance it out (Clint, 2006). However, this is in theory, due to some assumptions, such as no transaction cost and unlimited risk-free borrowing, cannot satisfy in practice, market anomalies consequently occur. Profit results from frequently transaction for pursuing abnormal interest may be canceled by transaction cost. While arbitragers cannot always unlimited risk-free borrowing from the market, this prevents them from achieving risk-free profit and let market distortion continue.

The current Chinese capital market structure, where market is dominated by individual investors tends to result in market is badly affected by individual investors’
behavioral biases, and make the security market be more fluctuating (Zhang et al., 2008). Even though with more and more the institutional investors enter into Chinese stock market, the volatility of the Chinese stock market reduced by 13% and 6% in SZSE and SSE respectively (He, 2008), the power of institutional investors in market is still relative weak. The current structure is not good for long-term healthy development of Chinese stock market (Zhang et al., 2008). Therefore, further increase the number of institutional investors is an important factor for the development of the financial market.

Relative to individual investors, institutional investors have higher rationality, and they have greater insight on the harmfulness of investors’ overreaction that caused by market’s irrational behavior. Therefore, institutional investors are more inclined to conduct passive trading and usually use contrarian investment techniques. They buy stocks whose prices they believe are underestimated, and sell ones whose prices they believe are overestimated. The behavior conducted by institutional investors on stock market can make stock price back to its intrinsic value, and in turn relieve the fluctuation range of stock price. (Song, Yang & Shen, 2007) Philip Davis (2003) believed institutional investors would strengthen the stability of market, even though sometimes they would expand the market fluctuation and cause liquidity problem. Qi (2005) found out negative correlation between institutional investors’ proportion of holding share and stock price’s fluctuation. Therefore, institutional investors are helpful for the healthy development of stock market.

However, we are not saying that institutional investor is the panacea for stock market. We can not get the conclusion that the performance of China’s stock market would become perfect as long as we increase the share and number of institutional investors. Institutional investors show psychological biases when they conduct investment behavior, which can aggravate stock market’s fluctuation conversely.

Studies show institutional investors exhibit obvious herding effect. Friedman (1984) believed that herding effect result in institutional investors buy, hold or selling some stocks, and lead to these stocks’ prices rise or slump suddenly and sharply. This kind of investment behavior increases market’s fluctuation to a great extent. Sias (1996) found out for one stock, the more shares hold by institutional investors, the stronger it fluctuates. Patrick (2002) shows there is positive correlation between institutional investors’ proportion of holding share and the stock price’s fluctuation in the period of stock market fluctuates widely.

It will see from this that institutional investors have two sides effect. On one side, it can reduce stock market’s fluctuation on the basis of their professional knowledge; on the other side, it would aggregate stock market’s fluctuation due to some psychological biases. Therefore, besides increase ratio of institutional investors, in order to play down market fluctuation, reduce irrational speculation of individual investors, it is necessary to educate individual investors how to conduct investment.
This kind of education should not only include technique skill, but also how to overcome psychological biases that usually occur in the course of their investment decision making. At least, let investors know which kinds of biases may significantly influence their investment behavior, and what the consequences are if these heuristics occur in the process of investment. Finally, we make their investment behavior become more rational consequently.

Psychological biases usually take place in the process of decision making. Afterwards whether or not some people can efficiently avoid or reduce such influence caused by those psychological biases, based on their knowledge, experience, and cognitive ability?

1.1.2 Cognitive ability influence people’s behavior

People are different. Some individuals obviously can solve unfamiliar problems faster than others, and adapt to new environment much quicker. They can find out relationships that others do not, understand new concepts more quickly than others, and consistently have more knowledge than others, at least on some aspects. We usually consider this kind of people is clever or intelligent. However, psychologists have their own professional term, and regard them as people higher cognitive ability.

Michelon (2006) defines cognitive ability as people’s brain-based skills and mental processes, such as thinking, problem solving and interpretation of perception, which are necessary to perform any kind of task, no matter it is simple or complex. That is, no matter you are smart or not, as long as people conduct the behavior of work, study, thinking, even plays games, they will show their cognitive abilities.

Cognitive ability can affect many aspects of people’s life, and the influence of cognitive ability on people’s life has already been proven by psychologists. Studies show people with higher cognitive ability, on average, usually could make more money, would have longer life, have shorter reaction time to emergent events, and have larger working memories than those with relative lower cognitive ability level (Jensen, 1998). It is easy to understand that under the assumption of everything is equal for a task but two persons to perform it, the person with higher cognitive ability will achieve better results than the other.

Based on the importance of cognitive ability on people’s daily life, it has been attracted worldwide attention. Nowadays, many different cognitive ability tests are used by government, school, and army and so on, in order to test applicant’s qualification, or to differentiate people into various groups for diversified work. Take the Chinese Civil Service Exam as an example, since the year of 1994, people who want to work in Chinese government agencies have to take part in unified test, which is called Chinese Civil Service Exam. In the examination, one of the most important parts is to exam candidates’ cognitive ability. Without questions, candidates with
higher scores will gain good chances of success.

Cognitive ability affect so many different aspects of people’s life, it also influence people’s investment behaviors. Empirical studies exhibit it has influence on behavioral biases (Benjamin & Brown 2006; Oechssler et al. 2008) and formulation of decision making (Frederick 2005). Frederick’s study (2005) showed, people’s time preference and risk preference in the course of financial decision making are closely related to their cognitive ability, people with higher cognitive ability show more time patient than lower cognitive ability persons, and they are more rational when they are facing risky choices. Biases such as people’s preference anomalies, which include short-term discounting and small-stakes risk-aversion, also have their relationship with cognitive level (Benjamin and Shapiro, 2005). Those previous studies exhibited that people with higher cognitive level would show less biases, while for low cognitive ability individuals, such biases would carry much heavier weight.

With the development of psychological study extended into the area of investment behavior and financial market phenomena, more and more financial scholars are accustomed to combine financial theory with psychological research findings. This prompts the study of behavioral finance.

### 1.1.3 Study of behavioral finance

Before 1970s, there was seldom research in mainstream finance to consider psychology and its related disciplines. Whereas today, there are so many studies integrate traditional finance with psychology and so many related papers in world’s leading economical and financial journals. The influence of people’s psychological factors and behavior on financial market has caught more and more attention from researchers. Whether one agrees or not, financial economists are in the midst of a paradigm shift toward behavioral modeling. They are trying to modify traditional financial models, such as capital asset pricing model (CAPM), through incorporating people’s psychological and behavioral factors. Behaviorists are conducting engaging research and are becoming increasingly prominent in the profession. (Richard Roll, 2001)

The field of psychology directly applied to financial market can date back to the beginning of 20th century, when Selden (1912) discusses the influence of emotional and psychological forces on stock market investors and traders (Ricciardi &Simon, 2000). While the real start of behavioral finance study was from 1972, when Slovic published his paper-‘Psychological study of human judgment: Implications for investment decision making’ (Shefrin, 2001).

In Slovic (1972)’s paper, systematic biases, including conservatism and availability in people’s judgments when making investment decisions had been proved. the belief in the law of small numbers induces some investors cannot make rational choice. Slovic
(1972) explained the reasons why it is necessary to apply behavioral psychologists’ findings to security analysts, stock brokers, and investor. Through Slovic (1972)’s study, he showed the necessity of financial study incorporate peoples’ psychological factors, pushed the development of behavioral finance studies.

Behavioral finance examines the cognitive factors and emotional issues that have an influence on the decision-making process of individuals, groups, and organizations. It explains the what, why, and how of finance and investing from a human perspective, different from what traditional finance used to do (Ricciardi and Simon, 2000). Shefrin (2002, p1-2) believed the studies of behavioral finance can help practitioners, like individual investors, institutional investors, analysts, portfolio managers, and other market participants, recognize errors made during the process of investment decision making, and those errors cause deviations from theoretically ‘correct’ values in securities’ prices.

Behavioral finance integrates psychology into financial studies. It uses psychological factors, such as herding, regret, and so on, to explain financial phenomenon. For example, Guedj and Bouchaud (2008) studied the statistics of earning forecasts of US, EU, UK and JP stock during the period of 1987-2004, and found out the over-optimistic and herding behavior broadly exist in financial analysts’ decision making. This situation let financial analysts can not make prediction based on the rationally way, result in poor forecast quality, and made the stock prices become more fluctuating.

Behaviorists doubt the effectiveness of traditional financial theories in asset pricing and market prediction. Therefore, the debate between traditional financial theorists and behavioral financial theorists has never stopped.

One of the most important conflicts comes from the traditional assumption of ‘rationality’. In traditional finance, people are assumed to be rational. Even if there is irrational behavior, irrationality of populations as a whole can be canceled. It is assumed that rational people always have perfect self-control, they are always risk averse, and never regret their decisions (Statman, 1999). Under this assumption, traditional finance studies do not have to consider the human motivations and human nature. They limit themselves under the field of pure theoretical economics. Therefore, they do not think about the influences of biological factors, psychological factors, and sociological factors on human being. What they believe is that people always seek the most cost-effective methods to achieve their specific goals.

But in behavioral finance studies, people do not obediently follow that rational pattern (Statman, 1999). They release the rational assumptions under traditional finance, and believe people’s decision-making cannot totally rational due to their cognitive abilities, imperfect information and time. Behavioral finance believes people will make mistakes, regret some choices they have made, deviate from rational choices due to
many kinds of cognitive and emotional reasons, individually and collectively.

Behavioral decision making is the micro-foundation of behavioral finance (Shefrin, 2001). Some cognitive biases in the course of investors’ decision making will induce them to make wrong judgments, which may systematically deviate from rational choice. For example, heuristics, such as representativeness, availability, anchoring and adjustment, which are highly economical and usually effective in our daily life to solve problems, would also lead to systematic errors in the course of decision making under uncertainty (Tversky & Kahneman, 1974).

A standard model to describe rational people’s choice under uncertainty is the expected utility theory (EUT). The theory shows what people should do in a rational way when make decisions. It has been widely applied by traditional finance. Under EUT, there are several axioms including independence, completeness, transitivity, continuity and risk aversion, which we will discuss more deeply in literature part, to define a rational person. Following the guidance of axioms, people can make a rational decision anytime, like automatic machines and computers.

However, people’s decision making under uncertainty is not as rational as described by EUT, but behaviorists have developed several alternative theories to explain people’s decision making, such as prospect theory (Tversky & Kahneman, 1979) and regret theory (Loomes & Sugden, 1982). Under prospect theory, people have inconsistent preferences, and weigh gains and losses differently. Under EUT, people are assumed to have preference consistency; they value gains and losses equally. Under regret theory, people incorporate forecasted feeling of regret and rejoicing into their decision making. They recall and connect past experience to current decision making rather than solely applying current available information. The more intense of their regret or rejoicing feelings, the easier they deviate away from rational choices.

Behavioral finance examines the process of decision making of people on finance field and its influence on market when people show different ability and behavior trying to solve similar problems. Within this area, a subset of researchers has studied the relationship between cognitive ability and behavioral biases, and investigated the influence of different cognitive levels on economic behavior made by behavioral finance (Frederick, 2005; Benjamin, 2006; Dohmen et al. 2007; Oechssler et al. 2008). These cognitive levels are for example biases of conjunction, conservatism and anchoring, which are usually involved in the behavioral finance study could be related to cognitive ability.

People with higher cognitive ability could effectively resist biases of conjunction and conservatism than people with relative lower cognitive ability, while the difference is not significant on anchoring effect (Oechssler et al. 2008); those with higher cognitive ability exhibit more risk preference consistency than lower cognitive ability people and show more time patience in the course of financial decision making (Frederick,
2005; Dohmen et al. 2007); while short-run impatience are statistically weaker affected by different cognitive ability levels than small-stakes risk aversion through the laboratory experiment of Benjamin (2006). All these previous studies shows that cognitive ability plays an important role in people’s decision making, and some psychological biases earlier there was assumed will affect their behaviors in finance field.

1.1.4 Behavioral finance in China

With the development of behavioral finance in theory and empirical studies, and following the development of Chinese stock market, Chinese researchers also conducted some studies on behavioral finance. Studies of behavioral finance in China mainly focus on three aspects: one is the introduction and explanation of existing foreign behavioral finance works; one aspect is to explain Chinese stock market anomalies through experimental study by imitating relevant methods used by foreign researchers; and another aspect is to analyze the psychological and behavioral activities of Chinese stock investors (Zhang &Chen, 2004).

Many Chinese scholars have introduced behavioral finance theories from abroad. They have discussed the origin of the behavioral finance, the development of its theory and empirical studies, and future prospect in model-building and formulation of standard theoretical framework (Li &Yang, 1997; Liu, 1999; Yang, 2002; Zhu &Wu, 1999; Wen &Jiang, 2002; Li, 2002). Overall, researchers have presented a general introduction about behavioral finance, its basic theoretical foundations and tactics (Li & Yang, 1997; Yang, 2002). In this research behavioral finance conflicts the efficient market hypothesis and expected utility theory has also been introduced (Liu, 1999; Wen & Jiang, 2002).

People’s investment behavior influences stock market, and systematically biases may result in some market anomalies. Based on the study of market anomalies from western academic literatures, market anomalies occurred in other countries are tested in Chinese stock market. Through these test, researchers found out similar market anomalies in Chinese stock market, even though they are some difference in periods or presentation.

Chinese researchers replicated relevant statistical methods of foreign behavioral finance theory, and based on Chinese stock market data, the stock market anomalies in China had been explained (Zhu & He, 2001; Li et al. 2001; Zhang & Bi, 2002). A study to detect market anomalies like the small firm effect and January effect in Chinese stock market in the period of 1995-1997, found that there was no small firm effect in market, but the January effect does occur (Zhu & He, 2001). Some have tested weekend effects in the Chinese stock market, and found out a low rate of return on Monday and Tuesday and high returns on Friday (Li et al. 2001). Some others test herding effects in stock market, studies have shown herding effect in funds investment,
and especially serious in stock of high-growth industry, small firms (Song & Wu, 2000, 2002). Through studies of Condlin and those Chinese researchers, we can make sure that market anomalies appeared in Chinese stock market are related with people’s investment behavior and psychological factors.

Another focus of behavioral finance researchers in China is on the analysis of individual investor’s psychological factors and behavioral biases in stock market (Song & Wu, 2000, 2002; Li, 2001). One of the most systematic studies on Chinese individual investors’ behavior and psychology analysis was performed by researchers in Shanghai Stock Exchange in 2002. They found many psychological biases in investor’s investment behavior, such as certainty effect, anchoring, framing, representative, overconfidence, conservatism, and so on (Li, et al. 2002). These show that such biases make the stock market become more variable. Such fluctuations have hurt people’s investment returns and affect the healthy development of Chinese stock market (SSE, 2001). So, there appears to be a place for educating investors in order to reduce such biases, at least let investors know which kinds of biases usually occur during their investment.

1.2 Knowledge Gap

The research of foreign economics works under market economy system in China has not existed in a long period. Before 1980s, Chinese government only used planned system to control the whole country’s economy, based on the knowledge of Marx's plutonomy. Market economy was politicalized and connected with capitalism. Therefore, for a long period after reform and opening-up, Chinese economists and researchers paid more attention on introducing market economics works, applying and testing traditional economics theories in China. Whereas behavioral finance as non-main stream economics was ignored, especially before the establishment of Chinese stock market. With the development of Chinese stock market from early 1990s, some Chinese researchers’ attention started to pay on behavioral finance. However, we hardly find relevant papers on this field before 1999. The time of behavioral finance study is so short that mainly focuses on theory introduction and testing anomalies and biases in Chinese stock market.

Cognitive and psychological forces influence people’s life and decision making (Jensen, 1998; Frederick, 2005; Benjamin, 2006; Oechssler et al. 2008), while it varies between individuals, especially the culture difference between east and west. How behavioral biases among Chinese stock investors are affected by their cognitive abilities?

Although studies on behavioral finance in China have shown that there are research interests in psychological biases among Chinese individual investors (Zhang & Chen, 2004; Li et al. 2006; Wang & Han, 2008), no research has been found focusing on the relationship between cognitive ability and psychological biases predicted by
behavioral finance theory.

1.3 Research Purpose

Nowadays, a large proportion of individual investors exist in the Chinese stock market, both in absolute numbers and market share, and makes more irrational speculation on the market. From the perspective of Chinese market regulators, current investment entity structure is not good for the market development. While it is difficult to develop adequate institutional investors in short term, due to strict requirements, such as capital and qualified personnel, not to mention they also show biases. Therefore, it is much practical to improve the development of stock market through conducting investment education on individual investors, in aspects of both investment skills/techniques and psychological factors.

Through our research, related supervisory departments and security companies could draw some inspiration to conduct their business, and Chinese individual stock investors could realize those psychological factors that may influence their investment behaviors. That is, based on our research result, Chinese market regulators or related institutions can decide whether investment education should be separated into different level or not; it helps security companies conduct more professional education on their investment, especially on the aspect of investment behavioral biases, prompt their competitive advantage; Chinese individual stock investors realize those psychological factors, they might make a relative rational decision.

Previous studies exhibited cognitive ability had influence on behavioral biases in the process of people’s investment decision making. In order to find out the relationship between cognitive ability and investment behavioral biases from the view of Chinese individual investors, we have to choose a cognitive ability test. Then, whether there is a tool exists that can measure Chinese individual investors’ cognitive ability in a reliable and concise way? Especially the tool relates people’s investment decision making. Through our research we will find out this tool and understand Chinese individual investors’ characteristics in decision-making process through the tool, further solving our research question.

Our research is to study the difference in cognitive biases between people with higher cognitive ability and those with relative low cognitive ability, from the perspective of Chinese individual stock investors. Through carefully searching in both finance an psychology field, we do not find any research on this subject. Therefore, it is meaningful to put forward our research question, and thus complement our study to the Chinese research field.
1.4 Research Question

With the achievement on behavioral finance studies, especially based on the last 30 years’ theoretical study and empirical evidences, it is no longer as controversial as it once was. Financial economists, portfolio managers, investment analysts, and other market researchers, have become accustomed to consider the role of human psychology and behavior in driving stock prices (Thaler, 1999). Psychological and behavioral factors in the course of people’s investment decision making have become necessary considerations for market evaluation and analysis.

With the development of Chinese capital market, stock market is playing a more and more important role in the development of national economy. It helps companies diversify financing channels, prompt the growth of economy, and increase investment opportunities for corporation and individual investors. However, due to the development of Chinese stock market is only 20 years, the proportion of institutional investors is low relative to mature market. So many individual investors in the market intensify its fluctuation, which not only may hurt investors’ interest, but also is not good for market development.

We have already introduced that cognitive ability influence many aspects of people’s lives. While whether or not Chinese individual stock investors with high level of cognitive ability will effectively avoid psychological biases in the process of investment decision-making? In the paper, we choose six famous biases in behavioral finance study, that is, representativeness, availability, herding, regret, framing effect and anchoring.

Therefore, in order to fill in the knowledge gap, based on previous outstanding studies of behavioral finance, and according to the current unreasonable investment entity structure in Chinese stock market, we define our research questions as:

**Whether Chinese individual stock investors with high level of cognitive ability can effectively reduce psychological biases, including representativeness, availability, herding effect, regret, framing effect and anchoring, than investors with low level of cognitive ability?**

In order to solve our research question step by step, we divide it into two sub-questions:

1. **Do the biases of representativeness, availability, framing effect, regret, herding effect and anchoring effect exist in Chinese individual stock investors?**

2. **Do investors with different (high or low) cognitive abilities show significant difference in those six psychological biases?**
For the first sub-question, we refer to previous theoretical study and empirical evidences on psychological biases, and mainly show the exhibition of these six biases in Chinese individual stock investors.

Our study of the second sub-question is based on previous research about the relationship between cognitive ability and psychological biases. We will use Frederick’s CRT and imitate the study model of Oechssler, Roider and Schmitz (2008), to check the relationship between cognitive ability and the six significant psychological biases from the perspective of Chinese individual stock investors. In order to make it clear, we will measure their relationship one by one, which will be described in detail in the practical methods part.

1.5 Delimitation

Behavioral finance is a quite large research field. It not only considers traditional financial theories, but also incorporates psychology into its study. For our current stage, we do not have the ability to solve such a tremendous project. Therefore, we have focused our study on the point that can narrow our research range.

Because there are some studies both on behavioral biases and the relationship between cognitive ability and biases that we can refer to, we pay our attention to the six psychological biases usually studied by behavioral finance researchers. This choice makes our research more comparable. We check the relationship between cognitive ability and those biases on Chinese individual stock investors, and test whether there is significant difference in those biases due to different cognitive levels.

We do not emphasize how and to what extent those psychological biases affect asset prices, or how to quantify them into risk and return expectations. To our knowledge, there is still no standard model for such measurement. Even though Shefrin and Statman (1994) developed a behavioral asset pricing model (BAPM) as an alternative to the Capital Asset Pricing Model (CAPM), it is not generally accepted due to lack of accurate measurement of its variables. We have limited our study to the quantification of percentage differences when showing these six behavioral biases between different cognitive groups, rather than how much fluctuation in stock prices will happen due to certain biases.

In the thesis, we delimit our study on the individual investors in the Chinese stock market. Therefore, we can focus our questionnaires on that specific group, and make the results become more pertinent.
1.6 Disposition

In order to make the structure of our paper very clear and give the readers a general idea before going deeper into our research, after introducing the background of our research and putting forward the research question, we present the remainder of our thesis as follows:

**Part 2: Theoretical Methodology**
In this part, according to our research characters, we introduce different theoretical methodology, and choose the ones that used to conduct our research through comparison.

**Part 3: Literature Review**
In this chapter, many traditional financial theories including EUT, EMH will be introduced, and some findings of behavioral finance will be mentioned. Six biases including representativeness, availability, herding, regret, anchoring and framing are presented, and show how these biases affect people’s rational choice. The influence of cognitive ability on people’s daily life and decision making is also depicted. The studies of behavioral finance and psychology predominate this part.

**Part 4: Practical Methods**
In this part, under the guidance of theoretical methodology and the knowledge of previous literatures studies, we design the questionnaires, and describe the process of collecting research data. Meanwhile, we decide relevant statistical techniques that are applied to test the relationship between cognitive ability and biases.

**Part 5: Research Findings and Description**
In this part, we present the answers of questions in our questionnaires and describe the answers of CRT questions and biases questions. After that, we compare data of each bias based on different cognitive ability groups.

**Part 6: Data Analysis and Discussion**
In this part, we first analyze the CRT results, compare them with previous studies, and discuss the characteristics of Chinese individual stock investors. Secondly, we analyze those 6 behavioral biases one by one, test the difference of biases between investors in high and low CRT groups. Finally, we discuss the results through combing behavioral finance theories and previous studies with our data analysis.

**Part 7: Conclusion**
In this part, we solve our research question, state its quality criteria, and also recommend some further studies on the related subjects.
Part 2 Theoretical Methodology

Through introducing the background of Chinese stock market and behavioral finance studies, we have put forward the knowledge gap, research purpose and research question for this study. In order to conduct the research in a scientific and effective way, now we consider the methodology we should adopt.

For the purpose of presenting our research in a logical manner, and tighten the connection between chapters, we separate the research methods into two parts: theoretical methodology part and practical methodology part. Here, we will introduce the theoretical methods first.

2.1 Choice of Subject

Behavioral finance is a very practical topic, which combines finance study with psychology. It replaces ‘rational person’ assumption under traditional financial study with ‘normal person’. Therefore, it is more practical to explain market phenomena, especially market anomalies.

We have chosen 6 psychological factors that affects people’s decision making. Those six biases include availability, representativeness, anchoring, framing, herding, and regret, which systematically deviates investors away from rational choices, expose them under investment risk. Especially, most of time, investors do not know those kinds of psychological factors exist, not to mention controlling them for avoiding investment risk. So, it is necessary to conduct certain education on investors, both in technical skills and psychological factors.

Psychological biases lead investors to investment risk through influence their decision making process. It is better for investors to know and control them during their investment. While people have different amount of cognitive ability, previous studies have shown cognitive ability affects personal life, and it strongly correlates with decision making. Then, whether investors with high level of cognitive abilities could lower those six biases that we mentioned above efficiently should be a very interesting question.

Nowadays, there are many methods to test people’s cognitive ability. Even on internet, we can find many cognitive ability tests. In order to make the cognitive ability test can measure the preference in the process of people’s investment behavior, special concise cognitive test that focus on decision making has been developed to measure investors ability to control these biases.

As Chinese oversea students, we want to do something for the healthy development of
Chinese stock market and individual investors. Meanwhile, as students majoring in finance and accounting, we are interested in Chinese stock market. It is such an amazing and weird market, which uses only less than 20 years to become the world second largest stock market in the aspect of capitalization, and the world largest stock market in the number of individual investors. However, due to the Chinese government’s over-interference to the stock market, and the individual investors are the mainstream on the market, the situation in Chinese stock market is different from mature market of western countries. Based on this, it is useful to do the special research on Chinese stock market.

Therefore, we would like to examine the correlation between this cognitive test and biases on Chinese stock investors, which also can help us decide how to conduct investment education on them.

As master students of finance and accounting program, we have good knowledge of investment. We have the confidence in the future development of behavioral finance in financial field, and we want to analyze how psychological factors affect investors’ decision making, and to which degree. We are enjoying conducting analysis on the current stock market environment in China. Combined those factors, we choose this subject to solve our research question.

2.2 Authors’ Background

As students who study finance in Umea School of Business (USBE), both of us have the knowledge of traditional finance theory, such as efficient market hypothesis (EMH), arbitrary pricing theory (APT), capital asset pricing model (CAPM), expected utility theory (EUT), Mean-variance portfolio theory and so on. The knowledge we have learn from arranged courses in USBE provide us with necessary reserve to conduct the research in our thesis work, and grant us the fundamental knowledge for further study on behavioral finance.

Except for the fundamental financial knowledge from our university, Ning An, has been taking part in the international CFA (Charted Financial Analyst) since 2009, and has passed the Level II examination. The CFA charter is a qualification for finance and investment professionals, particularly in the fields of investment management and financial analysis of stocks, bonds and their derivative assets. The CFA program focuses on portfolio management and financial analysis, and provides a general knowledge of other areas of finance (CFA, 2011). This kind of education background let our thesis have much broad knowledge in the investment practice area.

Our theoretical knowledge about behavioral finance and psychology is mainly from the literature-study. We have borrowed almost all the books about behavioral finance from university library, we have downloaded scientific articles from websites related to what we are studying, and we have read them carefully to find the information we
are focusing on. This literature-study makes us get more knowledge about behavioral finance and different kinds of psychological biases, especially the influence of those psychological biases, makes us have adequate confidence to conduct our research and solve the research question.

Besides theoretical knowledge we get from courses and self-study, we both invest in Chinese stock market. Besides this, Ning An also conducts investment in the international foreign exchange market. We both have the experience to be influenced by other people’s investment behavior and other biases. We usually contact with other stock investors about their stock choices and investment decision in exchange halls, through chat room of investment. Therefore, we know the way of thinking when investors choose stocks, we know there are psychological factors affecting their decisions, though we did not study them systematically before.

Therefore, our background both in the aspect of education or investment practice, qualify us to conduct this research.

2.3 Research Philosophy

2.3.1 Epistemological considerations

An epistemological issue considers the question of what is or what should be regarded as knowledge that is acceptable in a discipline. Under epistemological considerations, it questions whether the social world including economical life can and should be studied under the same principle. Based on the different view of whether or not the methods of the natural sciences should be applied to the study of social reality and beyond, the epistemological considerations present two contrasting schools of thought, which are referred to as positivism and interpretivism. (Bryman & Bell, 2011, p15-20)

a) Positivism

Bryman and Bell (2011,p15) consider that positivism is an epistemological position that affirms the importance of imitating the natural sciences, and it advocates the application of the natural sciences methods to the social study and business research. Besides complying with natural sciences study methods, positivism also includes principles, such as the principle of deductivism, which states the purpose of theory is to generate hypotheses that can be tested and will allow explanations of laws to be assessed; the principle of inductivism, which explains that knowledge is arrived at through the gathering of facts which provide the basis for laws; and the rule of objective, that is, science must be conducted in a way that is value free, and so on(Bryman & Bell, 2011, p15).

Through the above doctrine, we can get the picture that positivism includes the
elements of both deductivism and inductive strategies, which we will introduced in the part of research approach.

b) Interpretivism

As we mentioned before, the epistemological considerations present two contrasting schools of thought. A contrasting epistemology to positivism is interpretivism, which is predicated upon the view that a strategy is required that researchers should respect the differences between people and the objects of the natural sciences. The interpretivism requires social scientist to grasp the subjective meaning of social action. (Bryman & Bell, 2011, p17)

From the perspective of interpretivism, people and their institutions, as the subject matter of the social sciences, are fundamentally different from the subject of natural sciences. Interpretivism leads the emphasis on the explanation of human behavior, which is the important element of the positivist approach, to the social science and the understanding of human behavior. (Bryman & Bell, 2011, p18-19)

Through the comparison of the two contrasting views, we know the difference between interpretivism and positivism. Therefore, we can infer which one should be used in our research study.

In our research, we conduct the research to find out whether or not in Chinese stock market there exist a relationship between the level of cognitive ability and the psychological biases that are generally mentioned in behavioral finance literatures. We will use the objective methods to explain the phenomenon that exists in people’s investment decision-making process; and we try to explain whether people with higher level of cognitive ability can reduce these six psychological biases, thus make a more rational investment decision. Therefore, the positivism is very suitable for the research.

We will not try to understand each sample’s thinking when he or she faces investment decisions, while view them as unified groups. We do not want to test why their cognitive ability is different, and what the degree of their biases. We just examine whether there are biases, and the phenomenon showed from different cognitive groups. Also, we view the difference in cognitive ability and psychological biases exist in human being naturally, and we apply the methods of natural sciences to our research study. Therefore, it is not suitable for us to use interpretivism in this research.

2.3.2 Ontological considerations

Besides epistemology we discussed above, another research philosophy named ontology, which considers the questions of the nature of social entities. According to whether social entities can and should be considered objective entities that have a
reality external to social actors, or whether they can and should be considered social constructions built up from the perceptions and actions of social actors, ontological considerations are referred to respectively as objectivism and constructionism (Bryman & Bell, 2011, p20):

a) Objectivism

As an ontological position, objectivism considers the existence of social phenomena and the meanings of social phenomena are independent of social actors.

Through the conception of objectivism, we know from the perspective of objectivism social phenomena is an independent existence. No matter people realize it or not, objectivism likes a social order that exerts pressure and influence on individuals to conform to the rules and regulations. Even though those rules and regulations might lead them to be under risk, they still objective existence.

b) Constructivism

An alternative ontological position is constructivism, which considers social phenomena and their meanings are continually being accomplished by social actors.

Unlike objectivism, which asserts the existence of social phenomena is independent, constructivism considers social phenomena are produced by social interaction, and they continually being revised. That is, social phenomena will be changed with time and the development of social activities.

Based on our research, it is common sense that people have different levels on cognitive ability. The influence of different cognitive ability has shown on people’s life is also different as what we mentioned before (Jensen 1998; Frederick 2005). Therefore, it is a common social phenomenon, and we view it as an independent existence.

Those six biases we are studying also have been proven exist, which can deviate people’s rational decision systematically. So, it is reasonable to regard they exists independently, which will not be changed by social interaction or participants activities. Even though people can resist some weaknesses through study and education, those biases still exist and affect people’s decision making.

Most importantly, we focus on our research question to study whether investors with higher level of cognitive ability could reduce those biases’ influence effectively in the process of investment.

Through above analysis, we can make sure that the objectivism is suitable for our research, rather than constructivism.
2.4 Research Approach

According to the relationship between theory and research, Bryman and Bell (2011, pp7-8) present two outstanding approaches, one is induction, and the other one is deduction.

2.4.1 Deduction

In deductive method, according to the known related theoretical knowledge in an area, researchers deduce a hypothesis or hypotheses which subject to empirical scrutiny, to test whether findings and observations follow the rules of the related theories (Bryman & Bell, 2011, p11).

The deductive process presents a very clear and logical sequence, which appears very linear:

*Figure 3: Deductive Process*

![Diagram of Deductive Process]

Source: *Business research and methods*, Bryman & Bell, 2011, p11

2.4.2 Induction

Inductive method regards theory occurs after the collection of relevant data associated with a project and conduct corresponding analysis. It is a reverse sequence comparing to deductive approach. In inductive stance, theory is the outcome of research. To be
clear, we can view deduction is a process from theory to findings and observations, while inductive process is from findings and observations to theory.

Our research is based on already known knowledge of influence of cognitive ability to human life and decision making, and focuses on the influence of different level cognitive ability on the six behavioral biases that have been proven systematically affect people’s decision making.

Based on those previous studies and evidence, we propose our research questions, set up the corresponding hypotheses, collect the data from Chinese stock investors, and then use the statistical methods to test the relationship between cognitive ability and those biases. In the whole process of our research, we do not construct any theory. Instead, we observe the relationship between cognitive ability and biases, take a look at whether people with higher cognitive ability are less influenced by those six biases, or visa versa. Therefore, we use the deductive method in our study.

2.5 Research Strategy

Research strategy is a general orientation to conduct the research. In other words, it asserts that which methodology researchers will use during the process of their research. Bryman and Bell (2011, p26) states two different research strategies: qualitative research strategy and quantitative research strategy.

2.5.1 Qualitative research strategy

Qualitative research strategy is a research strategy that focuses on words rather than quantification in the process of data collection and data analysis. It focuses on the inductive method and the ways of interpretivism, using individuals to interpret the social society. And qualitative research strategy considers social reality to be revising with time constantly through individuals’ interaction (Bryman & Bell, 2011, p26).

2.5.2 Quantitative research strategy

Contrary to qualitative research strategy, the accent of quantitative research strategy is on quantification of collected data and analysis (Alan, 2008). Therefore, whether quantify data and analysis is one of the observable important differences between these two research strategies. The quantitative research strategy focus on the testing of theories, which is a deductive way, applies the practices of the natural scientific model to social reality study. Also, it considers social reality as an objective reality (Bryman & Bell, 2011, p26-27).

Through the following table, we will be clear and get a whole picture about the
differences of these two research strategies.

**Table 1: Differences between quantitative and qualitative research strategies**

<table>
<thead>
<tr>
<th>Principal orientation to the role of theory in relation to research</th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deductive;</td>
<td>Inductive;</td>
</tr>
<tr>
<td></td>
<td>testing of</td>
<td>generation of</td>
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<tr>
<td></td>
<td>theory</td>
<td>theory</td>
</tr>
<tr>
<td>Epistemological orientation</td>
<td>Natural science model, in particular positivism</td>
<td>Interpretivism</td>
</tr>
<tr>
<td>Ontological orientation</td>
<td>Objectivism</td>
<td>Constructivism</td>
</tr>
</tbody>
</table>

Source: *Business research and methods*, Bryman&Bell, 2011, p27

Through our previous study in this part, we can easily get the conclusion that we will use the quantitative research strategy.

Our study will not explain each individual investor’s cognitive ability and his or her behavioral biases, we view them as an organization to explain the general biases they have, and find out the objective existence. We test different degree of biases in Chinese stock investors, to quantify whether these kinds of differences are significant. We make the analyses of our data by using statistical analyses. Therefore, it is very natural to take quantitative research strategy to conduct our study.

Also, from the view of research process, quantitative research strategy is suitable for our study. In this study, on the basis of previous studies on cognitive ability and behavioral finance, we propose our research question is to study the relationship between cognitive ability and those six psychological biases, test whether investors with higher level of cognitive ability could reduce the influence of biases significantly. And then, we collect relevant data that we want to test from individual investors in Chinese stock market, after that we process and analyze these data using certain statistical methods, and finally get conclusions from the findings. Therefore, our research structure matches quantitative research strategy well.

**2.6 Research Design**

A research design provides the framework for collecting data and analyzing data, and reflects researcher’s priority to a range of dimensions of the research process (Bryman &Bell, 2011, p40). Generally, research design can be divided into experimental and non-experimental design (Bryman&Bell 2011, p40).

Experimental research is to provide strong evidence for cause-and-effect relationships (Gabriella 2008). In an experiment, researchers usually manipulate the independent variable to find out whether it affects dependent variable or not. Experimental subjects are divided into two or more groups, one group for each level of independent
variable and then test the differences between those groups from a dependent variable (Bryman&Bell,2011, p42-43).

In our research, even though we will divide stock investors into two different groups, high cognitive level and low cognitive level, according to people’s CRT results, and then use 7 classical questions to test their reflection to the six psychological biases, however, we cannot control or manipulate the independent variables, in our research variables are investors’ cognitive abilities and behavioral biases. Therefore, the experimental research does not fit our study.

Non-experimental research includes variables that are observed as they exist and these variables are not manipulated by researchers, for example, gender, or other personal trait (Gabriella 2008). Bryman and Bell (2011, p53-63) present non-experimental design includes case study design, longitudinal design, cross-sectional or social survey design, and comparative design.

Case study design requires researchers conduct detailed and intensive analysis of a single case. The single case can be an organization, a location, a person or an event. Case study usually emphasizes on intensive examination of the certain situation (Bryman and Bell, 2011, p59-62).

A longitudinal design requires researchers examine the change of phenomena at vertical and horizontal levels, and the interconnections between those levels through time. In other words, the longitudinal design does not collect data at a single point in time, it organize the changes of its subjects (Bryman and Bell, 2011, p57).

A cross-sectional design, according to the definition of Bryman and Bell, requires the collection of data on more than one case and at a single point in time in order to get a body of quantitative or quantifiable data in connection with two or more variables, which are then examined to detect patterns of association (Bryman and Bell, 2011,p53-54).

Comparative design requires studies using more or less identical methods of two or more contrasting cases. This kind of research design emphasizes social phenomena could be better understand when two or more contrasting cases are compared. That is, comparative design needs a least two cases or groups to get comparable data (Bryman and Bell, 2011, p63).

For our research, firstly, we use questionnaires, which include ten questions, to find out those investors’ cognitive abilities and behavioral biases, i.e. we collect the required data on several cases at a single point in time. This character lets our study fit the cross-sectional design. Secondly, according to the collected data, we separate our subjects into two different groups on the basis of their answers of cognitive ability questions. And then we compare behavioral biases of these two groups. This character
makes our research be suitable for comparative design.

Therefore, we will use cross-sectional design and comparative design to conduct our study.

2.7 Ethical Considerations

Because we will test people’s cognitive ability in our research, which may make some investors feel uncomfortable. Therefore, before we deliver our questionnaires, we have to consider problems of ethical principles we face.

When conduct social research, according to Bryman(2008, p118), we should consider whether there is physical or psychological harm to participants, such as harm to participants’ self-esteem, stress; whether there is a lack of informed consent; whether our questions invade subjects’ privacy, such as money and personal life style; and whether there is deception in the whole period of data collection.

In order to avoid such conflicts, firstly, we deliver our questionnaires to investors directly in person, tell them our research purpose, do not hide anything about our questionnaire, and stand by to be ready for responding questions they may put forward, let them clear about the questionnaire, and avoid any harm that may happen to them. Secondly, all of the data we collect get consent from subjects. Otherwise, they could refuse to fill it in. Due to there are no questions related to those investors’ privacy, we will not confront such problem.
Part 3 Literature Review

Basing on the theoretical methodology we have set for the research, we focus our study on the relationship between cognitive ability and those six psychological biases. We review previous literatures and studies on related fields very carefully for solving the research question mentioned in the introduction part.

We conducted a comprehensive literature review both in financial field and related psychological area. Under those two research framework, we carried out detail study on rationality hypothesis, irrational biases, the influence of psychology and cognitive ability, and naturally get the point of their relationship.

Behavioral biases of investors in financial field result from their irrational activities. For understanding what irrationality activities are and their manifestation, we looked through what the rationality is and its application in financial market first. After that, we will be clear about the requirements or assumptions to become a rational person, understand the reasons why people’s certain behaviors systematically violate rationality. Based on our research purposes, we conduct a thorough review on related psychological knowledge, which is helpful to understand the process of understanding, reasoning and decision-making, and to be clear about the importance influence of cognitive ability.

In the process of reviewing literatures, we conform to the following steps: firstly, we look through the assumptions of efficient market hypothesis, which are criticized by many behavioral economists; secondly, we exhibit the generally accepted rational choice under uncertainty, expected utility theory, and display how it works; thirdly, we conduct psychology review on the characteristics of human decision-making and judgments; fourthly, we introduce the expressions of those six famous cognitive errors, and several famous test methods can be used to measure people’s cognitive ability; and finally, we introduce some previous studies on the very knowledge of the relationship between cognitive ability and behaviors.

3.1 Efficient Market Hypothesis (EMH) and Its Challenge

Since Paul A. Samuelson and Eugene F. Fama developed the efficient market hypothesis (EMH) in the 1960s (Lo, 2007), the argument of whether the stock market is efficient in pricing shares has never been stopped. Proponents of EMH claim that security prices rationally reflect available information in an efficient capital market, while opponents of EMH doubt the hypothesis of market efficiency, one of which is that they believe the nature of human being would let investors conduct irrational behaviors, and thus systematically breach market’s rationality.
The EMH implies new information will be incorporated into the share price movement and the size of that movement (Arnold, 2008, p563). Fama (1970) stated security prices could always fully reflect availability information at any time in an efficient market. Under efficient market, only new information that causes prices to change, and nobody will have the opportunity to make a greater return on a share than a fair return for the risk associated with that share, except by chance(Arnold, 2008, p563).

Under EMH, there are three arguments that rely on its assumptions about rational investors, random walk and effective arbitrage (Shleifer, 2000, p2):

- Investors are assumed to be rational and hence to value securities rationally;
- To the extent that some investors are not rational, their irrational trades are random and therefore the effects of those irrational actions cancel each other out without affecting prices;
- If the majority of investors are irrational in similar ways, which cause a tendency to push security values away from the efficient level, rational arbitrageurs will eliminate the influence of those irrational traders on price.

Under the first condition, it assumes all investors calculate the securities’ present value of the future income flow using an appropriate discount rate, to examine securities’ fundamental value (Arnold, 2008, p597). That is, investors in a market will choose the same activities to conduct their investment, they are identical, and there is no difference between investors. For the second argument, EMH believes that market will not be influenced by irrational investors due to ‘random walk’ could cancel them out. The third condition argues that even there are numerous investors making cognitive errors; those rational arbitrageurs will be strong enough to restore market efficiency (Arnold, 2008, p597). In other words, no matter the occurrence of herding, representativeness, and other cognitive errors that deviate market efficiency significantly, the market would immediately come back to normal due to arbitrageurs’ reverse trading.

Surely, after the appearance of EMH, it has been applied extensively to economical field both in theory and in empirical studies. However, due to it bases on the assumption that investors are rational, which neglects characteristics of human behavior. It was criticized by a lot of psychologists and behavioral economists(Lo, 2007).

First, investors are not always irrational and hence value securities irrationally. It is very common that the majority of share traders do not consider company’s future income flow and discount rate when they value a share. Most of them conduct trading according to suggestions from friends, brokers even their own intuition. People do not following the precepts of von Neumann-Morgenstern rationality (Shleifer, 2000, p2), i.e. Expected Utility Theory (EUT).
Second, although there is growing evidence that investors do not deviate from rationality randomly, there is a bias to deviate in the same way. Such as psychological biases including overconfidence, representativeness, regret, framing, and so on, all of them lead prices away from fundamental value. (Arnold, 2008, p597)

Thirdly, arbitrageurs can bring down the security’s price to its fundamental value in EMH (Arnold, 2008, p597). However, it is only in theory. In an ideal arbitrage, arbitrageurs can make profits without risk, meanwhile let security’s price back to normal. While due to the limitation of the real world, perfect arbitrage can never occur. Those limitations include the difficulties to find a close-substitute security for arbitrage, the borrowing or opportunity cost of your capital. (Arnold, 2008, p598)

Therefore, the three assumption of EMH are unrealistic in reality. The combination of limited arbitrage and investor irrationality pushes the market to inefficient pricing (Arnold, 2008, p597). Those psychological biases do not fit with the EMH’s ‘rational man’ model, lead the efficiency of markets seriously influenced. It is very useful to make clear which kinds of cognitive errors are affecting people’s decision-making. However, before we introduce those errors, we first explain the traditional rational choice model in economic field, i.e. expected utility theory, which is used widely under EMH to keep people in rational way.

### 3.2 Expected Utility Theory (EUT)

Expected utility theory, which is generally accepted as a standard model of rational choice, has been widely applied as a descriptive model in traditional economic and financial field (Tversky & Kahneman, 1981). However, experiment and empirical studies have proved that people usually do not follow EUT’s principles when they make decisions under uncertainty due to internal or external factors. In order to favor latter discussion, make it clear why those six behavioral biases we are talking about violate the rational choice requirement, we first make a brief introduction about EUT and its several basic axioms.

The original explanation of expected utility theory can go back to 1738 (MONGIN, 1997; Abdellaoui, 2002), when Daniel Bernoulli proposed the notion of expected utility. In Daniel’s (1738) notion, he believed that people in games of chance should evaluate risky ventures by the sum of utilities of outcomes weighted by the corresponding probabilities. The first time clearly using the notion of risk and uncertainty for analysis of economic matters was suggested by Frank (1921), he also considered the individual psychology of valuation into the economic analysis. However, in Frank’s (1921) work, he did not give us a normative rule; we should follow as a rational behavior, nor provide some explicit axioms to guide behavior under risk and uncertainty.

It was not formally proved to be a rational decision criterion until Neumann and
Morgenstern (1944) put forward expected utility maximization. Neumann and Morgenstern formally incorporated the notion of risk into the expected utility model, that is, the theory of Games and Economic Behavior. In their theory, the explicit formulation of rational foundations is used in evaluating expected utility in individual decision-making under risk. (Mohammed, 2002)

According to the work of Neumann and Morgenstern, Schoemaker (1982) concluded NM’s axioms about expected utility maximization, which included the following five statements:

1. Preferences for different choices are complete and transitive. Completeness means for any choice between A and B, people either prefer A, or prefer B, or both A and B are equally attractive. Transitivity means if A is preferred to B, and B is preferred to C, then A is preferred to C.

2. If there are three outcomes A, B and C, there exist a probability p, which can make \( pA + (1-p)B \) has the same preference as C for certain.

3. If A and B are equally attractive, then for any value of p and C, \( pA + (1-p)C \) will be equal attractive as \( pB + (1-p)C \). In other words, preference between different choices will not change when other things are equal.

4. Consider two choices E and F, let E equal \( p*A + (1-p)*B \), F equal \( q*A + (1-q)*B \). If A>B, then E will be preferred over F if and only if \( p>q \).

5. A compound choice is equally attractive as the simple choice that would result when multiplying probabilities through.

\[
\begin{align*}
E &= (1-p)p + qA \\
F &= (1-p)r + rB \\
\end{align*}
\]

That is, the choices of E and F should have equal attractiveness.

These axioms make it possible to formally incorporate risk and uncertainty into economic and financial theory (Abdellaoui, 2002), and let expected utility theory be widely accepted applied to represent the essence of rational behavior under risk.

However, it is well known that many people do not always behave in rational ways. In certain situations, they systematically violate these axioms, which had been studied by researchers (Loomes & Sugden 1982, Schoemaker 1982). Schoemaker (1982) pointed
out three problems that EU theory as descriptive model of decision-making: first, people do not analyze problems as comprehensively as EUT suggests; second, people do not process information based on the EUT axioms; and thirdly, as an ‘as if’ model, EUT poorly predicts choice behavior in laboratory situations. In view of above-mentioned reasons, EUT is doubted whether or not it is good enough as a general descriptive model of rational decision-making.

Besides these five axioms formally mentioned by Neumann and Morgenstern (1944), another important tenet for applying expected utility theory to choices is risk aversion, which implies people not being risk seeking under any situation. However, this is not true. In certain circumstance, people will show risk-seeking character, such as when they face loss (Kahneman & Tversky, 1979). We will see detail in the following framing effect bias part.

Through above literatures reviewing in EMH and EUT, we understand the rationality in traditional economic area and its application in financial market. We are clear about the requirements and assumptions to become a rational person. Meanwhile, we learn there are criticisms on them due to their idealism. After that, we turn to the psychological field to reviewing the influence of psychological factors on people’s rational choice.

### 3.3 The Influence of Psychology

#### 3.3.1 The importance of psychology

Nowadays, more and more people realize the importance of psychology. When a company wants to prompt a new product to consumers; when an institution, such as EF, which is the world leader in international education field, is going to recruit new trainees; when a policeman is trying to learn the truth from a suspect; and when a security company is trying to attract investors to do stock trading through its system, etc.. All of these activities, if want to succeed, analyzing the psychological factors of their opposite sides would be an advantage. If they know people’s minds and behavior, they would play the leading role in their social activities.

Psychology is very important in people’s daily life. But they seldom know what psychology is and what psychologists do. According to professor Eysenck (2000, p3), the most common definition of psychology is that it is the scientific study of behavior. To be more precise, he defined it as the science that makes use of behavioral and other evidence to understand the internal processes leading people and members of other species to behave in the ways they do. That is, psychologists’ work is not only to observe and to measure behavior, but they try to understand why people act in those ways and what are the internal processes and motives behind those behavior.

Then, how could psychologists understand human behavior? Is there a scientific and
uniform system to conduct such research? Eysenck (2000, p3) stated due to our behavior is jointly determined by many different factors, there are a large number of different approaches exist to analyze human behavior. Those factors include but not limit the following:

- The specific stimuli presented to use.
- Our genetic endowment.
- Our physiological system.
- Our cognitive system (our perceptions, thoughts, and memories).
- The social environment.
- The cultural environment.
- Our previous life experiences (including those of childhood).
- Our personal characteristics (including intelligence, personality, and mental health).

Therefore, it is very hard for us to interpret a behavior using only one of those factors. Such as the herding behavior in stock market, investors follow other investors to buy or sell stocks. This phenomenon may depend on this investor’s personal characteristics, for example, he is skeptical in his daily life, usually follow other people’s behavior. It may depend on his previous life experiences or memories, for example, he once made a loss due to insist his own opinion, and now, he has the fear. It may depend in part on this investor’s genes, which inherited from his parents. Etc...

With the development of psychology, psychologists, sociologists, neurologists, zoologists, anthropologists, biologists and others do contribute a lot. Those contributions influence the research area within psychology, some of which are social psychology; biopsychology; abnormal psychology; cognitive psychology (Eysenck, 2000, p4):

Social psychology, which based on the fact that we are social animals, examine how we relate to other people and the society;

Biopsychology, it tries to understand human behavior from the biological perspective, such as function of the brain;

Abnormal psychology, which considers the causes of mental disorders and with the treatment of those disorders;

Cognitive psychology is concerned with internal processes, such as attention, perception, language, memory, thinking, decision, judgment and reasoning.

For our research, we will test the biases of representativeness, availability, herding, regret, anchoring and framing effect, which will affect people’s reasoning, decision making and judgment. From this clue, we can decide that cognitive psychology is the
very one we should use to follow our research.

3.3.2 Study of cognitive psychology

Ashcraft (2006, p9) regarded cognitive psychology as the scientific study of human memory and mental processes, which is named ‘internal processes’ in Eysenck (2000)’s book. In psychology, the collection of mental processes and activities is cognition, while memory is the mental process of acquiring and retaining information for later retrieval and the mental storage system that enables these processes. It includes 3 critical ideas: first, we remember things from the past but experience things in the present; secondly, memory is a mental act in which stored information is recovered from some current use; thirdly, memory is a place to store all the events, information, and knowledge of a lifetime (Ashcraft, 2006, P10).

For example, behavioral bias resulted from regret. When investors are computing the timing of buying, selling or holding part shares of one stock, memory of past events usually appears in front of them. They remember gains or losses due to last trading in a similar situation, fear or prefer to have that experience again this time, finally influence their decision. And after the current trading, there is one more piece of information is stored in their brains, which would be used for future trading or other events.

Until now, we know cognition and memory play an important role on our mental and body behavior. Then, how do we make decisions? How do we make a choice among several alternatives? And how do we decide which of several options is the best under some set of circumstances? Ashcraft (2006, P483) presented two general approaches to achieve a problem solution or reason out an appropriate answer: algorithmic approach and heuristic approach.

An algorithm is a specific rule or solution procedure that is guaranteed to furnish the correct answer if it is followed correctly (Ashcraft, 2006, P483). Such as formulas in arithmetic and geometry, for example, we all know how to compute the area of a triangle, which is the base times one half of the height. Based on this formula, if we are given the information about the base(3) and the height(4), we can get the answer of this triangle’s area(0.5*3*4=6). Thus, the algorithm rule provides us the correct answer. Just as those five axioms we have reviewed in EUT part, a rational person is assumed to follow those rules and algorithm to make his decision. While in reality, people do not behave like that, they use heuristic approach a lot.

A heuristic, which is an informal method or guideline to people’s reasoning and problem-solving, and it’s a seat of the pants approach, which does not guarantee to get the correct answer (Ashcraft, 2006, P483). Many times, people use their experience rather than normative model like algorithm, to solve problems and learn new knowledge. Because sometimes, it is impractical for everyone to do an exhaustive and
complex research on certain problems, while heuristic methods, such as availability and representativeness, can help them to find a satisfactory answer quickly, even though this answer sometimes is not correct.

When we confront complex problems or new information, our brains usually filter out some information and use shortcuts to reduce their complexity. And this procedure usually results in satisfactory estimates before conducting careful and all-round consideration. This is the process of heuristic simplification, which can cause psychological biases for people. For example, people usually show much confidence on solving new problems than they should have. When they make a decision, they would like to seek available information to support their belief. This kind of self-deception might lead to decision error. (Ito, Pynadath & Marsella. 2009)

There is a truthful example. 10 months ago, on March 11, 2011, when Japan suffered serious earthquake and tsunami. At that time, Ning An was conducting foreign exchange trade in international market. He speculated the exchange rate of Japanese Yen to US dollar would be depreciated, due to the Japanese government had to buy more goods and medicals from abroad, and printed more money for reconstruction after the disaster. Mr. An also confirmed his belief through some professional trading website, such as www.forex.com. Most weirdly, he preferred those analyses that confirmed his belief, for other analyses, which were conflict with his opinion, he thought they were wrong, and did not consider their comments. However, several hours later, Ning An lost all his money due to the appreciation of Japanese Yen. This loss gave him a big lesson, which also intrigued him to study more on behavioral finance and psychological factors.

Psychology influences people’s lives, naturally it also affects investors’ decision making in financial field. For the research in this paper, we exhibit the influence of heuristic approaches and cognitive biases on people’s decision making and investment market, further to study the relationship among cognitive ability and behavioral biases.

With the following content, we will introduce the six behavioral biases that are wildly studied by behavioral finance separately, and illustrate them by using several representative examples.

3.4 Heuristics and Biases

3.4.1 Representativeness

What is the probability that event A derive from B? What is the probability that event A belongs to group B?’ Representativeness heuristic is usually employed when people face such probabilistic questions, which was defined by Tversky and Kahneman
(1983) as an evaluation of the degree of correspondence between a sample and a population, an instance and a category, or more generally, an outcome and a model.

The representativeness heuristic is a judgment rule in which an estimate of the probability or likelihood of an event is determined by one of two features, how similar the event is to the population of events it came from or whether the event seems similar to the process that produced it (Ashcraft, 2006, p488). That is, as we said in the beginning, we judge whether event A derive from B based on the extent to which event A represent B or the degree to which A seems like B.

Representativeness is widely used and very effective in people’s daily life. It helps us to identify patterns in complex events, let us gain a reasonable result at least in appearance, and save our time. However, representativeness may lead people go astray, make irrational choice, and even result in losses for investors. Tversky and Kahneman (1974) mention several factors that representativeness does not consider in the course of probability judgments, which will lead the result to serious errors in decision making. Such factors include prior probability of outcomes, sample size, and misconceptions of chance:

**Prior probability of outcomes**, which is a very important reference for event evaluation, helps people make reasonable inference. While people usually show different reflection when they are given worthless information and when they are given no information. When there is no information offered, people properly consider and refer to prior probability, but when there is some information given, even if those information is worthless, people usually ignore prior probabilities. Instead they make their judgments solely on the worthless information. (Kahneman, 1974)

**Sample size** is one essential factor to evaluate the similarity of a sample parameter to a population data, the closer the size of sample to population, the more accurate the evaluation. People usually employ representativeness heuristic and use sample results to assess their similarity with corresponding population parameters. While whether sample data can represent population, the sample size is an important reference. In other words, the bigger the sample size, the closer to the population, the more representative the sample can be.(Kahneman, 1974) However, when the model and outcome are described in the same way, people usually believe they are the same thing based on representativeness (Tversky and Kahneman 1983), while ignore the sample size.

**Misconceptions of chance**, which means people usually mistake the representativeness of chance, and wish a sample result generated from a random process can stand for the essential characteristics of the population, even the sample size is very small. These people have faith in law of small numbers, though they might do not realize it. They believe population can be highly represented by small sample. Therefore, people often overestimate the replicability of sample results. (Kahneman, 1974)
In order to illustrate the phenomena of representativeness bias, Tversky and Kahneman (1983) use the following sample:

*Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and also participated in anti-nuclear demonstrations.*

- Linda is active in the feminist movement. (*F*)
- Linda is a bank teller. (*T*)
- Linda is a bank teller and is active in the feminist movement. (*T&F*)

Through the experiment to 88 undergraduates, they found 85% students choose the probability order, *F* > (*T &F*) > *T*. However, as a classical application of representativeness heuristic, most subjects use the worthless information that the question gives out to make their judgments, and ignore the probability of each choice. Actually, from the knowledge of basic probability principles, as two independent events *T* and *F*, the probability of combination, *T&F*, cannot be more than the probability of each independent event. Therefore, representativeness heuristics makes people violates the rational choice systematically, it induces people’s judgments to be based on stereotypes, i.e. influenced by the similarity of a description, which is also one of the most important principle affecting financial decisions (Shefrin, 2000, p14).

This is also violates the axiom five of EUT, which means people can look through the essence of complex events. However, most people show representative heuristics, which deviate away their judgments from rationality.

### 3.4.2 Availability

‘What is the risk of heart attack among old-aged people? What is the divorce rate in your city? What is the most frequent cause of death in your country?’ If people are asked such questions, most of them will depend on their experience and memory, and recall the times of such events comes to their minds in order to get their answers, when this kind of phenomenon appears, people show availability heuristic (Shefrin 2000). At that time, a bias occurs when estimates based on availability, which are distorted by the influence of factors, such as drama, relevance, similarity, familiarity, concreteness or vividness of instances (Rious&Russo, 1988).

The availability heuristic is a decision-making heuristic in which we judge the frequency or probability of some events on the basis of how easily examples or instances can be recalled or remembered (Ashcraft, 2006, p566). In the availability heuristic, people evaluate frequency or probability of certain event by the ease with which instances or associations could be brought to their minds. A series of experimental studies that are concerned with judgments of frequencies and probabilities shows that availability heuristic has influence on the estimation about frequencies and probabilities of events, at last, leads to systematic biases. (Tversky
Generally speaking, large classes’ examples are usually recalled better and faster than less frequent examples. Therefore, availability heuristic is a very useful tool to help us to evaluate frequency or probability of certain events in practice, it is a reliable way and often the only way we have of making estimates in many situations (Ashcraft, 2006, p493). However, some biases and distortions might come from this heuristic, due to our judgments are based on what we can remember easily, any factor that leads to storing information or events in memory can affect people’s reasoning. If the information or events in memory is reasonably accurate and undistorted, then, people probably make a right judgment or get a reasonable answer; while when the memory contains inaccurate, incomplete information or events, people might make an unreasonable judgment (Ashcraft, 2006, p493).

Take an example, if your classmate has a Lenovo laptop, which return to the mechanic frequently, says 3 times per month. Then, you might develop a bias that Lenovo is not good at quality. If your conclusion is only from your neighbor’s event, then, the availability heuristic has biased your judgment. In other words, the information in your memory is inaccurate and incomplete.

Tversky and Kahneman (1974) show systematic biases would appear during decision making when people rely on availability to conduct evaluation due to retrievability of instances, effectiveness of a search set, and imaginability:

**Biases due to the retrievability of instances.** When people judge the size of a class by the availability of its instances, a class whose instances are easily retrieved will appear more frequent than a class of instances is less retrievable, even though the latter might have equal or more frequency. It means the easier certain information appears in your mind, the more likely we are affected by this information.

**Biases due to the effectiveness of a search set.** People usually use the easier way they can get to solve corresponding problems, regardless of the reliability of the search set they use. In Tversky and Kahneman (1974)’s research, they conducted a research to ask their subjects that ‘is it more likely that a word begins with p or that p is the third letter?’. And after this test, they found people answer this question usually through assessing the relative frequencies by the ease with which situation come to their minds.

**Biases of imaginability.** When people have to evaluate the results of some events, but they do not have relevant experience or knowledge on those aspects, they usually generate their answers based on a given rule. Such as if a young high school student wishes to study abroad next year. He goes to make inquiry from his friends and relatives. If many difficulties are presented by his friends and relatives, and they might take other students’ examples to prove how difficult it is. Then, he may
overestimate the difficulties to study abroad. On the other hand, such difficulties will be underestimated if most of his friends and relatives ignore or do not have such knowledge, or only take successful students’ examples to him.

All of these biases can attribute to the times that certain types of events come readily to mind, i.e. availability heuristic. Shefrin(2002) defined availability heuristic as the degree to which information is readily available, and takes the following example to explain it:

*What is the more frequent cause of death in the United States, homicide or stroke?*

He explains that when people are asked this question, most of them will rely on their memories, in other words, how many times these kinds of events come to mind. If people readily recall more homicide than stroke in their mind, they will get the answer ‘homicide’.

Experimental study shows that more people choose homicide, while the truth is stroke. Why this happens? Shefrin (2002) explains the media coverage biases people’s answers, because media more prefer newsworthy reports than common, and homicide can draw more people’s attention. Meanwhile, people get their answers to minds according readily recall, they usually get news like homicide from different kinds media, which give them more frequency and strong impression.

Therefore, even though availability heuristic is usually employed by people, and it sometimes is very useful, while due to the limitation of it, systematic biases might occur when conduct decision making under uncertainty.

**3.4.3 Regret**

When you face an alternative decision, do you recall your last experience in similar situation and combine the feeling of regret or rejoicing due to your last choice into your decision for this time? An individual’s capacity to anticipate feelings of regret and rejoicing affects people’s decision-making under risk systematically, which violates the axioms of expected utility theory (Loomies and Sugden, 1982).

Regret is a common factor in the course of decision making. When making a choice between two alternatives, people will forecast the various experiences of pain and pleasure that each might lead, this foresight would affect people’s decision making (Loomies & Sugden, 1982). Studies have shown the feeling of regret influences people’s investment decisions (Shefrin, 2000, p31) and consumer satisfaction about purchased goods (Taylor, 1997), the regret factor causes them try to change their decisions in order to avoid regret.

After the presentation of ‘prospect theory’ by Kahneman and Tversky(1979), and
based on the belief that many people behave in ways that systematically violate those axioms under Expected Utility Theory, Loomies and Sugden (1982) developed their own alternative theory of rational choice under uncertainty, that is, Regret Theory, which they believe has great appeal to intuition.

The essential concept of regret theory is that people usually compare the actual choice they have made with the one they would have made, and think about what is the result if they make a different choice at the beginning. If they find the different choice would have resulted in a better result than they have done, people may experience a painful sensation, which is regret. But if they realize the different choice would have led to a worse result, they might have a pleasurable sensation, i.e. rejoicing. After that, when they confront a new decision making environment in the future, people will recall their previous experiences before making the choice, and form an expectation about the feelings that the present one might bring, finally make their decision with those expectations (Loomies & Sugden, 1983). However, those expectations would disturb their rational choices.

People cannot always make right choices, when they experience a wrong decision, the regret feeling occurs. This feeling could influence people’s decision making. People, who have the feeling of intense regret, usually don’t have strong preference for changing. While those people who experience little regret feeling, might like to keep the same route every day for minimizing possible future regret. For example, Shefrin (2000, p31) stated some investors might prefer to receive dividends periodically rather than sell stocks in order to minimize the regret feeling. That is, in order to avoid or minimize the feeling of regret resulted from selling stocks, investors become very conservative. They fear to make wrong decisions and the following imaginable losses, while this behavior hampers their rationality.

The fear of regret expectation let people deviate away from rational decision-making. While even when people start from the purpose of minimizing regret, they may feel new regret feeling due to their decision, which will also influence their rationality. However, when there is an unexpected poor outcome, active choice usually suffers greater regret than passive choice. People feel deeply self-recriminating about the worse result due to their active actions, while corresponding rejoicing is postulated for active choice that leads to good outcomes (Connolly et al. 1997). However, as we will mention in the figure 3 of prospect theory value function, people value the losses heavier than gains even the amount is the same, i.e. they put more weight on regret feeling than pleasure feeling. Therefore, in order to minimize regret, they would prefer passive choice.

In order to explain regret phenomenon, Sugden (1985) use the following idea:

*Suppose someone has to choose between two actions, A and B, under uncertainty. He does not know which of a number of states of the world will occur. In some situation,
A will lead to a better consequence than B, while in other situation, B will perform better than A. Suppose he chooses A, after that, when the uncertainty is resolved, the consequence that actually occurs is worse than that would have occurred had he chosen B.

In such an event, the investor will experience regret, i.e. a painful sensation through comparison, or vice versa, will experience a pleasurable sensation. However, the degree of this emotion would largely influence their decision making for the next time, the stronger the feeling, no matter regret or rejoicing, the more possible to affect their decisions.

3.4.4 Herding

Imagining such a picture that you are travelling abroad, and decide to go to restaurant A to have your dinner. The restaurant A is recommended by a very reliable guidebook. After arrival, you find that restaurant B nearby is very busy, and there is a long queue waiting for dinner, while restaurant A has only a few customers, in this situation, will you change your minds and go to restaurant B? If you are, then you follow the way of herding.

Herding, in most general term, often occurs when many people take the same action, maybe due to some mimic the actions of others (Graham, 1999). According to Caparreli et al.’s study (2004), there are two types of herding, intentional herding and spurious herding. Intentional herding means people neglect their available information and change their minds arbitrarily to copy one another. They follow the behavior of majority without knowing why it happens. The fear of making a mistake probably affect people’s decision and let them go with the flow, and with the conviction that a shared error. Such decision is purely imitative, and this kind of behavior deviate away people from the original rational decision they should have. The other type of herding is spurious herding, which means people adopt the same behavior based on their similar investment decisions according to their analysis and available information. That is, this type of herding behavior reacts macro- or micro-economical information, shows the market efficiency. While when people’s decisions are out of rational range, for example, the market prices deviate away their intrinsic values significantly, then the spurious herding might be turned to intentional herding.

Herding behavior in stock market can cause huge fluctuation on share prices. Sometimes, price fluctuations are not necessarily related to new information or changes in fundamental economic variables, which suggest high fluctuation in stock market may related to people’s collective phenomena (Cutler and Shiller, 1989). In financial field, the study on herding is relatively well documented empirically, few theoretical studies on this aspect, especially on the implications of herding and imitation for the statistical properties of market demand and price fluctuations (Cont & Bouchaud, 2000). However, those empirical studies have shown the significant
influence of herding phenomenon on the market and investors’ behavior, and may deviate from people’s rational choices.

Many economic activities and financial activities have been proved to show linkage with herding behavior, such as investment decisions and recommendation (Scharfstein & Stein, 1990), funds investment management and individual stock investment (Song & Wu, 2000, 2002), and product choices on the Internet (Huang & Chen, 2006). Take Huang & Chen’s study as an example, they used three studies to conducted a research about ‘product choices on the Internet’. The first two studies were about the influence of sales volume and customer reviews on on-line products choice, and the third study examined the effectiveness of two recommendation sources, other customers and experts. Through their study, they found their subjects showed herding behavior when they conducted on-line shopping. They used choices and evaluation of other customers as cues for making their own decisions. Furthermore, they found recommendations of other consumers influence the choices of subjects more effectively than recommendations from an expert.

Therefore, from those previous empirical studies, we know that herding behavior usually occur in the course of people’s decision making, and it will significantly influence people’s choice.

3.4.5 Anchoring

When you are assessing the probability of certain events, will you refer to some starting points that have been given out to adjust your evaluation? In many situations, people usually make their evaluation based on an initial value has been given out, and then conduct certain adjustments to get the final answer. However, such adjustments are typically not enough, different staring points usually get the corresponding values that are close to those starting values, this phenomenon is called anchoring (Tversky and Kahneman, 1974).

Anchoring effects occur unintentionally and non-consciously. Even though when people are forewarned to be careful about anchoring problems and let them have strong incentive to be accurate, they are still obviously influenced by the starting points or reference information. Anchoring effect shows its influence on people’s judgment even if they are given some arbitrary and meaningless numbers as starting points. These numbers has no reasonable meaning to answer target questions, but people will regard it as an important reference. (Wilson et. Al., 1996)

Shleifer (2000) took an example about risky gambling game, stated that people in risky gambles do not look at the levels of final wealth they can get, but care much at gains and losses relative to some reference point, which may vary from situation to situation. That is, anchoring effect influence people’s decision, and the reference point changes frequently.
Tversky and Kahneman (1974) mentioned several problems caused by sticking to certain starting points, one is the insufficient adjustment to those initial points, and the other one is biased results from evaluation of conjunctive and disjunctive events in the course of people’s decision making:

**Insufficient adjustment.** As we mentioned at the beginning, people do make some adjustments to starting reference points, however, those adjustments are usually insufficient. Tversky and Kahneman (1974) conducted an experiment to examine anchoring effect, which asked two groups of subjects to answer the following two questions:

1. *Do you think the percentage of African countries in the United Nations is more or less 10%/65%*

2. *What is the percentage of African countries in the United Nation?*

In this experiment, two different groups of people are asked to judge first whether they believe the percentage should be over or less a certain number, and then make their own evaluation. Their answers show anchoring effect. For the group that receives 10% as the reference point, the median estimate of the percentage of African countries in the United Nations was 25%; while for the group that receives 65% as the reference point, the median estimate is 45%. Even though the numbers of 10% and 65% are presented randomly and subjects believe it should be adjusted, they still make modification based on the given number, and the adjustment to the starting point is insufficient.

**Biases in the evaluation of conjunctive and disjunctive events.** Due to biases result from anchoring effect, people usually show overestimation to conjunctive events probability and underestimation on disjunctive events. Here is something like representativeness heuristic, however, due to the probability to presented event are naturally regarded as a starting point for estimating the probabilities of conjunctive or disjunctive events, while judgments on relevant starting points are not enough. As a result of anchoring effect, the probability of conjunctive event is usually overestimated, while the probability of disjunctive problems is often underestimated.

We can use Linda’s story as an example, first we describe Linda’s personality, specialty and part of her experience, which can be viewed as the reference point in anchoring effect. Then, we ask questions like what does Linda do? Subjects give high probability to (T&F), and believe Linda is a bank teller and at the same time is active in the feminist movement. This result shows subjects overestimate the probability of conjunctive events, influenced by anchoring effect.

Such anchoring effect happened in the course of decision making, also reflect in financial markets. Security analysts are usually influenced by anchoring effect when
they conduct earnings prediction. For example, according to new earning announcements from a company, analysts usually do not revise their predictions enough to reflect ongoing new information. While on the other hand, positive earnings surprises from firms usually followed by more positive earnings predictions from analysts, negative earnings surprises tend to be followed by more negative earnings predictions, this phenomenon shows analysts are biased by the anchoring number from the relevant financial information (Shefrin, 2002, p20).

3.4.6 Framing

Framing effect means that the decision is influenced by the phrasing or frame in which the problem is presented (Eysenck, 2000, p369). It exists when a decision maker’s risk tolerance is dependent on how the set of options is described (Gonzalez et al. 2005). Many decision problems we meet can be stated or framed in more than one way. ‘In other words’, which we often use in communication, might be one of the best explanations about such case. While state the same thing under different ways usually give people different feeling about the problem, which induces them make a different judgment in the course of decision making.

Now, suppose you are facing the following pair of situations, which alternative do you prefer in each situation?

**First situation:**
A. a sure gain of $240
B. 25% chance to gain $1000, and 75% chance to gain nothing

**Second situation:**
C. a sure loss of $750
D. 75% chance to lose $1000, and 25% chance to lose nothing

Tversky and Kahneman (1981) conduct such an experiment to test framing effect. As rational choice under expected utility theory, people should compare the expected utility of these four choices using the following equation:

\[
\text{Expected Utility} = \text{probability of a given outcome} \times \text{utility of that outcome}
\]

In this example, the expected utility of A is \(100\% \times 240 = 240\), the expected utility of B is \(25\% \times 1000 + 75\% \times 0 = 250\); the expected utility of C is \((-100\%) \times 750 = -750\); and the expected utility of D is \(75\% \times (-1000) + 25\% \times 0 = -750\). From the result, we can compare their utilities \((U)\) that \(U(A) < U(B)\) and \(U(C) = U(D)\). Therefore, the rational choice should be B for the first situation, and for the second situation, C and D have the same utility.

However, through Tversky and Kahneman (1981)’s studies, there are 84% subjects choose ‘A’ in the first situation and 87% of subjects choose D in the second situation.
This kind of choice systematically violates the elementary requirements of expected utility theory (EUT) and the questions’ frame deviate away people from the assumption of rationally.

On the other side, when the question is presented in positive format, i.e. state in the format of how much people can gain, most of subjects choose ‘A’, and show risk averse. In their minds, a certain gain is better than a risky choice of equal or even greater expected value. While when the question is showed in negative format that the question is stated in the format of how much people can lose, they choose ‘D’ and show the nature of risk-seeking, they believe the risky choice is preferred to a riskless one of equal expected value. That is, people change their risk preference when they are confronting with different formats of similar questions.

Prospect theory, which was developed by Tversky and Kahneman(1979), can be used to explain this phenomenon. Prospect theory criticizes the EUT’s tenet of preference transitivity, and finds the incompatibility between people’s preference patterns with EUT. It believes that people’s preference and choice is not constant as expected utility theory states, and uses the S-shaped figure to explain such situation:

**Figure 4: Value Function in Prospect Theory**

From figure 4, we can find out the arc in the loss (−) part show convex shape, which means in that area investors value one more unit loss is less than his last one unit loss, that is, investors show out risk-seeking character when they face loss. While in the part of gains ‘+’, the curve shows concave shape, that is, in the area of gains investors value one more unit gain is less than his last one unit gain, which shows risk-averse character. Therefore, people are not always consistent with their preference as EUT assumes, the preference will change when the face gains and losses.
Also, from the figure, we can see the slope is steeper for losses utility curve than that for gains utility curve, which represents that even the same amount of losses and gains, investors will value them differently, and the value of losses is much heavier than the value of gains. In other words, positive frame and negative frame for the similar problem will make people have different choices.

Utility expected theory assumes people are rational and can differentiate various ways that problems might be presented, i.e. framing is transparent. However, many frames are not easy to understand, they are not obvious but opaque. When people are difficult to look through an opaque frame, their decisions usually depend on the particular frame they use (Shefrin, 2002, p23), while these frames sometimes can deviate away people from rational choice.

Another example used by Tversky and Kahneman (1981) to illustrate framing effect is the following:

*Imagine that the United States is preparing for an outbreak of an unusual Asian disease that is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Scientific estimates often consequences often programs are as follows:*

**Positive frame:**
*If Program A is adopted, exactly 200 people will be saved.*
*If Program B is adopted, there is a 1 in 3 probability that all 600 people will be saved and a 2 in 3 probability that no people will be saved.*

**Negative frame:**
*If Program C is adopted, exactly 400 people will die.*
*If Program D is adopted, there is a 1 in 3 probability that nobody will die and a 2 in 3 probability that all 600 will die.*

In this study, most people choose the answers A and D. In other words, when the problem is presented in a positive way, people tend to show risk averse. While if the problem is presented in a negative way, people would exhibit a risk seeking tendency.

Therefore, people’s preference would change under different situations, even for the same problem. And the framing questions are not always transparent, when they are presented in a different way, a choice might not be equally attractive, even though they might have the same result.

Availability, representativeness, anchoring, framing, regret and herding, all of those six biases we have mentioned are common for human being, can induce people deviate away from rational choice systematically in the course of decision making. While people are different, each person has his or her own character. They may have
different experience, different level of knowledge, and different cognitive ability level. It is good to take a look at whether such factors have influence on those biases. Here we will focus on the influence of cognitive ability on them.

Before we conduct our test, we should make it clear that what cognitive ability is, and which reasonable method we should choose to test cognitive ability in our research.

3. 5 Cognitive Ability Tests and CRT

In order to examine people’s cognitive abilities, researchers have developed and used many intelligence quotient (IQ) tests to measure the different cognitive level that exists in different people. While, nowadays, this type of tests has a more popular name, cognitive ability test, which is widely used to test people’s cognitive ability. (Dickens, 2007)

The first proper intelligence test was devised by Frenchman Alfred Binet at the beginning of the 20th century, which was for identifying mentally retarded children and provided them with special educational facilities. Later (1905), Binet and his associate Simon produced a wide range of tests to measure comprehension, memory, and other cognitive processes. This led to numerous later tests. (Eysenck, 2000, p737)

From modern psychological view, there are a number of dimensions of cognitive ability (Dickens, 2007). Based on different dimension and purpose, psychologists and other researchers of the world have developed many cognitive ability tests, such as Scholastic Achievement Test (SAT), which is a test for college admissions in America to measure students’ academic achievement; Wonderlic Personnel Test (WPT), which is to measure people’s general cognitive ability; “need for cognition” scale (NFC), which is good at measuring people’s tendency to engage in and enjoy thinking (Frederick, 2005), administrative aptitude test for civil servants in China, which is to test people’s ability to work for government, and so on.

Eysenck (2000, p738) stated that a good intelligence test should have high reliability and validity. Reliability means the extent to which a test provides consistent findings. That is, if one group of subjects takes the same intelligence test on two separate occasions within a short time later, the results should be the same. Otherwise, the test would clearly be unreliable. Validity refers to the extent to which a test measures what it is supposed to be measuring, and there are 2 main ways to assess it: empirical validity and test validity:

The basic idea of empirical validity is that we would expect highly intelligent people to be more likely than less intelligent ones to achieve certain criteria, such as doing well at school or career.

Test validity means if there are a well-established test and a new test, and the two tests
correlate positive highly, and then we can regard the new test has good reliability and validity.

For our study, we cannot use empirical validity method due to the limit of time. Therefore, we use the test validity method to prove the cognitive ability question in our questionnaires is a brief and effective way.

As we said before, after Binet and Simon’s work (1905), nowadays, there are numerous different kinds of cognitive ability tests. However, few of them focus on the relationship between cognitive ability and people’s decision making. In order to detect the very relationship, Frederick(2005) developed cognitive reflection test (CRT), which is used to reflect the influence of people’s cognitive ability on decision making, and mainly to measure people’s ability to resist reporting the response that first comes to mind.

The Cognitive Reflection Test (CRT)

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? _____ cents
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

These three problems looks very easy, however, even Frederick himself also admit an erroneous intuitive answer that springs “impulsively” to his mind first for the three questions before he gets right answers. Biases usually happen when we believe the problem should like what we think, rather than what the problem really is. If we do not reflect these problems we face, to conquer our impulsive answers, we would get wrong solutions.

CRT reflects two types of cognitive process in the course of decision making: one type shows quick execution with little conscious deliberation, and the other one shows slower execution and more reflective (Frederick, 2005). We all can have these two types of process, while the point to get right answers is whether we can conquer the impulsive erroneous answers. Anchoring effect, representative bias, availability bias, framing effect, herding effect and regret, and other psychological biases studied by behavioral finance, all of them appear during the process of investment decision making (Shefrin, 2000). Therefore, use a cognitive ability test that focus on decision making to measure biases in the course of decision making would be a preferable option.

Also, Empirical study shows CRT has positive correlation with some other
well-established cognitive measures, such as SAT (0.44), ACT (0.46), WPT (0.43), NFC (0.22) (Frederick, 2005). These results mean CRT has the good reliability and validity, can be reasonably regarded as a useful measurement to test people’s cognitive ability.

3.6 Previous Studies on the Relationship

Behavioral finance incorporates psychological factors into finance field, whether or not those subjective factors are also affected by cognitive ability, and to what extent they are influenced by cognitive ability, intrigues researchers’ interest. Some researchers have conducted studies to analyze the correlation between them.

Benjamin and Shapiro (2005) conducted an examination on the relationship between cognitive ability and two deviations from standard decision theory, that is, short-term discounting and small-stakes risk-aversion. Through this study, they believed cognitive ability can improves people's decision-making through better acquired heuristics. They found out a negative relationship between cognitive ability and those two preference anomalies. Relative to low cognitive ability people, high cognitive ability people were more likely to choose a larger later reward over a smaller sooner one (Frederick 2005), which effectively reduce the bias of short-term discounting. Basing on their experimental study, it showed that individuals with higher cognitive ability were less likely to display behaviors that have been associated with the two anomalous preferences than people with lower cognitive ability. In Benjamin and Shapiro’s study, they used Scholastic Achievement Test (SAT) math scores as the measurement tool for cognitive ability.

Frederick (2005) put forward cognitive reflection test (CRT) and conducted a research on the relationship between cognitive ability and time/risk preference in the course of decision-making. He found that intelligent people are more patient, and they devalue future rewards less, which was similar to the study result of short-term discounting preference presented by Benjamin and Shapiro (2005). When people face losses, high cognitive ability people showed more rationality. They were less risk seeking and more willing to accept a sure loss to avoid playing a gamble with lower expected value.

Oechssler, Roider and Schmitz (2008) studied on the relationship between cognitive ability and three psychological biases. That is, conjunction fallacy, anchoring, and conservatism biases, all of them play prominent roles in behavioral economics and finance. Through their research, they found that people with higher cognitive ability show less biases in conjunction fallacy and conservatism, while anchoring effect appears no significant difference between different cognitive ability groups.

Therefore, in virtue of these previous studies, we have reason to believe cognitive ability surely influences investors’ decision making in the process of their investment.
There is certain relationship between cognitive ability and people’s preference or psychological biases. In certain situations, people with high cognitive ability can effectively reduce psychological factors’ influence to make more rational decisions than people with low cognitive ability.

Through the whole chapter, on the basis of previous valuable studies, we have known the six biases, availability, representativeness, anchoring, framing, herding, and regret. And we are clear how they systematically violate people’s rational judgment in the course of decision making. Researches have shown cognitive ability do have influence on people’s decision making. There is certain relationship between cognitive ability and people’s psychological biases. Then, how about this kind of relationship exhibits in Chinese stock market? And what is Chinese stock market investors’ reaction? We will make it clear.
Part 4 Practical Methods

After deciding the theoretical methodology and conducting a thorough literature review, now, we ascertain the practical methods for the purpose of solving the research question that has mentioned.

In this part, we first introduce the way we collect data, which includes questionnaire design and how we get the necessary data. Secondly, we put forward 6 pairs of hypotheses on the basis of our research question. Finally, according to the research question, hypotheses and characteristics of collected data, we choose corresponding statistical techniques for measuring the difference between high and low CRT groups on those six behavioral biases.

4.1 Data Collection

In our study, we measure the relationship between cognitive ability and behavioral biases of Chinese individual stock investors. Therefore, in order to get the primary data for our research questions, we separate our data collection into two steps: questionnaire design, questionnaire collection.

4.1.1 Questionnaire design

In order to test the relationship between cognitive ability and those six behavioral biases, our questionnaire has to include two different kinds of questions: questions for testing investors’ cognitive ability, and questions for measuring biases of representativeness, availability, herding, regret, anchoring and framing effect.

4.1.1.1 Cognitive ability test method

According to the literature review of cognitive ability test, we have know there are many different cognitive ability tests, such as Scholastic Achievement Test (SAT), Wonderlic Personnel Test (WPT), ‘Need For Cognition’ scale (NFC), and so on. All of these cognitive ability test methods have their own special purposes. SAT is special for measuring people’s academic achievement, WPT is used for testing people’s general cognitive ability, and NFC is good at measuring people’s tendency to engage in and enjoy thinking (Frederick, 2005). We also have considered the Chinese cognitive ability test methods. One of the most famous methods is the ‘administrative aptitude test for civil servants’, which aims at testing people’s ability to work for Chinese government. All of these methods can be used for testing people’s cognitive ability, and Scholastic Achievement Test (SAT) math scores had ever been used by
Benjamin and Shapiro (2005) as the measurement tool for cognitive ability to examine the relationship between cognitive ability and two deviations (short-term discounting and small-stakes risk-aversion) from standard decision theory.

However, one of research purposes for this research is to find out a reliable and concise test method which is special for measuring people’s cognitive ability in the course of their decision making. After careful comparison, we believe cognitive reflection test (CRT) developed by Frederick (2005) is very suitable for this case based on the following reasons:

Firstly, it is concise. As a three-item test, subjects do not need to spend much of their time on answering questions. This characteristic reduces investors’ feeling of boredom, lower the probability of rejection to respond our questionnaire. While other test methods such as WPT, SAT and Chinese administrative aptitude test for civil servants usually have many questions to answer, which will take up too much peoples’ time.

Secondly, CRT is a good test to measure people’s cognitive ability in the course of decision making. Especially, it reflects people’s ability to resist the first thought that comes to their minds, and shows their reflective and impulsive characteristics in decision-making process. Those six psychological biases we are studying usually occur when investors make investment decisions or choices. They influence investors’ final decisions and may deviate away them from rational choices. Therefore, it is reasonable to use a test method that focuses on people’s characteristic of decision making to measure investors’ cognitive ability in this research. On the other hand, other test methods, as we said, have their own special purposes to measure people’s cognitive ability, none of them aim at testing people’s cognitive ability in decision-making process.

Thirdly, CRT positively correlates with other cognitive test methods. As we have shown in the part of literature review, the correlation between CRT and SAT (0.44), ACT (0.46), WPT (0.43), which means CRT is reliable to be used as a tool for testing people’s cognitive ability.

Last but not least, collected data from three CRT questions will not only let us measure Chinese individual stock investors’ cognitive ability, but also present a clear picture about their behavioral characteristics (reflective and impulsive) in the process of decision making. Meanwhile, through those data, we can further verify CRT’s practicability for testing Chinese individual stock investors’ cognitive ability.

Therefore, above advantages of cognitive reflection test satisfy our research to test the relationship between Chinese investors’ cognitive ability and those six behavioral biases. For solving this research question and achieving our research purpose, cognitive reflection test (CRT) is the best tool.
4.1.1.2 Test of six biases

For solving the research question, and find the behavioral biases characteristics of different CRT groups, we use six representative questions to measure those six biases. In order to guarantee the validity of our research, we referred to precious famous literatures and cited models of their classic questions for measuring behavioral biases.

Our study focuses on Chinese individual stock investors, therefore, we make a few changes on those six questions in order to make them more familiar and more valid to them. For example, in order to test anchoring effect, we use the statement about percentage of minority representatives in China’s National People's Congress (NPC); for representativeness, we use a Chinese name ‘Xiao Fang’ instead of ‘Linda’; for the question of availability bias, we compare suicide with traffic accidents; and for measuring regret, we set a stock investment scene from investors. These changes make questions become more familiar to our subjects, which can help us to get the true psychological biases of their investment behaviour.

In our questionnaires, for biases of representativeness, availability, regret, and herding, we use four individual questions to test them. In order to test anchoring bias, we put two different numbers that are randomly chosen into the similar question for each 100-subjects group, which is randomly picked. For measuring framing effect, we use positive frame for one group, negative frame for another. The arrangement of different 100-subjects groups is the same as for testing anchoring effect. That is, positive framing question and low anchoring number question appear in one questionnaire, negative framing question and high anchoring number question are on the other questionnaire. The following questions are what we presented in questionnaires to test those 6 biases.

a) Representativeness:
Xiao Fang is 26 years old, single, outspoken, and very bright. She majored in Chinese. As a student, she was deeply concerned with issues of global warming and social justice, which of the following two statements is more likely to be true?
   A. Xiao Fang is a bank teller.
   B. Xiao Fang is a bank teller and is active in the social activity.

b) Availability:
Consider the pair of causes of death, and choose the one you think causes more deaths in the China 2009

Suicide vs Traffic Accidents
c) Regret:
There are two stocks you want to buy and hold for one month, however, due to your budget problem, you can only buy one of them, and the rates of return on these two stocks are uncertain, in some situation, stock A may have a higher rate of return, while in other situation, stock B might perform better. Suppose you finally buy stock A, and then, after one month, the result shows stock B has a higher rate of return. At that time, will you feel regret?
   a. Yes, but a little;       b. Yes, very regret

d) Herding:
Imagine you are travelling in Hongkong, and you decided to go to Restaurant A, which had been recommended by a reliable guidebook. When you arrive, you notice that Restaurant B nearby is very busy, while Restaurant A have only a few customers. So, will you change your mind to go to restaurant B or not?
   a. Yes;       b. No

e) Framing

➤ Framing--- positive
Imagine that the Ministry of Health is planning to prompt a treatment to a flu, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Scientific estimates of the consequences of the programs are as follows:
   a. treatment A saves 200 peoples' lives
   b. treatment B has a 33% chance of saving all 600 people and a 66% possibility of saving no one.
Which treatment do you think better?

➤ Framing--- negative
Imagine that the Ministry of Health is planning to prompt a treatment to a flu, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Scientific estimates of the consequences of the programs are as follows:
   a. treatment A in which 400 people die
   b. treatment B has a 33% chance that no people will die but a 66% probability that all 600 will die.
Which treatment do you prefer?
f) Anchoring

- **Anchoring---high number**
  Do you think the percentage of minority representatives in National People's Congress (NPC) in 2009 is more or less than 30% of all participants answered all the first three questions correctly?

  Could you guess what the percentage of minority representatives in 2009 National People's Congress is?

- **Anchoring---low number**
  Do you think the percentage of minority representatives in National People's Congress (NPC) in 2009 is more or less than 10% of all participants answered all the first three questions correctly?

  Could you guess what the percentage of minority representatives in 2009 National People's Congress is?

Of course, there are other questions can be used to measure those biases. However, we refer to previous studies and choose the ones which are the most representative to test them, and each question is a sufficient condition for the occurrence of corresponding bias. Therefore, those six questions are justified for testing those biases.

Through the questionnaire design, we have arranged three CRT questions and six biases questions to measure Chinese individual stock investors’ cognitive ability and psychological biases, separately. This research is to study the relationship between cognitive ability and those six biases, and learn the biases differences between high/low cognitive ability groups. We have chosen classic questions to measure these two aspects. Therefore, a clear picture about the relationship will be presented through careful study.

### 4.2 Questionnaires Collection

Our research is to find out the relationship between cognitive ability and behavioral biases, from the perspective of Chinese individual stock investors. Therefore, we focus our study on Chinese individual stock investors. Investors in exchange halls are very representative, and they are a perfect epitome of Chinese individual stock investors, who are different in background, such as work experience, education level and so on. Meanwhile, in order to make sure the reliability of our sample data, we referred to previous systematical studies on Chinese individual stock investors behaviour, which were performed by Shanghai Stock Exchange (SSE) in 2002 (Li, et al. 2002). In the study of SSE, researchers totally delivered 880 questionnaires and finally collected 419 effective questionnaires to analyze investors’ psychological biases in their investment process, and concluded that investors have psychological
biases such as anchoring, framing, representative, overconfidence, conservatism, and so on, and suggested psychological biases did not change due to investors’ different education level, various work experience, and so on. However, it believed those biases can be effectively reduced through specialized training. SSE’s study result makes us increase the confidence not only in using our sample data, but also in our research’s value.

At the same time, besides psychological biases, we do not need to worry about the influence of different factors such as age, education level and work experience on investors’ cognitive ability. Our purpose is to find out the relationship between cognitive ability and behavioral biases. Then, when we have investors’ biases data, we can measure the relationship only if we know those investors’ cognitive ability. Therefore, as long as subjects in exchange halls are investors of Chinese stock market, we include them into our study. This sample is in accordance with our research, through the data analysis from such a sample, we are sure to get the accurate answers for this research.

We went to three securities exchange halls (Huatai Securities, Galaxy Securities, and Haitong Securities) in the city of Wuhan, which locates in the middle of China, and sent our questionnaires to investors. There were lots of chairs for investors in exchange halls, some of investors were sitting there and waiting for the best time to buy and sell stocks, some of them were discussing their investment experience and future plans. Investors did not work there as employees, they were free to move. It was up to them whether stayed in exchange halls and how long they stayed there. The environment of exchange halls was quiet, it was good for investors to think. Investors were in an atmosphere of peace and calm to conduct their investment in exchange halls. Especially, investors were in the environment of investment, which contributes to actually reflect investors’ behavioral characteristics in the course of investment decision making. Therefore, the environment where data were collected is fit for our research, and the collected data truly reflect Chinese individual stock investors’ psychological biases and cognitive ability in decision-making process. In order to collect 200 questionnaires, we totally spent 5 days. Every morning we walked into one of those three securities exchange halls at around 9 am, and asked for investors who were sitting there to answer our questionnaires.

Before we delivered questionnaires, we had consulted several workers of exchange halls and asked our subjects whether they had done or other researchers had done such investigations before, all of the answers were ‘No’. We have the confidence in using the questionnaires to collect data. Through the whole investigation in the three exchange halls, we had totally delivered around 317 questionnaires, and finally got 200 effective questionnaires. These 200 effective questionnaires satisfied requirements of our research, let us have reasonable data to conduct analysis.

As we have mentioned before, in order to avoid ethical problem and improve
investigation efficiency, we explained the purposes of our research, and standby to be ready for answering any question investors put forward. This action not only let our research do not harm any subject, but also improve the credibility of the research.

### 4.3 Group Division

After collecting those 200 questionnaires, we separate them into different groups based on the different questions and how many right answers they have on CRT questions.

Due to we measure investors’ reaction on different problem frames and anchoring numbers. We separate them naturally through different questionnaires. As we said, 100 subjects in one group is to test their reaction through positive frame and low anchoring number; the other 100 subjects in another group face the negative frame and high anchoring number.

According to results of the three CRT questions, how to separate investors into high CRT group and low CRT group is a big challenge. We referred to previous studies on CRT questions. In Frederick’s study(2005), he put subjects who had 0 right answer into low CRT groups, and those who have 3 right answers into high CRT group; in Oechssler, Roider and Schmitz’s study(2008), they separated subjects who have 0 and 1 right answer on the three CRT questions into the low CRT group, and consider those who have 2 and 3 right answers as high cognitive ability people.

Therefore, in our thesis, we conduct two kinds of tests. One follows Frederick’s model, to put 0 and 3 right answer(s) into low and high cognitive groups; the other follows Oechssler, Roider and Schmitz’s model. If these two kinds of tests get the same results, we will only present one model for briefness.

### 4.4 Hypotheses

Our research question is to test relationship among cognitive ability and psychological biases studied by behavioral finance, which mainly including representativeness, availability, herding, regret, anchoring and framing effect. In order to the corresponding statistics techniques for measuring their relationship, we first put forward our hypotheses as follows:

- **Hypothesis 1a**: Investors in different CRT groups have no difference in degree of representativeness bias.
- **Hypothesis 1b**: Investors in different CRT groups have significant difference in degree of representativeness bias.
Hypothesis 2a: Investors in different CRT groups have no difference in degree of availability bias
Hypothesis 2b: Investors in different CRT groups have significant difference in degree of availability bias

Hypothesis 3a: Investors in different CRT groups have no difference in degree of herding effect bias
Hypothesis 3b: Investors in different CRT groups have significant difference in degree of herding effect bias

Hypothesis 4a: Investors in different CRT groups have no difference in degree of regret bias
Hypothesis 4b: Investors in different CRT groups have significant difference in degree of regret bias

Hypothesis 5a: Investors in different CRT groups have no difference in degree of framing effect bias
Hypothesis 5b: Investors in different CRT groups have significant difference in degree of framing effect bias

Hypothesis 6a: Investors in different CRT groups have no difference in degree of anchoring effect bias
Hypothesis 6b: Investors in different CRT groups have significant difference in degree of anchoring effect bias

4.5 Quantitative Methods

For testing the relationship between cognitive ability and those biases correctly, we have to choose right statistical test methods, which are suitable for our research purpose and data characteristics. When we refer to statistics books, we find there are two different types of statistical technique are usually mentioned, that is parametric tests and non-parametric tests.

4.5.1 Choice between parametric and non-parametric method

Parametric tests, such as t-tests and analysis of variance, make assumptions about the population from which the sample has been drawn (Pallant, 2010, p213). Parametric tests often include many assumptions, such as the observations must be independent and drawn from normally distributed populations; these populations must have the constant variances; the means of these normal populations must be linear combinations of effects due to columns and/or rows (Hebel, 2002). Therefore, before using parametric tests, we must make sure whether our sample and data qualify those requirements.
Compare to parametric statistics, non-parametric techniques, such as Chi-square test and Mann-Whitney U test, do not have such strict requirements. They do not make assumptions about the underlying population distribution (Pallant, 2010, p213), only ask for observations are independent and variable under study has underlying continuity (Hebel, 2002). However, even though non-parametric techniques have less strict assumptions, they still have two general assumptions: random samples and independent observations (Pallant, 2010, p214). These two assumptions mean each subject is drawn randomly, can be counted no more than once, cannot appear in more than one group, and cannot affect other subjects.

Non-parametric techniques are often the only way to analyze nominal (categorical) or ordinal (ranked) data and draw statistical conclusions (John, 2002). They are useful when samples are very small and do not meet assumptions of parametric techniques. They supplement the invalidation of parametric methods under looser assumptions. Especially, nonparametric statistics are very helpful for study populations that take on a ranked order, rather than clear numerical data.

However, compare to non-parametric techniques, parametric techniques have more statistical power. Therefore, if we have the right type of data, parametric techniques will always be the first choice (Pallant, 2010, p213).

Through comparing parametric and non-parametric techniques, we can decide the technique that is suitable for our case. First of all, the collected data neither distributed normally nor have constant variances. Most of our questions are answered by A or B, they are nominal data, except for the anchoring question, which is answered by percentage. However, we use the percentage is only to get the mean number of each group, for comparing their difference. For this case, it also can be regard as nominal data. Therefore, the parametric techniques are not suitable for our case, due to our data cannot satisfy their stringent requirements. Secondly, our data accord with these two assumptions under non-parametric techniques. Our samples are randomly picked and they do not affect each other’s answers and behavior. So, we believe non-parametric methods are suitable for our study.

However, non-parametric techniques include many statistical test methods, such as Mann-Whitney U(MWU) test, Chi-square test ($\chi^2$), Wilcoxon Signed Rank test, Kruskal-Wallis Test, Sign test and so on. After careful reference and comparison, we finally take Chi-square test and Mann-Whitney U test for solving our research question.

**4.5.2 Chi-square test ($\chi^2$)**

In the nonparametric family of statistical tests, the Chi Square ($\chi^2$) test is undoubtedly the most important and most used member (Key, 1997). Chi Square is employed to test the difference between an actual sample and another hypothetical or previously
established distribution, and it can also be used to test differences between two or more actual samples (Key, 1997). That is, Chi-square test can be used for testing independence and goodness of fit (Pallant, 2010, pp215-217).

With Chi Square, a value is calculated from the data using Chi Square procedures and then compared to a critical value from a Chi Square table with degrees of freedom corresponding to that of the data. If the calculated value is equal to or greater than the critical value, the null hypothesis will be accepted. If the calculated value is less than the critical value, the null hypothesis (Ho) is rejected.

For our analysis purpose, we separate our questionnaires into two small samples according to their CRT achievements, and we hope to find out the relationship between these two CRT groups, and check whether investors in high CRT group work better on bias than investors in low CRT group. While Chi-square test for independence is the very right tool for us. It is used to explore the relationship between categories, and compare the observed frequency or proportions of cases in categories, and expect to find out whether or not there is association between the two variables being measured (Pallant, 2010, p217). Through the aforementioned description, we are clear that Chi-square test is very suitable for testing our samples’ difference in those 6 biases.

4.5.3 Mann-Whitney U (MWU) test

MWU test is a non-parametric test that can be used to test for differences between two independent groups on a continuous measure. It converts the scores on the continuous variable to ranks across the two groups, and evaluates whether the ranks for the two groups differ significantly (Pallant, 2010, p227).

When we test the biases of framing effect and anchoring biases, we separate it into two steps. The first step is to whether the high or low anchoring number and negative or positive frame will influence investors’ answers significantly; the second step is to find out whether investors in high CRT group can effectively reduce the influence of the anchoring number and framing presentation. The second step, as we introduced before, is suitable for Chi-square test, while the first step should use MWU test. Because we hope to find out the influence factors that affect investors’ judgments, and test the differences between two independent groups on the continuous measure, in our case it is 10%, 30%, positive and negative frame. Therefore, MWU test is very suitable for our research purpose.

To conclude, in our research we will use Chi-square test for representativeness, availability, herding and regret; for the biases of framing effect and anchoring, we will use both Chi-square test and MWU test.
Part 5 Research Findings and Description

Through the introduction part and literature review part, we have presented the whole picture about Chinese stock market, looked through the necessary knowledge of traditional finance, behavioral finance and their main arguments. Meanwhile, through reviewing previous studies of behavioral biases, cognitive ability, and their relationship, we are sure the similar influence should appear in Chinese stock market individual investors.

In order to find out the influence of cognitive ability on those six behavioral biases, i.e. availability, representativeness, anchoring, regret, framing effect, and herding, from the perspective of Chinese individual investors, we establish the suitable research methodology both in theoretical and practical aspects.

Under the guidance of previous studies and research methods, we get essential data to conduct our research. In this part, we will present each question’s answer first; secondly, we compare data of each bias based on different cognitive ability groups. Because the test results are the same no matter our test follows Frederick’s model (0 right on CRT questions belongs to low CRT group; 3 rights belong to high CRT group) or Oechssler, Roider and Schmitz’s model (0 and 1 right belong to low CRT group; 2 and 3 rights belong to high CRT group), therefore, in this part we only present the phenomena under Oechssler, Roider and Schmitz’s model.

Due to the different questions on framing effect (negative and positive) and anchoring bias (10% and 30%), we separate this chapter into four parts: answers of CRT questions—200 samples; answers of biases questions—representative, availability, herding and regret; answers of CRT questions—100 samples; and answers of biases questions—framing effect and anchoring bias.

5.1 Answers of CRT Questions -- 200 Samples

5.1.1 The answer of ‘bats and balls’ question

From the following tables and figures, we can find out there is 118 people’s answers are 5, which takes up 59% of total, and the other 82 respondents give wrong answers, takes up the rest 41%. While 37.5% of respondents, 75 persons, show obvious impulsive behavior, give the answer of 10, which takes up 91.46% of the wrong answers. (See Appendix 1)
5.1.2 The answer of ‘widgets’ question

From the following tables and figures, we can find out there is 156 people’s answers are 5, which takes up 78% of total, and the other 44 respondents give wrong answers, takes up the rest 22%. While 20% of respondents, 40 persons, show obvious impulsive behavior, give the answer of 100, which takes up 90.91% of the wrong answers. (See, Appendix 1).

Figure 6: widgets bias data of 200 samples
5.1.3 The answer of ‘lily pads’ question

From the following tables and figures, we can find out there is 89 people’s answers are 47, which takes up 44.5% of total, and the other 111 respondents give wrong answers, takes up the rest 55.5%. While 52% of respondents, 104 persons, show obvious impulsive behavior, give the answer of 24, which takes up 93.69% of the wrong answers. (See, Appendix 1).

Figure 7: Lily pads bias data of 200 samples
5.1.4 The answers collection for CRT questions

In these 200 questionnaires, on the three CRT questions, there are 12.16% investors get 0 mark; 56 persons, namely 28% of investors only answer 1 right answer; 25% only answer 2 right questions, there are 34.5% of our samples, i.e. 69 investors get three rights.

Figure 8: Percentage of right CRT answers of 200 samples

For these 3 questions, 78% of our samples give the right answer to the question about widget, while this number to bat-and-ball question and lily-pad question is 59% and 44.5%, respectively.

Figure 9: Proportion of each right CRT answer of 200 samples
5.2 Answers of Biases Questions -- Representativeness, Availability, Regret and Herding

5.2.1 The answer of ‘representative’ question

To test the behavioral bias of representative, we simulate famous Linda’s question. In our 200 questionnaires, 121 investors show obvious representative bias, takes up 60.5% of total. They choose B, and believe Xiao Fang is a bank teller and active in the social activity. The rest 39.5%, 79 investors choose A, do not show obvious representative bias. (See, Appendix 2)

Figure 10: Representative bias data

In these 200 investors, 119 belong to the group of high cognitive ability, 81 are in the group of low cognitive ability. Due to we first group our samples based on their answers of the three CRT questions, biases of representativeness, availability, regret and herding have the same numbers and percentages about cognitive ability groups. Therefore, we will not mention those figures again in the following biases description. In the test of representative bias, we find out 63 of 119 high cognitive ability investors show obvious bias, which take up 52.94% of total high cognitive ability investors. 58 of 81 low cognitive ability investors show obvious representative bias, which take up 71.6%. (See Appendix 2)
5.2.2 The answer of ‘availability’ question

To test the behavioral bias of availability, we compare the number of deaths caused by suicide and traffic accidents. In our 200 questionnaires, 153 investors show obvious representative bias, believe deaths caused by traffic accidents are more than that caused by suicide. This figure takes up 76.5% of questionnaires. The rest 23.5%, 47 investors think deaths caused by suicide are more than that caused by traffic accidents. (See Appendix 2)
84 of 119 high cognitive ability investors show obvious availability bias, which take up 70.59%. 69 of 81 low cognitive ability investors show obvious representative bias, which take up 85.19%. (See Appendix 2)

**Figure 13: Comparison of each CRT group’s data on availability**

![](image)

**5.2.3 The answer of ‘regret’ question**

In the collected 200 questionnaires, 85 investors show strong regret emotion. The number takes up 42.5%. The rest 57.5%, 115 investors express themselves less regret for the assumptive loss. (See Appendix 2)

**Figure 14: Regret bias data**

![](image)
In the test of regret bias, 50 of 119 high cognitive ability investors show strong regret emotion, which take up 42.02%. 35 people in low cognitive ability group, i.e. 43.21% of them also admit themselves will regret strong. (See Appendix 2)

Figure 15: Comparison of each CRT group’s data on regret

5.2.4 The answer of ‘herding’ question

In order to test the behavioral bias of herding, we use restaurant question to check investors’ reactions. In the 200 questionnaires, 78 investors will change their previous decision, but to another restaurant. The number takes up 39% of total 200 samples. The rest 61%, 122 investors prefer their own previous decision, and do not follow the long queue. (See Appendix 2)

Figure 16: Herding bias data
From the following table, we know 42 of 119 high cognitive ability investors would like to change their minds, which take up 35.29%. 44.44% of low cognitive ability investors also would like to change their minds, that is, 36 people. (See Appendix 2)

**Figure 17: Comparison of each CRT group’s data on herding**

<table>
<thead>
<tr>
<th></th>
<th>high CRT group</th>
<th>low CRT group</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>investors</td>
<td>120.00%</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>bias</td>
<td>64.71%</td>
<td>64.71%</td>
<td>64.71%</td>
</tr>
<tr>
<td>no bias</td>
<td>35.29%</td>
<td>35.29%</td>
<td>35.29%</td>
</tr>
<tr>
<td>total</td>
<td>100.00%</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

5.3 Answers of Questions (100 samples) – Positive Framing and Low Anchoring Number

In this part, firstly we will introduce 100 CRT answers based on positive framing and low anchoring numbers (10%), and then descript the answers to those two biases. Thirdly, we will present the other 100 CRT answers, and finally state the answers of negative framing and high anchoring number (30%).

5.3.1 CRT answers - positive framing and low anchoring number

➢ The Answer of ‘Bats and Balls’ Question

From this samples’ group, it is very funny to find out 59 people’s answers are right, which takes up 59% of total. This number is just the very half of total right answers on this question. The other 41 respondents give wrong answers, takes up the rest 41%. While 36% of respondents show obvious impulsive behavior, give the answer of 10, which takes up 87.8% of wrong answers. (See Appendix 3)
The Answer of ‘widgets’ Question

From the following tables and figures, we can find out there are 72 investors giving the right answer, takes up 72% of total. The other 28 respondents give wrong answers, takes up the rest 28%. While 25 respondents show obvious impulsive behavior, give the answer of 100, which takes up 89.29% of the wrong answers. (See Appendix 3)
➢ The Answer of ‘lily pads’ Question

From the following tables and figures, we can find out there is 44 people’s answers are right, which takes up 44% of total, and the other 56 respondents give wrong answers, takes up the rest 56%. While 52% of respondents show obvious impulsive behavior, give the answer of 24, which takes up 92.86% of the wrong answers. (See Appendix 3)

Figure 20: Lily-pads bias data of 100 samples- positive framing and low anchoring number

➢ The Answers Collection for CRT Questions

In these 100 questionnaires, on the three CRT questions, there are 19% investors get 0 mark; 24 investors only answer 1 right answer; 20% only answer 2 right questions, there are 37 investors get three rights.

Figure 21: Percentage of right CRT answers of 100 samples-positive framing and low anchoring number
5.3.2 Positive framing effect

From the answers of positive framing question, we find out 74% of investors would like to use treatment A to save 200 people for sure, rather than taking the 33% chance to save 600 people. While the other 26 investors would like to take the risk that 66% chance to save no one. (See Appendix 4)

*Figure 22: Frame positive bias data of 100 samples*

In these 100 investors, 57 belong to the high cognitive ability group, 43 are in the group of low cognitive ability. Through the collected answers from the high cognitive ability group, we find out 41 of 57 are inclined to save 200 people for sure, which take up 71.93%. However, the counterpart number in low cognitive ability group is 76.74%, i.e. 33 people.

*Figure 23: Comparison of each CRT group’s data on framing positive*
5.3.3 Anchoring bias-low number

When the anchoring number is 10%, these 100 investors’ average on this question is 15.36%, the minimum number is 3%, and the maximum number is 35%. The mean of the low cognitive ability investors is 15.19%, while the counterpart number of the high cognitive ability investors is 15.49%.

In the total 100 samples, there are three numbers have the highest frequency, 10%, 20%, and 25%. They take place 10% of frequency respectively. More investors with low cognitive ability choose wrote their answers are 25%, while more high cognitive ability investors’ answers are 10%, 20%. (See Appendix 4)

Figure 24: Anchoring-low bias data of 100 samples

5.4 Answers of CRT Questions (100 Samples) – Negative Framing and High Anchoring Number

5.4.1 CRT answers

➢ The Answer of ‘Bats and Balls’ Question

As we stated before, the general results of bats-and-balls question in these two 100-sample groups are the same. Therefore, we can check the figure 25 and Appendix 4.1. However, in this group there are 39% of respondents, 39 persons, show obvious impulsive behavior, give the answer of 10, which takes up 95.12% of the wrong
The Answer of ‘widgets’ Question

In this group, there are 84 investors giving the right answer, takes up 84% of total. The other 16% respondents give wrong answers. While 15% of respondents, 40 persons, show obvious impulsive behavior, give the answer of 100, which takes up 93.75% of the wrong answers. (See Appendix 5)
The Answer of ‘Lily Pads’ Question

In this group, there are 45 investors giving the right answer, takes up 45% of total. The other 55 respondents give wrong answers, take up 55%. While 52% of respondents, 52 persons, show obvious impulsive behavior, give the answer of 24, which takes up 94.55% of the wrong answers. (See Appendix 5)

Figure 27: Lily-pads bias data of 100 samples-Negative Framing And High Anchoring Number

The Answers Collection for CRT Questions

In these 100 questionnaires, on the three CRT questions, there are 6% investors get 0 mark, 32 investors only answer 1 answer right; 32% only answer 2 questions right, there are 32 investors get three rights. The distribution of people on 1, 2, 3, rights is quite similar.

Figure 28: Percentage of right CRT answers of 100 samples-Positive framing and low anchoring number
5.4.2 Negative framing effect

In the answers of negative framing question, only 32% of investors would like to use treatment A to take 400 people’s lives, 68% of investors would prefer to treatment B to take the 33% chance to save all or 66% chance to kill all. There are 32 people would like to let the 400 people die instead of taking the bigger risk. (See Appendix 6)

**Figure 29: Frame negative bias data of 100 samples**

In these 100 investors, 62 belong to the high cognitive ability group, 38 are in the group of low cognitive ability. Through the collected answers from the high cognitive ability group, we find out 41 of 62 are inclined to choose treatment B to take the risk for saving 600 people, which take up 66.13%. However, the corresponding number in low cognitive ability group is 71.05%, i.e. 27 people. (See Appendix 6)

**Figure 30: Comparison of each CRT group’s data on framing negative**
5.4.3 High anchoring number

When the anchoring number is 30%, these 100 investors’ average on this question is 30.93%, the minimum number is 10%, and the maximum number is 48%. The mean of the low cognitive ability investors is 32.26%, while the counterpart number of the high cognitive ability investors is 30.11%.

In the total 100 samples, there are 10 people guess the answer is 30%, which have the highest frequency. Both high and low cognitive ability investors each have five persons guess the answer is 30%. And in high cognitive group, there are more people guess values of 20% and 25 %. (See Appendix 6)

*Figure 31: Anchoring-high bias data of 100 samples*
Part 6 Data Analysis and Discussion

After describing the answer distributions of 3 CRT questions and 6 behavioral biases questions through 200 collected questionnaires, we now can conduct pertinent research based on those findings.

In this part, first we analyze the CRT results, compare them with previous studies, and discuss the characteristics of Chinese individual stock investors. Secondly, we analyze those 6 behavioral biases one by one. Based on the collected data, we use statistical hypothesis testing methods, i.e. Chi-square test and Mann-Whitney test, to certify whether the difference of between high and low cognitive ability groups on each bias is significant. In other words, whether or not investors with higher cognitive ability can avoid or reduce the influence of each bias efficiently. Finally, we discuss the results through combing behavioral finance theories and previous studies with our data analyses.

6.1 CRT Data Analyses

As we have mentioned in the introduction part, one of research purposes through our study is to find out the concise and reliable tool for measuring Chinese individual investors’ cognitive ability, and exhibit the biases characteristics in their decision-making process through the tool.

In the parts of ‘literature review’ and ‘practical methods’, we have shown CRT’s validity based on previous studies, and believe it is a reliable tool for testing people’s cognitive ability, especially in the course of decision making. In order to highlight Chinese individual stock investors’ decision-making characteristics, further to reflect their behavioral biases, it is persuasive to compare the CRT results of Chinese individual stock investors with previous studies’ results, and then exhibits their own characteristics.

Through comparing CRT results, we find out the average CRT score for Chinese individual stock investors is 1.82, lower than MIT’s data, 2.05. This result shows that MIT’s students have higher cognitive ability than Chinese individual stock investors, and they can resist impulsive emotion better when making decisions. However, the mean score of Chinese individual stock investors is higher than that of the other three universities’ students’ test results, which are Princeton University, Carnegie Mellon University and Michigan State University. It implies that Chinese individual stock investors are more reflective than students of those three universities, in the course of decision making.
Table 2: Comparison of CRT Scores

<table>
<thead>
<tr>
<th>Subject groups</th>
<th>Mean CRT score</th>
<th>Percentage scoring 0, 1, 2, 3</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Chinese stock investors</td>
<td>1.82</td>
<td>12.5%</td>
<td>28%</td>
</tr>
<tr>
<td>MIT</td>
<td>2.18</td>
<td>7%</td>
<td>16%</td>
</tr>
<tr>
<td>Princeton University</td>
<td>1.63</td>
<td>18%</td>
<td>27%</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>1.51</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Michigan State University</td>
<td>0.79</td>
<td>49%</td>
<td>29%</td>
</tr>
</tbody>
</table>

Notes: in order to compare results of each question with previous study, we replicate data of these four universities from Frederick (2005).

In the part of literature review, we introduced that previous studies had proved there were positive correlation with some well-established cognitive ability measures, such as Wonderlic Personnel Test (WPT), which is to measure people’s general cognitive ability, the correlation coefficient (r) between WPT and CRT tests results is 0.46; American College Testing (ACT) and Scholastic Achievement Test (SAT), the correlation coefficient (r) between ACT and CRT is 0.46, and 0.44 for CRT and SAT. Those correlation coefficient data not only show CRT as well as other test methods are good measurement tools for testing cognitive ability, but also imply the higher score investors gain through CRT test, the higher cognitive ability they have, the less impulsive characteristics appear.

Besides comparing those four groups’ mean CRT scores, we also consider accuracy rate of each question. Through comparison, we find out they are various in different groups. From those data, we find out the distribution of correct answers in those four universities appear a tendency, which is extremely obvious in MIT (upward), Michigan State University (downward), and Carnegie Mellon University (equal). While there is no such tendency in our sample, we can clear at a glance through figure 32.
Figure 32: Distribution of correct answers in different samples

Notes: 0, 1, 2, 3 stands for the number right answers for the three CRT questions.

This is a very interesting phenomenon, and we are not sure what cause this situation. However, based on our previous analysis, we believe it should be related to the different backgrounds of research subjects.

At the same time, from the test results, we can reject the possibility that CRT is too easy for Chinese investors, which means almost everyone can answer the three questions correctly. Another consideration is the culture difference. Even though CRT using arithmetic questions and it does not show culture factors, it is still created by an American. Most importantly, CRT is used to test people’s cognitive ability, not like chemistry, physics, and other natural subjects, which have general language in the entire world. So, it is necessary to verify its validity through experiment. After the data analyses we made on CRT questions, we can justify the usefulness of CRT for our research purpose.

6.2 Comparison of Impulsive / Reflective

In order to make our subjects’ results are more persuasive, and comparable with previous study, we regard subjects who only answer 1 or 0 question correctly as low cognitive ability or impulsive people; while others are called as high cognitive ability or reflective people.
Table 3: Comparison of impulsive/reflective

<table>
<thead>
<tr>
<th>Answers</th>
<th>Bat and ball</th>
<th>Widgets</th>
<th>Lily pads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese investors</td>
<td>59.0%</td>
<td>78.0%</td>
<td>44.5%</td>
</tr>
<tr>
<td>Previous study</td>
<td>54.8%</td>
<td>70.7%</td>
<td>78.0%</td>
</tr>
<tr>
<td>Impulsive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese investors</td>
<td>37.0%</td>
<td>20.0%</td>
<td>51.0%</td>
</tr>
<tr>
<td>Previous study</td>
<td>40.2%</td>
<td>21.6%</td>
<td>11.3%</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chinese investors</td>
<td>4.0%</td>
<td>2.0%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Previous study</td>
<td>5.0%</td>
<td>7.6%</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

Notes: Data of previous study come from the study of Oechssler, Roider and Schmitz (2008)

From table 3, we know the results of ‘bat and ball’ and ‘widgets’ from our sample are similar to those of Oechssler (2008)’s study, but the answers from ‘lily pads’ have big difference between these two samples. For our subjects of Chinese investors, more than half percent show impulsive characteristics (24 days), while this number for previous study is only 11.3%. Such a big difference draws our attention. We are not sure the accurate reason, and suppose it is much easy for Chinese investors to get an impulsive answer on questions like ‘lily pads’.

Figure 33: Comparison of CRT data between our research and previous study

Therefore, according to data collected from our questionnaire, we use CRT to separate 59.5% of our subjects into the reflective group, i.e. high cognitive ability group, who show higher ability to resist impulsive answers to their minds; put the other 40.5% of people into the impulsive group, i.e. low cognitive ability group, who show relative low ability to resist impulsive answers. We use these two groups to compare the six biases and solve the research question.

In finance field, Frederick (2005) showed high cognitive ability people had more
patience in their investment, and they devalued future rewards less. That is, high cognitive ability investors are more reflective than low cognitive ability investors, and they are not as impulsive as low cognitive ability investors are. High cognitive ability investors would like to wait for a longer period to get a higher present value, which show their rationality in the investment. On the contrary, when investors are confronted with investment loss, high cognitive ability investors were less risk seeking and more willing to accept a sure loss to avoid playing a gamble with lower expected value (Frederick, 2005). This choice is fit for the risk aversion characteristic of rational people.

Though our data, we have grouped 40.5% investors into low cognitive ability group, and 59.5% investors are in the group of high cognitive ability. Based on previous psychological and behavioral finance studies (Jensen 1998, Frederick 2005, Oechssler et al. 2008), we have the reason to assume high cognitive ability investors could effectively reduce the influence of those six behavioral biases. However, the study of Oechssler, Roider and Schmitz (2008) had shown that even though there was significant difference between high and low cognitive ability groups in the biases of representativeness and conservatism, the bias of anchoring effect appears no significant difference between these two cognitive ability groups. Therefore, we should analyze these two cognitive ability groups and measure biases difference between them carefully, to get to know Chinese stock investors’ characteristics of those six behavioral biases and the reactions of different cognitive ability group.

6.3 Behavioral Biases Analysis

Through 10 questions in our questionnaires, we test investors’ biases of representativeness, availability, regret, herding, anchoring and framing. According to different cognitive ability groups investors belong to, the difference in those six behavioral biases between them has been measured.

6.3.1 Representativeness

In our sample, there are 60.5% subjects believe Xiao Fang is a bank teller, and at the same time, she is active in social activity. This kind bias results from worthless information we give out, ‘Xiao Fang was deeply concerned with issues of global warming and social justice’. According to this question, the model and outcome are very similar each other, make some subjects naturally think these two events correlate each other, and ignore the probability of two independent event occur together should not be larger than each independent event.

From the perspective of each cognitive ability group, there are 71.6% subjects in relative low cognitive group show bias of representativeness, they believe ‘Xiao Fang
is a bank teller and is active in the social activity’. While the number in high cognitive group is 52.94%, which is 18.66% lower. The difference is statistically significant at 5% level, where $\chi^2 = 7.025$, $p=0.008<5%$. That is, we have 99% confidence to reject the null hypothesis of ‘investors in different CRT groups have no difference in degree of representativeness bias’, and accept the hypothesis that ‘investors in different CRT groups have significant difference in degree of representativeness bias’.

The answer of similar question in Roider et al’s study(2008) is 62.6% for low CRT group and 38.3% for high CRT group, which also showed significant difference in the bias of representativeness between different CRT groups. Their test result is in accordance with our result.

Therefore, according to the test result, we declare that Chinese individual stock investors with higher cognitive level can efficiently reduce the influence caused by representativeness bias. They can make a more rational choice than low cognitive ability investors in the course of decision making.

6.3.2 Availability

In our sample, there are totally 76.5% investors believe compare to suicide, traffic accident is the major reason causes death in the year of 2009 in China. However, the truth is that the number of death caused by suicide in china was around 300,000 in 2009 (www.tiexue.net, 2010), much higher than the number of people who died from traffic accident, which are 100,000 (www.tiexue.net, 2010).

The reason people make such choice is that media in China, such as newspaper, television, and internet seldom report suicide event, while traffic accidents are widely reported. Therefore, people can get much more news from many channels about details caused by traffic accidents than suicide events. The availability behavioral bias misleads investors’ choice on this question.

For the different CRT groups, we find that 70.59% of investors in high CRT group show obvious availability bias. While the counterpart number in low CRT group is 85.19%, which is larger. Through Chi-square test, we measured their difference, and found out at 5% level, the difference is statistically significant, where $\chi^2 = 5.712$, $p=0.017<5%$, which means we have 99% confidence to reject the null hypothesis of ‘investors in different CRT group have no difference in degree of availability bias’, and accept the hypothesis of ‘investors in different CRT groups have significant difference in degree of availability bias’.

Therefore, based on data analysis, we can conclude that Chinese individual investors within high CRT group can efficiently reduce the influence caused by availability bias, than investors in low CRT group.
6.3.3 Regret

In our question, there are two stocks, and the future performance of them is uncertain. Totally, 42.5% Chinese individual stock investors have shown intense regret feeling, and state they will feel very regret if they made a wrong choice between the two stocks. Therefore, according to our literature review on regret theory, we can infer that investors with strong regret feeling maybe more easily affected by their expectation of painful and pleasurable sensation in the course of decision making than those with a little regret feeling, and more likely result in deviation away from rational choice.

From two CRT groups’ data, we find the difference in percentage is very small on the ‘regret’ question. 42.02% of our subjects in the high CRT group show intense feeling; 43.21% investors who are in the low CRT group exhibit intense regret feeling, which is merely 1.19% higher than the high CRT group. And the statistical test shows the difference is not statistically significant at 5% level, where $\chi^2=0.028$, $p=0.867>5%$. Therefore, we cannot reject the null hypothesis of ‘investors within different CRT groups have no difference in degree of regret’.

Through the data analysis, we can infer that investors with higher cognitive ability cannot be better than those with relative lower cognitive ability investors to effectively reduce the influence of regret feeling.

6.3.4 Herding

In our questionnaires, we set a question related to restaurant choice, to test whether investors would like to change their minds only because of other people’s behavior. In this question, no more information about the two restaurants is provided except for a reliable guidebook and a crowded queue. Totally, 39% of our subjects state they will change their mind to have dinner in the restaurant that has a long queue. This result shows that those investors who change their mind to another restaurant in our sample may be more easily affected by other investors’ behavior. However, the percentage is not as high as representativeness and availability biases.

From the perspective of different CRT groups, we find that 35.29% of investors with higher cognitive ability show herding effect. They would like to change their mind because they saw most people act in another way. While the counterpart number in low CRT group is 44.44%, which is 9.15% larger. The difference is not statistically significant at 5% level, where $\chi^2=1.696$, $p=0.193>5%$. This result means we should accept the null hypothesis of ‘investors with different cognitive ability level have no difference in degree of herding bias’.

Therefore, based on our data analysis, we have the foundation to state that no mater Chinese individual stock investors in high CRT group or low CRT group Chinese
individual investors are all influenced by herding effect. High CRT group investors cannot effectively control their herding behavior than low CRT group investors.

Table 4: statistical text for biases of representativeness, availability, herding and regret

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>CRT group</th>
<th>Chi-square value ($\chi^2$)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Representativeness</td>
<td>% thinking Xiao Fang bank teller less likely than bank teller and activist</td>
<td>52.94%</td>
<td>71.6%</td>
<td>7,025</td>
</tr>
<tr>
<td>Availability</td>
<td>% thinking traffic accident more likely than suicide for causing death</td>
<td>70.59%</td>
<td>85.19%</td>
<td>5,712</td>
</tr>
<tr>
<td>Regret</td>
<td>% showing intense regret feeling</td>
<td>42.02%</td>
<td>43.21%</td>
<td>0.028</td>
</tr>
<tr>
<td>Herding</td>
<td>% going to another restaurant</td>
<td>35.29%</td>
<td>44.44%</td>
<td>1,696</td>
</tr>
</tbody>
</table>

6.3.5 Anchoring

In our questionnaire, we use the question about percentage of minority representatives in National People's Congress (NPC) in the year of 2009 to test anchoring effect. Each subject is given one of the two different initial numbers randomly, 10% and 30%. For the group that the initial number is 10%, the average guess is 15.36%; while for the group that the initial number is 30%, the average guess is 30.93%.

As we have mentioned in practical methodology part, we use MWU-test to measure the anchoring bias. After testing, we find the difference is significant at 5% level, and P<0.001. Therefore, we can infer that the evaluation made by two groups’ people is largely affected by the corresponding initial number. That is, when a reference point is given out, investors’ decisions would bias to the reference value, which may deviate them away from rational choice.

In order to check the difference between high and low CRT groups when they face the same anchoring number, we regroup our subjects as high and low CRT units in each anchoring number. According to Chi-square test, both in 10% and 30% anchoring number group, the difference between different CRT units is not statistically significant. When the anchoring number is 10%, the mean of low cognitive ability
investors is 15.19%, and the counterpart number of the high cognitive ability investors is 15.49%, \( \chi^2 = 19.97 \), and \( p = 0.643 > 5\% \). When the anchoring number is 30%, the mean of low cognitive ability investors is 32.26%, and the counterpart number of the high cognitive ability investors is 30.11%, \( \chi^2 = 24.74 \), and \( p = 0.534 > 5\% \). The test results show no matter investors in high CRT unit or those in low CRT units, they all affected by the given reference number, to almost the same degree.

In a word, through the statistical test and our data analysis, we can conclude that we should accept the null hypothesis that ‘investors within different CRT groups have no difference in degree of anchoring effect biases’.

Table 5: Statistical text of anchoring bias

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>CRT group</th>
<th>Test value</th>
<th>Significant level (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>Low</td>
<td>( \chi^2 ) value</td>
</tr>
<tr>
<td>Anchoring (10%)</td>
<td>Avg. guess</td>
<td>15.49%</td>
<td>15.19%</td>
<td>( \chi^2 = 19.97 )</td>
</tr>
<tr>
<td>Anchoring (30%)</td>
<td>Avg. guess</td>
<td>35%</td>
<td>36%</td>
<td>( \chi^2 = 24.74 )</td>
</tr>
<tr>
<td>Anchoring (total)</td>
<td>Avg. guess when anchor 30%: Avg. guess when anchor 10%</td>
<td>Anchoring number (high/low)</td>
<td>Avg. guess (30%)</td>
<td>Avg. guess (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.3.6 Framing effect

In our questionnaire, we use two opposite types to present the same framing question, and each type is answered by 100 subjects. We ask them to make a choice between treatment A and B. When the problem is stated in a positive way, there are 74% of subjects would like to choose treatment A, which save 200 people for sure, rather than treatment B to take the risk for saving 600 people. However, when the question is presented in a negative way, the subjects’ choices changed dramatically. Under the negative framing question, only 32% of subjects would like to choose treatment A, which will let 400 people die for sure. The number is 42% lower than that under positive framing question. In the negative frame, most of investors would like to choose treatment B to take the risk for saving 600 people, even though the probability
is not very high, only 33%.

Through these data, we find a significant effect of framing on each 100-subject group. The difference between average guesses of positive and negative framing is significant, and P<0.001 according to the MWU-test. Therefore, we can infer that most of stock investors in our sample cannot differentiate the similarity of the positive and negative framing problem. The different way to present the same problem would induce investors make a totally different choice.

For the different CRT groups, we want to know whether investors in high CRT group are significantly different with those in low CRT group. When the question is presented in a positive way, 71.93% of subjects that have higher cognitive ability would like to adopt treatment A for saving 200 people for sure. While the counterpart number for the low CRT group is 76.74%, which is a little higher. Through the result of Chi-square test, we find the difference is not significant at 5% level, where $\chi^2=0.295$, p=0.587>5%. When the problem is stated in a negative way, there are only 33.87% in high CRT group and 28.95% in low CRT group would like to choose treatment A to let 400 people die for sure. These numbers are much lower than those when the question is presented in positive way. Using the statistical test, we find out the difference between high CRT group and low CRT group is not significant at 5% level, where $\chi^2=0.262$, p=0.608>5%.

Therefore, through the data analysis and statistical test, we can conclude that we should accept the null hypothesis that ‘investors within different CRT groups have no difference in degree of framing effect biases’. In other words, investors, no matter they have high cognitive ability or low cognitive ability, are all affected by framing effect. There is no enough evidence to prove that investors in high CRT group are better than those in low CRT group on the aspect of reducing framing effect.
### Table 6: Statistical text of framing bias

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>CRT group</th>
<th>Statistics tests</th>
<th>Significant level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>% saving 200 people for sure (treatment A) rather than take risk (treatment B)</td>
<td>71.93%</td>
<td>76.74%</td>
<td>$\chi^2=0.295$</td>
</tr>
<tr>
<td>(positive)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>% losing for sure (treatment A) rather than take risk to save people (treatment B)</td>
<td>33.87%</td>
<td>28.95%</td>
<td>$\chi^2=0.262$</td>
</tr>
<tr>
<td>(negative)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>Average % choosing treatment A (not separate high/low CRT)</td>
<td>Positive states</td>
<td>Negativ e states</td>
<td>MWU=2900</td>
</tr>
<tr>
<td>(total)</td>
<td></td>
<td>74%</td>
<td>32%</td>
<td></td>
</tr>
</tbody>
</table>

### 6.4 Results Discussion

Through our analyses of cognitive ability and psychological biases, we focus on sloving this paper’s research question by the argument on rational person assumption. Rational person assumption is one of the most important assumptions in traditional finance study. It ignores the diversification of human behavior and assumes people act in rational way in all circumstances. This assumption helps economists to conduct economic research and form valuable theories and models. Surely, those traditional finance theories and models are very powerful to explain market rules and have the guiding significance for market prediction. However, due to they put aside the influence of psychological factors on economic activities and ignore people’s irrational behavior, solely use those theories and models may lead mistakes.

Behavioral finance combines psychology study with traditional finance research. In the course of applying traditional finance knowledge, it also considers the characteristics of human nature. Behavioral finance acknowledges the existence of irrational behavior, and takes notice of the influence of behavioral biases on the market. On the basis of previous behavioral finance studies, in this paper, six well-known behavioral biases are studied from the perspective of Chinese individual stock investors, that is, representativeness, availability, regret, herding, anchoring and framing effect. Through data analyses, we conclude that both high cognitive ability investors’ group and low cognitive ability investors’ group, more or less, are affected...
by those six behavioral biases:

Representativeness reflects people make judgments base on stereotypes, evaluate the degree of correspondence between outcomes and models (Tversky & Kahneman, 1983). It is helpful in our daily life. However, it also lets them make some mistakes in the course of decision making. As Shefrin (2000) said, representativeness is one of the most important principles affecting financial decisions because people’s judgments are based on stereotypes, i.e. influenced by the similarity of a description. For Chinese individual stock investors, they show this bias. There are totally 60.5% of investors has this bias, which increases investors’ risk in the course of investment. Due to the factors of the prior probability of outcomes, sample size and misconceptions of chance are not considered in the course of using representativeness, investors cannot make rational decision about buying, selling or holding certain stocks. Thus, they are exposed to unknown investment risk. Also, Chinese individual stock investors violate the axiom five of EUT. They cannot look through the essence of complex events. They are influenced by worthless information, and deviate away their judgments from rationality.

Availability shows people evaluate frequency or probability of some events according to the times of such events comes to their minds (Ashcraft, 2006, p566). It helps people make a quick choice. However, due to the incomplete information people get, availability would let people make wrong evaluation. Due to the limit of retrievability of instances, effectiveness of a search set and imaginability, when availability is employed in the course of decision making under uncertainty, systematic biases might occur. When Chinese individual stock investors conduct investment decision in stock market, this kind of bias also occurs. According to the data analysis, there are 76.5% investors obvious show this availability. When investors want to buy, sell or hold certain stocks, events that have the most frequency and newest information would come to their mind. Such as the gain or loss of his/her friend through buying or selling the same stock, the related information about this stock from one local newspaper, all of these events will affect investors choice on investment. Because they put too much weight on the easy-recalled information, their rational behavior will be limited, and rational investment decision making could be deviated.

Regret theory describes people usually forecast the various experiences of pain and pleasure that each choice might lead through their decisions. People integrate the possible painful sensation and possible pleasurable sensation into their decision-making process (Loomies & Sugden, 1982). In order to avoid regret or painful sensation, people with intense feeling are usually reluctant to make changes, keep the same route every day to minimize possible future regret. The stronger the regret feeling, the greater the possibility of making an irrational decision will. For Chinese, there is an old saying that adversity makes a man wise. Investors learn from their painful investment experience, they would like to avoid this kind of feeling in their further investment. With the fear to make the similar mistake again, investors’
investment rationality will be deviated. Through our data, there are totally 42.5% investors showing strong regret feeling, 57.5% investors showing a little regret feeling. In the questionnaire, investors have regret feeling due to their choices on stocks. As Shefrin (2000) described that some investors might prefer to receive dividends periodically rather than sell stocks in order to minimize the regret feeling. That is, if investors sell their stocks, they will face the possibility that stock price will be higher in the future, at that time, investors will regret their previous selling behavior. Therefore, in order to minimize this regret feeling resulted from imaginary possibility, investors may would like to receive dividends periodically rather than sell stocks. The fear of regret feeling may mislead investors’ rational decision. They are afraid to make wrong decisions according to current situation, the painful memory or regret feeling caused by imaginary losses hampers their rationality.

Herding can be divided into intentional herding and spurious herding. Intentional herding show people take the same action merely due to mimic the actions of others; while when people adopt similar behavior based on the similar available information, the herding is called as spurious herding. Spurious herding has reasonable basis to explain people’s behavior. (Caparrelli et al., 2004) However, people in intentional herding have no sound reasons for their choices, and barely copy other people’s actions without knowing why they do that. In our question, 39% investors change their mind because they saw other people’s group behavior. They do not know the actual reasons why others would like to stand in line to eat in another restaurant. They show herding bias in the course of their decision making. In investment field, this kind of behavior is also called ‘following the herd’(Lux, 1995). That is, investors buy stocks whose prices are rising and sell stocks whose prices are falling without analysis and clear thinking. Cutler and Shiller (1989) suggest that price fluctuations are not necessarily related to new information or changes in fundamental economic variables, it may result from investors’ irrational collective phenomena. Due to this kind of collective behavior is not on the basis of rational analysis, and it lacks of adequate information support but other investors’ behavior, therefore, investors may make irrational investment decision which can result in greater risk. Meanwhile, collective (herding) behaviour may make stocks prices deviate away from their reasonable prices and increase prices fluctuation, which let investors expose to greater investment risk.

Anchoring describes the tendency that people’s evaluation on certain event usually based on the initial value that has been given out. Even though, they will make adjustments according to the given value, such adjustments usually are not enough. (Tversky and Kahneman, 1974) People usually place too much weight on the initial value. In the course of investment, investors usually conduct prediction about earnings and prices for certain stocks. However, due to the influence of anchoring effect, investors usually show two different reactions on new information. Some investors do not adjust their predictions enough to reflect new information, and they are conservative to the initial reference point. On the other hands, some investors
show aggressive character when they face new information, which let them overestimate new information’s influence. From the data analysis, we know both groups of investors are all mislead by the reference number. Therefore, reference numbers in investors’ minds about stock pricing and earning expected seriously influence their investment decision making, which result in their irrational investment.

Framing effect shows that people’s decision to the same problem may change due to the different way used to state the problem. People cannot always look through different frame to get the consistent rational choice, as expected utility theory assumed. Though our question, we can find out this bias. Different statement of the same problem could have different effect. Just as prospect theory (Tversky & Kahneman, 1979) stated, the same amount of losses and gains, investors will have different value. The value of losses is much heavier than the value of gains. This situation can be regarded that the similar problem will make people have different choices under positive frame and negative frame. For Chinese individual stock investors, they may show this bias due to the (imaginary) gain and loss in the course of their investment. Not only the gains and losses in their investment process, but also the frame of related delivered information will affect investors’ decision making. Due to the influence of framing effect, investors may make different choice according to the same information but under different statement frames, just as these questions presented in our questionnaires. That is, investors cannot totally conduct in a rational way as EUT expected, their decision-making process is affected by how the related information is presented.

Based on the previous psychology studies, we understand that people have different cognitive ability, and higher cognitive ability people usually could make more money and have longer life than those with relative lower cognitive ability (Jensen, 1998). Then, what about Chinese individual stock investors? Whether high cognitive ability investors can effectively reduce those six behavioral biases than investors with low cognitive ability in the course of decision making is the research question we want to solve through this study. According to the data analysis, we find that for the biases of regret, herding, anchoring and framing, the difference between high cognitive ability investors and low cognitive ability investors is not significant. In other words, high cognitive ability investors cannot perform better than low cognitive ability investors to make a rational decision in the course of their decision making. For the biases of representativeness and availability, the difference between high cognitive ability investors and low cognitive ability investors is significant. The high CRT group shows obvious better ability to reduce the influence of these two biases than low CRT group. However, they still show the biases.

Therefore, even though cognitive ability has influence on Chinese individual stock investors’ decision making, behavioral biases still widely exist in both high cognitive ability investors and low cognitive ability investors. This conclusion means those six behavioral biases are not individual phenomena, they systematically occur in financial
market. Behavioral biases may let people make irrational decision. The stock market would be more fluctuating due to investors’ behavior caused by those systematical biases, which also leads investors to expose more investment risk.

Some heuristics such as representativeness and availability can give us the quick and easy way to get a plausible answer. However, due to the mentioned limit of them, the answers come from such heuristics maybe biased and lead investors make irrational decision. Other biases such as regret, herding, anchoring, and framing, and so on, do harm to people’s rational decision making. Especially for investors’ investment behavior, biases may result in losses. Meanwhile, people cannot resist it instinctively. Therefore, specialized education is necessary not only for investors’ benefit, but also for the healthy operation of Chinese stock market.
Part 7 Conclusion

With the development of Chinese economy and the innovation of its capital market, nowadays, more and more Chinese take part in the stock market and become individual stock investors. Meanwhile, most of individual investors lack professional investment knowledge. They are easily affected by cognitive errors and show various behavioural biases in the course of investment decision making, which lead them to greater investment risk.

In order to find out rules of economy’s operation, for several centuries, economists have been working hard to analyze all kinds of economic phenomena under certain assumptions. Rational people assumption is one of the most important assumptions in traditional finance study. Many famous economic theories and models are based on this assumption, such as Mean-Variance Model, Capital Asset Pricing Model, Arbitrage Pricing Theory, and Efficient Market Hypothesis, etc. However, this assumption ignores the diversification of human behavior, put aside the influence of psychological factors on people’ decision making, and deviate away from the real economic situation.

With more and more anomalies appear in market, people pay more attention to the influence of human behaviour on the asset pricing and investment decision making. Behavioural finance combines studies of psychology and finance theories. It criticizes the assumption of rational people, questions the theories of expected utility theory (EUT) and efficient market hypothesis, and believes people are not totally rational. Behaviour biases can lead investors to systematically mistakes, and let them make irrational investment decision. Some of the most important biases include representative, availability, herding, regret, anchoring, framing, have been mentioned and studied in this paper.

Meanwhile, people are different. They have different cognitive ability, and cognitive ability influences their life through various decision-making. In virtue of previous studies on finance field and certain psychological area, and based on the characteristics of Chinese stock market and investors, this paper conducts a thorough research on the relationship between cognitive ability and six behavioural biases, that is, representative, availability, herding, regret, anchoring, and framing. On the basis of systematic work, now we can clearly solve the research question and achieve research purposes of this paper.

7.1 Findings

The whole research of this paper is around to solve its research question, which is
‘Whether Chinese individual stock investors with high level of cognitive ability can effectively reduce psychological biases, including representativeness, availability, herding effect, regret, framing effect and anchoring, than investors with low level of cognitive ability?’ Through referring to previous precious theoretical knowledge and studies on its related field, and combining with scientific methodology, we have gotten the persuasive answer.

As the pattern as we used to put forward the research question, here we use the same two steps of sub-questions to make its answer clear:

1. **Do the biases of representativeness, availability, framing effect, regret, herding effect and anchoring effect exist in Chinese individual stock investors?**

Through the literature review and collected data of questionnaires, we find out those six biases do exist for Chinese individual stock investors in the course of their decision-making:

Chinese individual stock investors show bias of representativeness heuristic when they estimate the similarity of an event to the population of events. Due to the influence of factors such as sample size, misconceptions of chance, and so on, representativeness heuristic will affect investors’ rational judgment, and may lead them to irrational decision.

They show bias of availability heuristic. When Chinese individual stock investors judge the frequency or probability of some events, they base on how easily examples or instances can be recalled to their minds. While due to the limit of retrievability of instances, effectiveness of a search set, and imaginability, availability heuristic would lead investors to irrational decision.

Chinese individual stock investors show bias of framing effect. They change their choices when the frame of an event is changed, and they cannot perform like EUT axioms wish to follow certain rational formulas. This situation lets them explore to irrational decisions.

The emotion of regret influences investors’ rational decision-making. When they are in a similar condition, the previous regret feeling or future imaginary regret feeling would come out to interfere. Due to the (imaginary) pain caused by regret feeling, rational decisions are usually been disturbed, which lead to irrational decision.

Chinese individual stock investors show herding bias in their decision-making process. The fear to make the mistake affects investors’ decision and lets them follow the flow, even it maybe a common error. This kind of bias makes investors follow others’ behavior without careful analysis and judgment, and lead them to irrational decision.
And Chinese individual stock investors show the bias of anchoring effect. The certain reference points influence investors’ judgment, and let them make choices or guesses based on the given reference points. Even though some investors may make certain adjustment on given reference points, it is not enough to get rid of the influence of reference points, thus, lead investors to irrational decision.

2. Do investors with different (high and low) cognitive abilities show significant difference in those six psychological biases?

Through analyzing collected data from Chinese individual stock investors, we find out that cognitive ability has different influence on different psychological bias.

Chinese individual stock investors with different (high and low) cognitive abilities show significant difference in the biases of representativeness and availability. High cognitive ability investors can effectively reduce the biases influence caused by representativeness and availability heuristics than investors in group of low cognitive ability level, to make a rational decision. That is, when Chinese individual stock investors confront information related to representativeness and availability heuristic in the process of investment decision-making, high cognitive ability investors can make a more rational choice on buying, selling or holds certain stocks than low cognitive ability investors.

However, for the biases of regret, herding, framing effect and anchoring heuristics, the difference between high cognitive ability stock investors and low cognitive ability stock investors is not significant. In other words, high cognitive ability investors cannot effectively reduce the biases influence caused by those four biases to make a more rational decision than low cognitive ability investors. When the regret feeling, group psychology, framing effect and anchoring heuristics come out in the process of Chinese individual stock investors’ investment decision making, high cognitive ability investors can not perform better than low cognitive ability investors to make a more rational decision on buying, selling or holding certain stocks.

This kind of research result is accordance with previous psychological and behavioral finance studies. First of all, as Jensen’s study (Jensen, 1998) stated, cognitive ability has an important influence on people’s life. Chinese individual stock investors with high cognitive ability could perform better than low cognitive ability investors in some psychological biases. They can effectively reduce the influence of some biases to make more rational decision. However, psychological biases are common in human behavior. Through our research, high and low cognitive ability groups are all influenced by those biases, more or less. Four of the six biases have no significant difference between these two groups. This result further prove those six biases are common in people’s decision making process. Those biases can let investors systematically deviate away from rationality to make irrational investment decisions. Meanwhile, systematically irrational decision caused by those psychological biases
will increase people’s investment risk, also it will aggravate stock market’s irrational fluctuation. Therefore, specialized education about those psychological biases in people’s decision making is necessary for both investors’ interest and the healthy development of stock market.

Until now, we have solved the research question. Based on our research and its finding, we finally fill in the knowledge gap through studying the relationship between cognitive ability and those six behavioral biases in stock market from the perspective of Chinese individual stock investors. It is a contribution to the China’s research filed in the aspects of behavioral finance, and can prompt the further study on the related areas.

We have introduced a concise and reliable cognitive ability test, i.e. cognitive reflection test (CRT), to the study field of Chinese behavioral finance. CRT reflects people’s behavioral characteristics in the course of decision making, is good at testing Chinese individual stock investors’ reflective and impulsive characters in their investment decision-making process. It has been approved that CRT has relative high positive correlation with many other cognitive ability test, and it show its adaptability to Chinese individual stock investors through this paper’s collected data and corresponding analysis.

Through this research, we have conducted a comprehensive study on the six important cognitive errors that usually occurred in people’s investment behavior, and find out the relationship between cognitive ability and those cognitive errors. For Chinese individual stock investors, through our research, they will be clear about the characteristics and weakness of psychological biases in their investment decision making, which help them to realize the harm of those biases, and let investors make a more rational investment decision. For security companies and other related institutions, such as investment advisory companies, according to our research, they will better understand the behavior and psychology of their clients, and thus marketing their products and conduct business more professional. To related investment supervisory institutions, they can conduct investment education on behavioral biases based on our research, which is not only good for the investors’ interest, but also it is helpful to avoid huge fluctuation of market due to the occurrence of systematical behavioral biases.

7.2 Quality Criteria

7.2.1 Validity

According to Bryman and Bell (2011, p42), validity is related to the question of whether or not a measurement is measuring what it is supposed to measure. In other words, it means whether or not we have chosen the right way to conduct this research.
For conducting our research scientifically, in the theoretical methodology part and practical methodology part, we have conduct careful studies on the use of different methodologies.

Based on the characteristics of our research elements, such as biases and cognitive ability, we use positivism and objectivism. According to previous studies on psychology and behavioral finance, we apply deductive approach to start our study. In order to solve the research question, we use cross-sectional design and comparative design to collect and analyze data, and use quantitative strategy to measure those data. And we choose statistical techniques carefully for testing the research question. Meanwhile, according to previous studies on behavioral biases of financial market and cognitive ability, we designed our questionnaires through referring to those classic questions.

All of these arrangements guarantee the effectiveness of this research, and let us have the confidence in its validity.

7.2.2 Reliability

Considering the reliability of one research, there are two types of consistency: inter-observer consistency and intra-observer consistency. Inter-observer consistency considers the problem that if other researchers conduct the same research on the same data, they will get the same results. While the intra-observer consistency means if the same research is conduct on another time, the research result should be the same (Bryman & Bell, 2011, p41).

Related to this research, we use quantitative strategy to test those collected data, and apply corresponding statistical techniques to measure the relationship between cognitive ability and behavioral biases. Therefore, as long as other researchers use the same data and analyze them using the same statistical methods, we are sure they will get the same results. This is consistent with inter-observer consistency.

For the intra-observer consistency, we cannot have that confidence. The mentality of human being is mystery and can change over time. If we use the same questionnaires for measuring people’s cognitive ability and their biases, especially under the assumption that CRT and those biases have been widely recognized over time. Then the effectiveness of this research will be affected. However, But the relationship can still be measured using the same way.

7.3 Future Research

What an interesting field it is to study the influence of human psychological factors and behaviors on the financial market and securities’ prices. With the development of
economics and finance, we believe deeply that more and more knowledge of psychology, sociology and other related subjects will be injected into the pure theoretical studies on those areas.

Based on our research and the tendency of behavioral finance, we put forward the following directions can be studies in the future:

1. Through education on those psychological factors, whether their investment achievement is better than those who do not have this kind of knowledge.

2. Find a better pricing model. In theory, the CAPM is good. But it ignores the influence of human behavior and psychological factors. Even behavioral asset pricing model (BAPM) has been put forward, it still hard to measure ‘noises’, i.e. psychological factors and human behaviors in markets, and has not been widely accepted. How to measure these ‘noises’ is a really interesting field. The research can be started from developed market first, such as Japan, Singapore, USA, European countries, and then to immature market, such as China.

3. How to become a good analyst? Analyze the group of analysts, such as CFAs. Besides the basic fundamental analysis in finance area, how to value market’s emotion, and thus get a better achievement. Whether achievements of those analysts are better.
REFERENCES


of Economic Perspectives, 12(3), 1-2.
Li, F., Yang, C., Lu, S., & Feifei, L. (2006), Study status and trend of biased beliefs, Journal of Qingdao University, 19(4), 90-96


APPENDIXS

Appendix 1: Answers of CRT Questions- 200 samples

### Bats and Balls

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- W stands for the wrong answers;
- R stands for the right answers

### Bats and Balls

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- W stands for the wrong answers;
- R stands for the right answers

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- W stands for the wrong answers;
- R stands for the right answers

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Appendix 2: The Answer of bases questions of representative, availability, herding, and regret

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- Y stands for investors who show obvious bias
- N stands for investors who do not show obvious bias

**representative * cognitive_ability Crosstabulation**

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**availability * cognitive ability Cross tabulation**

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#### herding * cognitive ability Cross tabulation

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### Regret

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#### regret * cognitive ability Cross tabulation

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### Appendix 3: The Answers of CRT Questions-100 samples

(Positive framing and low anchoring number)

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Appendix 4: Results of questions for positive frame and low anchoring number

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(Negative Framing and High Anchoring Number)

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frame_negative * cognitive_ability Crosstabulation

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Appendix 7: Questionnaire – negative framing and high anchoring number

1. A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost?

2. Xiao Fang is 26 years old, single, outspoken, and very bright. She majored in Chinese. As a student, she was deeply concerned with issues of global warming and social justice, which of the following two statements is more likely to be true?
   C. Xiao Fang is a bank teller.
   D. Xiao Fang is a bank teller and is active in the social activity.

3. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? [ minutes]

4. Consider the pair of causes of death, and choose the one you think causes more deaths in the China 2009
   Suicide vs. Traffic Accidents

5. Imagine that the Ministry of Health is planning to prompt a treatment to a flu, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Scientific estimates of the consequences of the programs are as follows:
   a. treatment A in which 400 people die
   b. treatment B has a 33% chance that no people will die but a 66% probability that all 600 will die.
Which treatment do you prefer?

6. Imagine you are travelling in Hong Kong, and you decided to go to Restaurant A, which had been recommended by a reliable guidebook. When you arrive, you notice that Restaurant B nearby is very busy, while Restaurant A have only a few customers. So, will you change your mind to go to restaurant B or not?
   a. Yes; b. No

7. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? [ days]
8. There are two stocks you want to buy and hold for one month, however, due to your budget problem, you can only buy one of them, and the rates of return on these two stocks are uncertain, in some situation, stock A may have a higher rate of return, while in other situation, stock B might perform better. Suppose you finally buy stock A, and then, after one month, the result shows stock B has a higher rate of return. At that time, will you feel regret?
   b. Yes, but a little;       b. Yes, very regret

9. Do you think the percentage of minority representatives in National People's Congress (NPC) in 2009 is more or less than 30% of all participants answered all the first three questions correctly?

10. Could you guess what the percentage of minority representatives in 2009 National People's Congress is?
Appendix 8: Questionnaire - positive framing and low anchoring number

1. A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost?

2. Xiao Fang is 26 years old, single, outspoken, and very bright. She majored in Chinese. As a student, she was deeply concerned with issues of global warming and social justice, which of the following two statements is more likely to be true?
   E. Xiao Fang is a bank teller.
   F. Xiao Fang is a bank teller and is active in the social activity.

3. Consider the pair of causes of death, and choose the one you think causes more deaths in the China 2009
   Suicide vs Traffic Accidents

4. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? [minutes]

5. Imagine that the Ministry of Health is planning to prompt a treatment to a flu, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Scientific estimates of the consequences of the programs are as follows:
   a. treatment A saves 200 peoples’ lives
   b. treatment B has a 33% chance of saving all 600 people and a 66% possibility of saving no one.
   Which treatment do you think better?

6. Imagine you are travelling in Hongkong, and you decided to go to Restaurant A, which had been recommended by a reliable guidebook. When you arrive, you notice that Restaurant B nearby is very busy, while Restaurant A have only a few customers. So, will you change your mind to go to restaurant B or not?
   a. Yes; b. No

7. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? [days]
8. There are two stocks you want to buy and hold for one month, however, due to your budget problem, you can only buy one of them, and the rates of return on these two stocks are uncertain, in some situation, stock A may have a higher rate of return, while in other situation, stock B might perform better. Suppose you finally buy stock A, and then, after one month, the result shows stock B has a higher rate of return. At that time, will you feel regret?
   c. Yes, but a little; b. Yes, very regret

9. Do you think the percentage of minority representatives in National People's Congress (NPC) in 2009 is more or less than 10% of all participants answered all the first three questions correctly?

10. Could you guess what the percentage of minority representatives in 2009 National People's Congress is?