MASTER THESIS

Momentum and Contrarian Trading Strategies:
Evidence from the Chinese stock market 2000-2010

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ABSTRACT

The paper employs Jegadeesh and Titman (1993)'s overlapping ranking period method to build winner-portfolio and loser-portfolio, and thereafter conducts empirical studies on the momentum and contrarian effects on the Chinese stock market from 2000 to 2010. One thing worth mentioning here is that the author processes the data using her own Matlab codes instead of doing tremendous manual work.

It is found in this paper that the Chinese stock market has short-term features, and is mainly characterized by a strong contrarian effect and supplemented by a weak momentum effect, and the whole market exhibits a unilateral feature. In the short and medium term, the contrarian effect is significant in the Chinese stock market; with the extension of the holding period, however, the contrarian effect weakens and certain momentum effects become significant.

In addition, the paper has tried to analyze the causes of the momentum and contrarian effects on the Chinese stock market. First, within the efficient market paradigm, the author uses CAPM to adjust for portfolio risk, and finds that this model cannot explain the two effects. Second, the two effects are analyzed from the perspective of behavioral finance. The empirical studies reveal that the underreaction of investors results in a momentum effect, and their overreaction results in a contrarian effect.

Key Words: Momentum effect, Contrarian effect, The relative strength portfolio, CAPM model, Overreaction, Underreaction.

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1. Introduction

1.1 Background

Over the last decades, there have been many studies on the time-series predictability of stock returns based on their past history, revealing that the predictable patterns in stock returns would result in abnormal returns. The abnormal returns are always related to asset pricing models, such as the CAPM and the Fama-French three-factor models. Take the CAPM model constructed by Sharpe (1964) and Lintner(1965) as an illustration. The theoretical model and the empirical model look as follows:

$$E(R_i) - r_f = \beta_i [E(R_m) - r_f], \text{ for asset i;}$$

$$R_{i,t} - r_{f,t} = \alpha + \beta_i (R_{m,t} - r_{f,t}) + \varepsilon_{i,t}$$

where $E(R_i) - r_f$ is the expected excess return of asset i, which equals the product of beta (β_i), the sensitivity of the expected excess return of asset i to the expected excess market return, the expected excess return of market portfolio $[E(R_m) - r_f]$. The variables in the regression are the realizations at time t and $\varepsilon_{i,t}$ is the error term. If CAPM holds, α is zero in the regression, or at least not significantly different from zero from the perspective of statistics, indicating that the CAPM model will be rejected when α is statistically significantly different from zero. In this circumstance, abnormal returns are verified arguably due to the omission of important factors that drive the returns.

So far, the traditional risk-based asset pricing models cannot explain the phenomenon consistently; therefore, many scholars turn to behavioral theories to explain the reasons behind the anomalies, and they mainly focus on the autocorrelation of the stock returns over different horizons. Jegadeesh and Titman (1993) have shown that there exist positive autocorrelations in stock returns, called continuation, or momentum, in the medium horizon, and many papers by Jegadeesh (1990) and Lehmann (1990) have revealed that stock returns tend to be mean-reverting in the long run. Consequently, there are two corresponding trading strategies: the momentum trading strategy, generating profits by buying the stocks with good past performance and selling the stocks with bad past performance, and the contrarian trading

strategy, which, in contrast to the momentum trading strategy, makes profits by selling a portfolio of winners and buying a portfolio of losers.

Up to now, the studies on momentum and contrarian effects are mainly from three perspectives: first, the existence of momentum effect and contrarian effect, which date back to Jegadeesh and Titman (1993) and De Bondt and Thaler (1985) respectively; second, the explanations on the reasons of momentum effect and contrarian effect, namely the answers to the questions of "how to respond to these anomalies" and "what do abnormal returns driven by the momentum trading strategy and contrarian trading strategy come from", represented by Jegadeesh and Titman (2001) and Lo and MacKinlay (1990); third, the relationships between the momentum effect and contrarian effect and some other factors, such as trading volume, some company characteristics (e.g. industry, size, book-to-market ratio) and so on, studied by Lee and Swaminathan (2000) and Liu et al. (1999), etc. Though scholars have applied different theoretical frameworks and empirical approaches in analyzing momentum and contrarian effects from different angles, the theories are complements to each other and constitute a monolithic body of theory. Meanwhile, studies with multi-layers and various orientations have exerted significant influence upon investments in stocks in reality. And this is mainly manifested from two aspects: on the one hand, most of the empirical studies, for example, Jegadeesh and Titman (1993) and De Bondt and Thaler (1985), have verified the existence of the momentum effect and the contrarian effect over different horizons in stock returns to some extent, indicating that significant profits can be gained by applying the momentum trading strategy and contrarian trading strategy appropriately; on the other hand, with a variety of methods on analyzing the underlying reasons for the two effects, some indicators related to stock price can be added as the factors in the model, which add practical value to the construction of a trading strategy.

1.2 Problem discussion

The momentum and contrarian effects are the most puzzling and robust anomalies in the stock market at present, and it is the case in the Chinese stock market as well.

With the history of twenty years or so, the Chinese stock market is experiencing the dynamic growth, but is still characterized as "developing" and far away from "developed",

due to imperfect trading mechanisms and functional defects, etc. Currently the Chinese stock market is still during a period of transition, urgently in need of eliminating obstacles embedded in systems and mechanisms, such as price limits, uniform financial instruments, a lack of hedging instruments and so on, which have substantial impacts on the time-series predictability of stock returns in China. Therefore the anomalies can even be viewed as "normal" in the Chinese stock market during this transition period. Though many scholars have concluded that the Chinese stock market has these two effects based on empirical research, for example, Kang et al. (2002: 243) have reported that there existed statistically significant abnormal profits for some short-horizon contrarian and intermediate-horizon momentum strategies over the period 1993-2000, there are not so many studies to explain these phenomena, and thus the Chinese stock market still remains a hotspot requiring a further study in depth.

Hence, it is of great interest to test the time-series predictability of stock returns in China in the period from 2000 to 2010 and the applicability of momentum trading strategy and contrarian trading strategy, and to trace to their causes, which is the innovative point compared with the prior studies on the Chinese stock market.

1.3 Purpose

Studies on the momentum and contrarian effects have propelled the development of traditional finance and behavioral finance theories fundamentally and thus formed profitable trading strategies in investment on stocks gradually. Most of previous studies on these two effects focus on the stock markets of USA and other developed countries, leaving the developing countries' stock markets awaiting such studies.

This paper tries to investigate the existence of the momentum and contrarian effects on the Chinese stock market and to exploit the reasons of the phenomena, in order to explain why some trading strategies would generate significant profits by trying to dig out some sources that generate the two effects. In brief, this paper will not only provide us with a measure on the non-effectiveness of the immature stock market of China, but also enable stock market traders to know more about a basic feature of the stock market.

2. Literature review

2.1 Non-Chinese stock market studies

2.1.1 Empirical studies on the existence of momentum and contrarian effects

In the last decades, many financial studies on stock returns have shown that there exists a certain predictable pattern on them. In sum, there are generally two patterns, momentum effect and contrarian effect: the former one refers to the phenomenon that stocks with high past returns would still outperform those with low past returns in the future, and thus momentum trading strategy that buy those well performed stocks and sell poorly performed stocks would gain profits; while the latter one means that stocks with low returns in the past would beat those with high past returns later, and thus contrarian trading strategy that buy past losers and sell past winners would make profits.

Jegadeesh and Titman (1993) are recognized as the pioneers to discover momentum effect by testing the documented profits of NYSE and AMEX stocks in the 1965-1989 sample period (1993: 67). They constructed the relative strength portfolios by ranking all stocks with a return history of at least 12 months at the end of each month on the basis of their past 1, 2, 3, or 4 quarters' return and assigning to one of ten relative strength portfolios, where 1 equals lowest past performance, or "Loser", 10 equals highest past performance, or "Winner" (Rouwenhorst, 1998: 269). Moreover, they formed 16 (4×4=16) kinds of cross trading strategies and found that past winners performed better continuously around their earnings announcements in the 7 months following the portfolio formation date than past losers (Jegadeesh & Titman, 1993: 67). By applying the momentum trading strategy that buy past winners and sell past losers, one of the strategies that selected stocks in terms of their past 6-month returns and held them for 6 months with a compounded excess return of 12.01% per year on average, and thus significant returns were detected, verifying the existence of momentum effect (Jegadeesh and Titman, 1993: 89).

On this basis, Rouwenhorst (1998) studied international return momentum of 12 European countries with a sample period from 1978 to 1995, where the sample consisted of monthly total returns in local currency of 2190 firms. By constructing the relative strength portfolios

proposed by Jegadeesh and Titman (1993), he concluded that the momentum effect was universal in European market and momentum trading strategy could beat the market due to the fact that a portfolio of past winners outperformed a portfolio of past losers by about 1% per month.

Liew and Vassalou (2000) constructed a zero investment portfolio that was long on past winners and short on past losers, as Jegadeesh and Titman did in 1993, and W-L (winners minus losers) was the corresponding return of the portfolio. By dealing with the data of ten developed countries' markets, they verified the significant profitability of the momentum trading strategy as well as the presence of momentum effect on all countries' markets but Italy's and Japan's, where W-L was not reliable in Italy, and W-L was negative on average in Japan, confirming the profitability of the contrarian trading strategy instead.

Unlike the previous studies of western developed countries' markets, Chui et al. (2000) studied the profitability of momentum trading strategies in 8 different Asian regions: Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand, and they found that the momentum trading strategy could earn obvious profits in all countries but two countries (Indonesia and Korea), though the profits were relatively less when compared with that of western developed countries.

More detailedly, Hameed and Kusnadi (2002) examined momentum profits in 6 emerging Asian markets with a sample period 1979-1994. The sample data included monthly stock return, size, trading volume, and number of days traded in a month of more than 1000 securities, and they applied the method that Jegadeesh and Titman (1993) and Rouwenhorst (1998) had used on the analysis of the presence of momentum effect. The most important thing in their research is that they did not find significant profits for momentum strategies in Asian stock markets, meaning that there was little momentum effect on these emerging markets. Nevertheless, when Jegadeesh and Titman (2001) made another research on all stocks traded on the NYSE, AMEX and NASDAQ after excluding the stocks with the price below five US dollars at the start of the holding period, there still existed a statistically significant momentum profit between 1990 and 1998, which supported their findings in 1993, indicating that the momentum is a common phenomenon in the U.S. stock market. Given that the sample correlation between Asian and U.S. momentum returns was only 0.09 (Hameed and Kusnadi, 2002: 392), demonstrating the returns in the emerging markets were

uncorrelated with those in U.S. market, and thus the factors that drive the predictability of returns in U.S. market cannot be used to explain the Asian momentum returns.

In respect of contrarian effect, it is often thought to be caused by the overreaction to price information of the stock market. De Bondt and Thaler (1985) captured contrarian effect by testing monthly returns for NYSE common stocks with at least 85 months of return data during the period between January 1926 and December 1982. There were four types of length of the formation period: one-year, two-year, three-year, five-year, and three-year period dominated, and they found that firms that performed poorly in the past three to five years earned higher average returns than firms with high past returns. In addition, they also explained the contrarian effect on an intuitive way, "If stock prices systematically overshoot, then their reversal should be predicable from past return data alone, with no use of any accounting data such as earnings" (De Bondt and Thaler, 1985: 795). Lo and MacKinlay (1990) have also verified the significant profitability of contrarian trading strategy in the short term by using the data from the Center for Research in Security Prices (CRSP) daily returns files with the sample period from July 6th, 1962 to December 31st, 1987. Furthermore, Lehmann (1990) investigated that stocks with negative returns in one week realized positive returns in the subsequent week, and vice versa, suggesting that there existed return reversals in one week's horizon. In addition, Chopra et al. (2000) suggested that past losers beat past winners by 5-10% annually in the following five years by forming portfolios based on previous five-year returns.

Moreover, some scholars have tried to establish portfolios to test the profitability of momentum trading strategy and contrarian trading strategy simultaneously. Conrad and Kaul (1998) made a research on the NYSE and AMEX securities during the 1926-1989 period, and analyzed eight basic strategies with holding periods from one week to 36 months. They found that 55 out of 120 trading strategies earned statistically significant profits, and 30 were momentum trading strategies, however, 25 were contrarian trading strategies. That is to say, there existed both momentum effect and contrarian effect on the USA stock market during that period.

2.1.2 Analysis on causes of momentum and contrarian effects

So far, though many empirical studies have shown that positive profits can be obtained from momentum and contrarian trading strategies over different horizons, in other words, momentum and contrarian effects indeed exist, yet the studies on the cause of momentum and contrarian effects have not reached consensus; there still exist a lot of arguments and further studies are required.

After De Bondt and Thaler (1985) first discovered that contrarian trading strategy could generate significant profit, Chan (1988) attempted to explain the finding from the angle of risk compensation which regarded that the joint risk factors of winner portfolio and loser portfolio varied with time. Within the holding period, the risk for loser portfolio would increase; to the contrary, the risk for winner portfolio would decrease. Given the risk factors were controlled within this period, the benefits brought by contrarian trading strategy would decrease.

Fama and French (1996) thought that the reason why stocks exhibited momentum effect was that the risk level of winner portfolio was higher than that of loser portfolio; and after the adjustment of risk level, the momentum effect would disappear spontaneously. Their null hypothesis assumed that the stock market was effective, namely, in the competitive stock market stock price had reflected all the given information and the situation that stock price was overvalued or undervalued did not exist; any trading strategy could not generate positive abnormal profits. In addition, even though in the weak-form efficient market, stock price has already reflected all the information gained from market transaction data, such as the stock price in the past, trading volume and so on. If momentum effect still existed after adjusting the risk level, the null hypothesis of the market being efficient should be rejected. They considered that market factor, size factor and book-to-market ratio factor represented the attributes of firms exposed to systematic risk under the background of empirical studies. When they applied the three-factor model, including market factor, size factor and book-to-value ratio factor, to account for the profits of momentum trading strategy, they found that their model could explain six anomalies, such as size effect, long-term contrarian effect and etc. but was not able to explain momentum effect because after picking out the influences exerted by market factor, size factor and book-to-value ratio factor, momentum trading strategy, nonetheless, got obvious positive abnormal profits. But Jegadeesh and Titman (2001) still regarded it was too early to reject efficient market hypothesis, and momentum trading strategy's abnormal profits probably came from risk compensation due to the reason that after

the adjustment of three-factor model momentum trading strategy's abnormal profits reduced dramatically. That meant that market factor, size factor and book-to-value ratio factor might not fully explain the risk of stock. In other words, there might be one kind or several other kinds of important unknown risk factors in the economy.

Cross-sectional variation in expected returns is closely connected with risk compensation theory. Some scholars, typified by Lehmann (1990), divided the profit source of momentum and contrarian trading strategies into three types: the covariance of sample stock returns, the variance of sample stock returns and the cross sectional variance of expected return. Consequently, the two possible return origins of momentum and contrarian trading strategies are the predictable time-series variation, and the differences of cross-sectional variations of the stocks that constitute investment portfolio. If the profit of momentum and contrarian trading strategies was generated by the latter origin, the corresponding profit could be seen as the compensation for taking the risk, and therefore efficient market theory or weak-form efficient market theory was maintained.

The representative figure advocating this theory also include Conrad and Kaul (1998) who decomposed the abnormal profits of momentum and contrarian trading strategies, regarded that the abnormal profits of these two strategies did not have an apparent relationship with whether the return of the stock portfolio performed momentum effect on time series; instead, to a great extent, they were resulted from the cross-sectional variations of the average returns of different stocks. They also explained that the winner portfolio based on momentum trading strategy just bought the stocks with high expected return while the loser portfolio just also bought the stocks with low expected return.

Some other scholars attempted to explain the cause of momentum and contrarian effects from the perspective of behavioral finance whereby they considered the abnormal profits of momentum and contrarian trading strategies as the consequence of the irrational behavior of investors. The empirical studies of De Bondt and Thaler (1985) demonstrated that the overreaction of market toward information facilitated contrarian trading strategy to make profits; and momentum trading strategy made profits because of the market's underreaction toward information (Chan, Jegadeesh and Lakonishok, 1996). The two occasions were both resulted from investors' psychological bias when interpreting information (Barberis et al., 1998; Daniel et al., 1998). Currently, most scholars regard it is reasonable to account for momentum and contrarian effect from the angle of behavioral finance.

In sum, there are still a lot of disputes about the cause of momentum and contrarian effects and thus this topic deserves further research.

2.2 Chinese stock market research

There are not many studies on momentum and contrarian trading strategies in the Chinese academia, and the extant studies are mainly concentrating on the empirical test of the existence of momentum and contrarian effects on the Chinese stock market, that is, to test whether momentum and contrarian trading strategies can generate positive profits in the Chinese stock market.

One research examined the momentum effect on the Chinese stock market by selecting all the A-shares listed before 1993 as its sample, and adopted non-overlapping ranking period to measure the transaction data from 1993 to 2000. The portfolio's ranking period and holding period was 1, 3, 6, 9 and 12 months respectively. They found out that for all the ranking period and holding period, the "buy winner-portfolio and sell loser-portfolio" momentum trading strategy could not obtain positive abnormal profits; the longer the ranking period was, the less profitable momentum trading strategy was. They thought that the momentum effect on the Chinese stock market was very likely to possess the attribute of a short-term feature. It is possible to detect obvious momentum effect if shorter ranking period is employed, due to the fact that most Chinese stock investors prefer short-term investment, which leads to the high turnover ratio of the Chinese stock market. However, the time they used overlapping ranking period to test contrarian effect, they found that contrarian effect existed when ranking period was from 1 to 3 years and holding period from 1 to 5 years (Wang and Zhao, 2001).

Zhou (2002) measured the monthly return of all the listed firm in Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE), and the ranking period and holding period he employed was same as that of Wang and Zhao (2001), being 1, 3, 6, 9 and 12 months. And the percentage of stock portfolio took up 5% and 10% of the entire effective stock sample respectively. Zhou found that the application of momentum trading strategy could generate positive abnormal profits; in addition, when the percentage is five, the momentum effect would be more obvious. Though their research objects and research method were quite similar, Zhou's conclusion was different from that of Wang and Zhao (2001). The

author thinks that the different sampling approaches might be the reason of different conclusions, since the non-overlapping sampling methods in ranking method cannot completely make use of information, and thus cannot timely adjust dynamic trading strategies.

Hua et al. (2003) chose the A-shares listed before 2000 as the sample and selected the weekly transaction data from January 2000 to July 2002 with 3, 6 and 9 weeks being the ranking period, 3, 6, 12 and 24 weeks being the holding period. Lee and Swaminathan (2000)'s method was employed to test the momentum effect on the Chinese stock market. The research finding showed that the one-dimensional "buy winner portfolio and sell loser portfolio" momentum trading strategy could bring investors significant profits. The two-dimensional momentum trading strategy incorporating trading volume (turnover ratio was treated as an indicator to measure trading volume of stock here), which contains the "buy low-turnover ratio winner portfolio and sell high-turnover ratio loser portfolio" momentum trading strategy, followed by the "buy high-turnover ratio winner portfolio and sell low-turnover loser portfolio" momentum trading strategy, had poorer performance than one-dimensional momentum trading strategy. That is to say, turnover ratio's effect was not that significant in the Chinese stock market; simultaneously, it implied that the two-dimensional momentum trading strategy, which was based on return and trading volume, and the momentum life cycle proposed by Lee and Swaminathan (2000) was not applicable to the Chinese stock market.

Liu (2003) conducted research on the momentum and contrarian effects on Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE). The timeframe was from May 1995 to April 2002. In the 49 momentum strategies he has analyzed, 41 strategies' profits are positive. Among others, the momentum strategies with one-week ranking period and one-week holding period got returns significantly less than zero; the 7 other momentum strategies with negative profits had ranking period or holding period more than 36 weeks. His research result showed that contrarian effect existed in ultra-short term, and medium and long term while momentum effect existed in short term.

When Chinese scholars make empirical studies in this field, there are great discrepancies in the aspects of data sample size, the time to inspect sample and the patterns of strategy formation. Consequently, it is no wonder to have different opinions on momentum and contrarian effects. They always concentrated on the existence of momentum and contrarian effects, but did not pay enough attention to the causes of the two effects, which as a result leaves a large research space for later researchers.

3. The method

3.1 Data

This paper uses the weekly returns of A-shares which consist of Shanghai securities composite index downloaded from CSMAR (China stock market & Accounting Research) database, with the sample period from 2000 to 2010. There are in total 403 effective stocks after excluding the stocks subject to ST and PT. ST is the abbreviation of Special Treatment. On April 22nd 1998, Shanghai Stock Exchange and Shenzhen Stock Exchange announced that they would put special treatment to the listed companies with financial problems and other unusual conditions, that is to say, the target of the policy is the firms that have financial problems or other unusual conditions. The stocks that are specially treated are titled with ST in front of their stock names (see China Securities Regulatory Commission). And PT is the abbreviation of Particular Transfer. According to Company Law and Securities Law, the listed companies which have showed deficits for three years running will receive listing suspension. From July 9th 1999, Shanghai Stock Exchange and Shenzhen Stock Exchange provide particular transfer service to the stocks being suspended, and title them with PT in front of the stock names (ibid).

On one hand, ST and PT stocks have low liquidity and poor fundamental, which possibly makes investors underestimate their prices in the long run. So the existence of these abnormal stocks might lead to negative return of loser portfolio. On the other hand, once these kinds of stocks encounter the opportunity of M&A, because of their low prices and therefore small total value of trade, they are quietly easily "stir-fried" by investors. This will result in soaring stock price and their possibly being included into winner portfolio and make the return of winner portfolio rise violently. The two characteristics of PT and ST stocks will generate momentum effect and contrarian effects. In order to keep the validity and stability of the research result, the two kinds of stocks are picked out.

In the empirical studies, the author employs stocks' weekly return which has experienced the adjustment of profit sharing, dividend and additional issues. The reasons why the author chooses weekly return instead of monthly return are as follows: First, the chosen sample period is from 2000 to 2010. If monthly return is employed the credibility of the research might be ruined because of the inadequate sample points. Second, the momentum effect on

the Chinese stock market is probably characterized as having short-term feature (Wang and Zhao, 2001), and the speculative atmosphere is quite strong; most investors prefer short operation. Consequently, the selection of weekly data can help observe the stock momentum effect within the timeframe of two weeks or one month, which makes it easier to capture accurately the features of the Chinese stock market.

In terms of the Chinese stock market, there are two stock exchanges - Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE) and two typical types of shares traded on the two exchanges, A-shares and B-shares. Before the reforms implemented in December 2002, A-shares were oriented to domestic investors and Renminbi (RMB) denominated, and later the system of QFII (Qualified Foreign Institutional Investor) was introduced to legalize the investment from foreign institutional investors in A-shares (Lin and Swanson: 2008). In respect of B-shares, they are oriented to the foreign investors with US dollar denominated in SHSE and Hong Kong dollar denominated in SZSE respectively. Given that one of the purposes of the paper is to capture the features of the domestic investors in China, B-shares that reflect the characteristics of foreign investors are not taken into account in this paper.

The reason why this paper focuses on SHSE rather than SZSE is that SHSE is much less subject to a worldwide financial turbulence than SZSE due to the fact that firms listed on SHSE are mainly large and state-owned, while most of the firms listed on SZSE are small and exporting enterprises (Wang and Liu: 2004), and thus the impact of Subprime Financial Crisis can be eliminated to some extent.

And in the end the author chooses the A-shares in Shanghai securities composite index as the research data sample for the reasons that Shanghai securities composite index has included all the listed stocks in Shanghai Stock Exchange (SHSE), and its value weighted sum is based on issue volume, embracing farming, forestry, fishing, husbandry, energy, traffic, electronics, chemistry, food, medicine and other industries. So it has strong representativeness and can reflect the basic movement of the Chinese stock market

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3.2 Methodology

This paper firstly investigates the presence of momentum and contrarian effects by applying the method proposed by Jegedeesh and Titman (1993) to construct the relative strength portfolios, that is, to rank all the stocks according to their past performance and identify winner portfolio and loser portfolio; and after enforcing the strategy of "buy winner-portfolio and sell loser-portfolio" for a period of time, calculate the cumulative yield of winner portfolio and loser portfolio within the holding period, and finally identify the profitability of momentum and contrarian trading strategies. The ranking period and holding period in Jegadeesh and Titman (1993)'s research were 3, 6, 9 and 12 months respectively, which are 13, 26, 39 and 52 weeks if counted in weeks. With regard to the short-term feature of the Chinese stock market, the paper adds the trading strategies of another four ranking periods and holding periods (1, 2, 4, 8 weeks), on the basis of Jegadeesh and Titman (1993)'s trading strategies. Then, the ranking periods and holding periods in this paper are 1, 2, 4, 8, 13, 26, 39 and 52 weeks respectively. Besides, Jegadeesh and Titman (1993) divided the strategies into two types, one with ranking period closely followed by holding period, and the other with ranking period followed by holding period by one week later, namely, the performance of the strategy is evaluated one week later than when investors buy winner-portfolio and sell-loser portfolio. As a result, the total number of the trading strategies involved in this paper is 128 ($2 \times 8 \times 8 = 128$). Different trading strategies are applied to exploit the relative performances of stock portfolios over different horizons.

The prototype of Winner-Loser portfolio strategy dates back to Beaver and Landsman (1981)'s test of semi-strong efficient market hypothesis; after that, De Bondt and Thaler (1985) and Jegadeesh and Titman (1993) made some modifications upon it, which becomes the current widely-used method. Winner-portfolio and loser-portfolio are determined by the performance within ranking period.

The computing methods of stock return within ranking period generally contain arithmetic method and geometric method. As Dissanaike (1994) suggested that the arithmetic method would yield biased results when computing cumulative returns and constructing the winner and loser portfolios, geometric method is applied instead in this paper. The corresponding formula is as follows:

$$R_{i,T}^{J} = \prod_{t=1}^{J}(1 + R_{i,T-t+1}) - 1, \quad J = 1, 2, 4, 8, 13, 26, 39, 52.$$

$R_{i,T}^{J}$: buy-and-hold return of stock i within in ranking period;

$R_{i,T-t+1}$: the weekly return of stock i in week (T-t+1) within ranking period; T is the week of forming portfolio, J is the week number of ranking period.

Sort different stocks by their returns within ranking period, and label the 10% of the stocks that have highest return with winner-portfolio (W), and 10% of the stocks with lowest return loser-portfolio (L). Immediately after ranking period or one week later, hold the zero-cost portfolio that is characterized as "buy winner portfolio and sell loser portfolio" for K weeks. This trading strategy is called strategy (J, K), which means that the ranking period is J weeks and the holding period is K weeks. And then separately calculate the return of winner-portfolio ($R_{W,T}^{J}$) within ranking period and the return of loser-portfolio ($R_{L,T}^{J}$).

The return here is the equally weighted average of the cumulative return of different stocks that constitute the portfolio within holding period, and the formula is as follows:

$$R_{W,T}^{J} = \frac{1}{N_T}\sum_{i=1}^{N_T}\left[\prod_{t=1}^{K}(1 + R_{i,T+t}) - 1\right], \text{K=1, 2, 4, 8, 13, 26, 39, 52.}$$

$R_{W,T}^{J}$: the buy-and-hold return of winner portfolio within holding period; $R_{i,T+t}$: the weekly return of stock i within holding period; N_T : the number of stocks in the portfolio within holding period; T represents the week when portfolio forms, K stands for the week number of holding period. Similarly, the return of loser portfolio $R_{L,T}^{J}$ can be calculated in this way.

A week later, repeat rolling the above-mentioned procedures. In the process of repeating the procedures, winner portfolio and loser portfolio will be updated continuously. The paper employs overlapping ranking period, that is, to re-sort order during every ranking period and rebuild winner-portfolio and loser-portfolio so as to increase sample size. In that way, the accuracy of the empirical research will be enhanced.

After that, calculate the average return of trading strategies ($\overline{R}_{J,K} = \overline{R}_W^K - \overline{R}_L^K$), in which $\overline{R}_W^K$ and $\overline{R}_L^K$ respectively refer to the average return of winner-portfolio and loser-portfolio within holding period, denoted as $\overline{R}_j^K = \frac{1}{T}\sum_{t=1}^{T} R_{j,t}^K$, $j = W, L$, where T is the time length of holding period.

Finally, use t-test to examine if $\overline{R}_{J,K}$ is zero: if $\overline{R}_{J,K}$ is significantly greater than zero, momentum effect exists; if $\overline{R}_{J,K}$ is significantly less than zero, then contrarian effect exists.

It is worthy of being mentioned that the paper firmly complies with the principle of continuousness and completeness in the process of data screening, making sure that the data within ranking period and holding period are continuous and complete. In other words, within ranking period and holding period, if a stock lacks data for one or several specific periods, it will be picked out and excluded from being considered. However, that does not mean this stock will be picked out forever because it may be complete within specific ranking period and holding period.

Considering that a new ranking period will appear every other week, building a new winner-portfolio and loser-portfolio is necessary. In the actual operation process, initially the week that contains more than or equal to 10 stocks is to be found out. In the data selected by the author, from the 18th week in 2008 there existed more than ten stocks. The reason why ten stocks are selected as a benchmark is that the author labels the top 10% of all the stocks with winner-portfolio, and labels the bottom 10% with loser-portfolio. If the total number of the stocks is not the multiple of 10, the stock number of winner-portfolio and loser-portfolio is rounded. For instance, if the total stock number is 23, then the stock number of the two portfolios are 2 respectively (23×10%≈2); if the total stock number is 28, then the stock number of the two portfolios are 3 respectively (28×10%≈3).

Secondly, every week after the 18th week in 2008 is a new start for ranking period unless the number of the rest weeks is smaller than the sum of ranking period and holding period. For example, if the number of the rest weeks is 5, the ranking period of the corresponding strategy is 2 weeks which is immediately followed by a 4-week holding period, then 5 is smaller than (2+4). According to the principle of continuousness and completeness, the data falling into these 5 weeks are excluded from consideration. It is necessary to identify winner-

portfolio and loser-portfolio every week according to their cumulative returns in the ranking period, and then calculate and record their cumulative returns within holding period.

In view of the huge number of the data which is selected by the author, that is, more than 400 stocks and over 130,000 numbers, manual computation will take a lot of time and efforts. Fortunately, this problem can be solved by means of Matlab, which uses program to process data cyclically. However, in the former literatures, relevant methods to process data have not been shown by former researchers; merely results were given. The researchers who employ small sample and non-overlapping ranking period method are capable of drawing more credible conclusions by utilizing large sample and overlapping ranking period method with the help of the Matlab codes in Appendix which is provided by this paper.

4. Empirical Results and Analysis

4.1 The test results of presence of momentum and contrarian effects

Table 1 and table 2 in Appendix A show the empirical results of returns for the relative strength portfolios (W-L) in the holding period, where table 1 corresponds to the performance of the relative strength portfolios (W-L) constructed immediately after the ranking period, and table 2 refers to the performance of the portfolios formed one week after the ranking period. The corresponding figures are shown in Figure 1 and Figure 2 in Appendix B respectively.

Through observing Table 1, the relative strength portfolios (W-L) constructed immediately after the ranking period show the following characteristics:

(1)   In the 25 ($5 \times 5 = 25$) strategies whose ranking period and holding period are 1, 2, 4, 8 and 13 respectively, except for the average returns of the trading strategies (2, 2) and (2, 13) are below zero but not significantly different from zero, the average returns of the rest relative strength portfolios (W-L) are all significantly less than zero. This means that the performance of loser-portfolio is better than that of winner-portfolio during the above-mentioned holding period; in other words, contrarian effect is significant. This conclusion coincides with the research results of Jegadeesh (1990) and Lehmann (1990), in which the short-term contrarian effect's ranking period and holding period are generally shorter than one week.

(2)   Amongst all the strategies, only the three trading strategies (13, 39), (26, 26), (26, 39) have average returns significantly greater than zero, which confirms the existence of momentum effect. This result also agrees with Jegadeesh and Titman (1993)'s research result that they discovered the ranking period and holding period of medium-term momentum effect were generally 3 to 12 months, or 13 to 52 weeks.

(3)   When ranking period is smaller or equal to 8, as holding period extends, the average return of the relative strength portfolios (W-L) has the tendency to continuously grow; besides, with the change of holding period, some returns have changed from negative to positive, which means that contrarian effect is substituted by momentum effect. When ranking period is more than or equal to 13, initially, the average return

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of the relative strength portfolios (W-L) perform continuous increase within a comparatively short holding period; as holding period extends, the corresponding returns revert to zero, that is, stock prices come back to the normal level.

(4) When ranking period is 1 week, the average return of portfolio (W-L) with one-week holding period is the lowest below zero, that is, the return of contrarian trading strategy is the highest and meanwhile it has the highest significance from the perspective of statistics.

(5) When holding period is 52 weeks, the average returns of all the relative strength portfolios (W-L) revert to zero.

(6) With the extension of ranking period or holding period, momentum and contrarian effects gradually disappear.

(7) all of the absolute values of average returns of W-L are less than that of loser-portfolio, indicating that the strategy that only holds loser-portfolio outperforms the momentum and contrarian trading strategies when transaction cost is not taken into account;

(8) From the perspective of significance level, when ranking period and holding period are short and medium term, namely 1, 2, 4, 8 and 13 weeks, the null hypothesis that the mean difference is zero can be rejected even at the significance level of 1%.

In sum, when ranking period or holding period stays within the time span of 13 weeks, applying contrarian trading strategy can often generate significant positive return, which is markedly superior to momentum trading strategy. When the time span exceeds 26 weeks, some significant signs of momentum effect appear in the market, which means that the stocks which have good early performance still outperform those bad stocks in the later period. One thing needs to be mentioned here. Within the sample periods selected by the author, the absolute values of all the weekly average returns of W-L portfolio strategy are less than that of loser-portfolio strategy. That is to say, investors can make more profits by simply holding loser-portfolio based on their previous performance, without constructing the dynamic trading portfolios on the analysis of updated information when transaction cost is out of consideration.

After observing Table 2, it can be said that generally, the results displayed in Table 2 is quite similar to that in Table 1. And the relative strength portfolios (W-L) constructed one week after the ranking period possess characteristics as follows:

(1) In the 25 (5×5=25) strategies whose ranking period and holding period are 1, 2, 4, 8 and 13 respectively, except for the average return of the 4 (2×2=4) strategies, with ranking period and holding period being 1 and 2, greater than zero, the rest 21 W-L portfolio trading strategies have average returns below zero, and nearly half of them are significantly less than zero. This means that loser-portfolio generally outperforms winner-portfolio during those holding periods. Compared with the result shown in Table 1, the contrarian effect manifested in Table 2 is less significant.

(2) In all the strategies, only five trading strategies, including (1, 2), (13, 39), (26, 26), (26, 39) and (39, 8), get average returns significantly greater than zero. This confirms the existence of momentum effect.

(3) All of the absolute values of average returns of W-L are less than that of winner-portfolio and that of loser-portfolio, indicating that the strategy that only holds winner-portfolio or loser-portfolio or both of them outperforms the momentum and contrarian trading strategies when transaction cost is disregarded.

The results of the above empirical studies show that:

(1) The momentum effect on the Chinese stock market is relatively weak. The research carried out by Jegadeesh and Titman (1993) demonstrated that within multiple ranking periods and holding periods, momentum trading strategy can lead to positive returns. However, in China, momentum trading strategy can only generate positive returns within given ranking period and holding period. What is more, even if the highest weekly average return of momentum trading strategies 0.15% is significantly less than the 1.31% monthly (approximately 0.3275% weekly) average return in US stock market brought by momentum trading strategy (Jegadeesh and Titman, 1993).

(2) Contrarian effect plays a dominant role in the Chinese stock market, which contradicts with Jegadeesh and Titman (1993)'s empirical findings in US stock market.

(3) The momentum and contrarian effects on the Chinese stock market have short-term tendency. In Jegadeesh and Titman (1993)'s empirical research, they selected 3, 6, 9 and 12 months as ranking period and holding period respectively, and found that momentum effect existed in the period from 3 to 12 months. But in the Chinese stock market, this process has been evidently shortened. The momentum and contrarian effects can be seen within ranking

period less than 13 weeks, that is, less than 3 months. These empirical findings confirmed Wang and Zhao (2001)'s surmise: the momentum and contrarian effect of the Chinese stock market is a within-one-month phenomenon, and can be verified only if by using weekly data.

(4) The Chinese stock market displays the characteristics of being unilateral, namely, the "buy winner-portfolio and sell loser-portfolio" trading strategy only originates from "buy winner-portfolio", while "sell loser-portfolio" does not increase, which in turn decreases the returns of corresponding trading strategies, due to the fact that holding loser-portfolio can obtain significant positive returns.

4.2 Sources of Relative Strength Profits

Considering that (1, 1) trading strategy that the holding period is immediately after the ranking period and (26, 26) trading strategy that skips a week between the ranking period and the holding period have the most significant results, with the former strategy gaining negative returns and the latter one having positive returns, they are capable to represent contrarian trading strategy and momentum trading strategy respectively. This is consistent with what Jegadeesh and Titman (1993: 69) had done in their research by only focusing on the 6-month/6-month strategy, regarding that the results for this strategy are representative of the results for the other strategies. In this sense, the author focuses on the two trading strategies mentioned above.

4.2.1 Risk-adjusted return

The prerequisite of identifying the existence of momentum and contrarian effects on stock market is to define the normal market responses. Concerning that currently there have not existed certain multi-factor models which have robust power in empirical studies, the author decides to employ the single-factor model to calculate abnormal return, that is, applying CAPM model to adjust portfolio's abnormal return. According to the empirical version of CAPM model,

$$R_{i,t} - r_{f,t} = \alpha + \beta_i (R_{m,t} - r_{f,t}) + \varepsilon_{i,t}$$

of which $R_{i,t}$ stands for the return of portfolio W-L within holding period and it is measured by weekly average return; $r_{f,t}$ represents the risk-free return during the corresponding period, and in the context of this paper it is the weekly risk-free return provided by CSMAR; $R_{m,t}$ is the market return (represented by the return of Shanghai securities composite index, provided by CSMAR as well) during the corresponding period and is measured by weekly average return; $\varepsilon_{i,t}$ is the error term at time t.

If α is significantly different from zero, the excess return of the portfolio cannot be explained by the market factor representing systematic risk; in other words, the portfolio is capable of attaining significantly positive or negative abnormal return after the adjustment of risk.

4.2.1.1 Unit Root – Augmented Dickey-Fuller (ADF) test

Many financial time series tend to wander a long way from the long-term mean without reverting to the mean again, and might behave as a random walk process as well, and series performing in this way is called non-stationary. The problem is that a spurious relationship with artificially high R^2 arises from the use of non-stationary variables. Therefore, before running a regression between variables, unit root testing should be applied to examine the stationary properties of the variables, to make sure that each of the variables is stationary.

In this paper, ADF test developed by Dickey and Fuller (1979) is employed to examine the stationarity of the series, under the null hypothesis that the series is non-stationary. The series include excess returns of trading strategies (1, 1) and (26,26), denoted by R_1 and R_{26} respectively, and corresponding market premiums R_{m1} and R_{m26}.

As shown in Table 3, under ADF test including a constant with the critical values -3.438508 at 1% level and -2.865030 at 5% level, all the series R_1, R_{26}, R_{m1} and R_{m26} are stationary, due to the rejection of the null hypothesis that the series contains a unit root at the 1% significance level.

4.2.1.2 CAPM model

After rendering all the variables stationary, the author employs a regression on portfolio's excess return and market premium. The results of the intercepts are shown in Table 4, from which we can see that both the intercepts are significantly different from zero at the significance level of 10%. That means contrarian effect or momentum effect cannot be eliminated through risk adjustment. This consequence reveals that within the framework of efficient market hypothesis risk compensation cannot explain these two effects.

4.2.2 Behavioral Finance's Explanations of Momentum and Contrarian Effects

Now that risk compensation cannot account for contrarian and momentum effects on the framework of efficient market hypothesis, the author turns to behavioral finance for explanations. Behavioral finance regards that various kinds of psychological biases will take place when investors are processing information; that is to say, they are not always rational.

Barberis et al. (1998) think that there are two prevalent decision biases when investors are making investment decisions. One is representative bias. Investors summarizes certain pattern based on the recent market activities; when such kind of pattern appears again, investors tend to neglect the possibility of contingency in the market while overvaluing the universality and applicability of the pattern they summarized, and utilize it to prejudge the future investment. This will lead to investors' overreaction towards the new information in stock market. Another is conservativism. The reaction velocity of investors toward new information is so slow that the new information will take a while to be reflected in stock price, and thus momentum effect is displayed through stock price.

As Jegadeesh and Titman (2001: 712) exhibited the long horizon momentum profits under different hypothesis shown in Figure 3, it is obvious that the return of portfolio W-L with holding period immediately after ranking period is steadily increasing; and then manifests decreasing tendency as time changes. This change pattern is in accordance with the overreaction hypothesis, that is, overreaction leads to contrarian effect on the Chinese stock market. When it comes to momentum effect, the corresponding change pattern agrees with the underreation hypothesis, and its main trend is in conformity with Figure 3. For example, the

return of portfolio W-L with holding period (26 weeks to 52 weeks) one week after ranking period (2 weeks) is increasing slowly to a certain level.

The empirical studies of this paper show that in the Chinese stock market investors' underreation toward information leads to momentum effect while their overreaction results in contrarian effect. However, the question about what kind of behavioral pattern generates overreaction and underreation still needs further study.

5. Conclusion

The paper selects the weekly returns of A-shares which are included in the Shanghai securities composite index, sets the sample period from 2000 to 2010, and conducts analysis on the stock momentum and contrarian effects on the Chinese stock market. The conclusions are as follows:

(1) Momentum and contrarian effects indeed exist in the Chinese stock market, with the contrarian effect being relatively strong and the momentum effect being relatively weak; and the weekly average returns brought about by momentum effect are significantly less than the 1.31% monthly average return in US stock market (Jegadeesh and Titman, 1993); the momentum and contrarian effects on the Chinese stock market have the characteristics of a short-term (to be specific, "within-one-month") phenomenon; the Chinese stock market displays a unilateral feature in that the loser-portfolio gains positive return, so selling loser-portfolio will decrease the return of "buy winner-portfolio, sell loser-portfolio" trading strategy.

(2) Within the framework of efficient market hypothesis, risk compensation cannot explain the cause of momentum and contrarian effects on the Chinese stock market. The author employs CAPM model to adjust the risk level of "buy winner, sell loser" zero-cost portfolio, but this cannot eliminate these two effects, arguably because CAPM cannot explain these two effects.

(3) Barberis et al. (1998) explains the momentum effect from the angle of the psychological biases among investors. The empirical results suggest that the underreation of investors toward information brings about a momentum effect, and the overreaction of investors toward information leads to a contrarian effect. But what kind of behavioral pattern on earth results in overreaction and underreation? This is a question worthy of more attention. From the perspective of behavioral finance, the interaction between the limitation of the channels whereby investors obtain information, various psychological biases, and other kinds of psychological factors might be the reason why momentum and contrarian effects exist, and still call for further research.

Through the analysis of the momentum and contrarian effects on the Chinese stock market, three conclusions are drawn. First, it discloses a basic feature of the Chinese stock market, namely, momentum and contrarian effects exist in the Chinese stock market. Second, feasible investment strategies are suggested that have some practiced and economic significance. Third, investors' behavioral patterns hidden behind the changes of stock price are recognized.

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7. Appendix

Appendix A:

Table 1. The performance of portfolio W-L

with holding period immediately after ranking period

		K=1	K=2	K=4	K=8	K=13	K=26	K=39	K=52
J=1	Winner	−0.0010	0.0016	0.0022	0.0027	0.0032	0.0042	0.0049	0.0053
	Loser	0.0063	0.0042	0.0040	0.0041	0.0042	0.0047	0.0052	0.0056
	W−L	−0.0073	−0.0026	−0.0018	−0.0014	−0.0009	−0.0005	−0.0002	−0.0003
	t value	−5.8392**	−3.2498**	−3.2117**	−3.2665**	−2.6556**	−2.0666*	−0.9811	−1.3220
J=2	Winner	0.0012	0.0028	0.0025	0.0029	0.0034	0.0043	0.0051	0.0054
	Loser	0.0058	0.0040	0.0046	0.0042	0.0043	0.0048	0.0052	0.0056
	W−L	−0.0045	−0.0013	−0.0021	−0.0013	−0.0009	−0.0005	−0.0001	−0.0002
	t value	−3.5624**	−1.5400	−3.2603**	−2.7432**	−2.4449	−1.8084	−0.4726	−0.7705
J=4	Winner	0.0021	0.0023	0.0019	0.0027	0.0033	0.0042	0.0051	0.0055
	Loser	0.0065	0.0054	0.0055	0.0046	0.0047	0.0048	0.0051	0.0057
	W−L	−0.0044	−0.0032	−0.0035	−0.0019	−0.0014	−0.0006	0.0000	−0.0001
	t value	−3.07**	−3.2185**	−4.7709**	−3.675**	−3.3619**	−2.0339	0.0601	−0.5780
J=8	Winner	0.0019	0.0023	0.0023	0.0026	0.0030	0.0042	0.0051	0.0055
	Loser	0.0068	0.0056	0.0052	0.0045	0.0045	0.0046	0.0048	0.0054
	W−L	−0.0049	−0.0034	−0.0028	−0.0019	−0.0015	−0.0003	0.0003	0.0001
	t value	−3.1903**	−3.2086**	−3.6934**	−3.5518**	−3.4449**	−1.1027	1.1914	0.4973
J=13	Winner	0.0022	0.0027	0.0028	0.0032	0.0034	0.0047	0.0056	0.0059
	Loser	0.0070	0.0060	0.0056	0.0046	0.0046	0.0045	0.0048	0.0055
	W−L	−0.0048	−0.0033	−0.0028	−0.0014	−0.0012	0.0002	0.0008	0.0004
	t value	−3.0805**	−3.0305**	−3.2217**	−2.4687*	−2.5064*	0.5671	2.6873**	1.6484
J=26	Winner	0.0027	0.0030	0.0033	0.0039	0.0045	0.0056	0.0058	0.0062
	Loser	0.0058	0.0049	0.0046	0.0040	0.0041	0.0043	0.0049	0.0059
	W−L	−0.0031	−0.0019	−0.0012	−0.0001	0.0003	0.0013	0.0009	0.0003
	t value	−1.9295	−1.6394	−1.4275	1.6482	0.6871	3.5908**	2.6786**	0.9264
J=39	Winner	0.0040	0.0044	0.0045	0.0049	0.0049	0.0052	0.0057	0.0063
	Loser	0.0050	0.0046	0.0043	0.0039	0.0042	0.0048	0.0054	0.0060
	W−L	−0.0009	−0.0002	0.0001	0.0010	0.0007	0.0004	0.0003	0.0003
	t value	−0.5809	−0.1778	1.6482	1.6056	1.2740	0.9966	0.7995	0.9843
J=52	Winner	0.0037	0.0038	0.0040	0.0042	0.0044	0.0051	0.0060	0.0066
	Loser	0.0057	0.0054	0.0052	0.0045	0.0048	0.0055	0.0059	0.0066
	W−L	−0.0020	−0.0016	−0.0013	−0.0003	−0.0004	−0.0004	0.0001	0.0000
	t value	−1.1967	−1.2556	−1.3230	−0.5098	−0.6352	−0.8409	0.3392	−0.1088

** is significant at the 0.01 level.
* is significant at the 0.05 level.

Table 2. The performance of portfolio W-L

with holding period one week after ranking period

		K=1	K=2	K=4	K=8	K=13	K=26	K=39	K=52
J=1	Winner	0.0042	0.0038	0.0029	0.0032	0.0037	0.0044	0.0051	0.0054
	Loser	0.0023	0.0023	0.0036	0.0037	0.0040	0.0045	0.0051	0.0055
	W-L	0.0019	0.0015	-0.0007	-0.0005	-0.0003	-0.0002	0.0000	-0.0001
	t value	1.9009	2.0034*	-1.1870	-1.1861	-0.9247	-0.6494	0.0757	-0.6636
J=2	Winner	0.0044	0.0034	0.0028	0.0032	0.0036	0.0044	0.0051	0.0055
	Loser	0.0023	0.0032	0.0043	0.0038	0.0042	0.0046	0.0051	0.0056
	W-L	0.0021	0.0002	-0.0015	-0.0006	-0.0006	-0.0002	0.0000	-0.0001
	t value	1.8445	0.2098	-2.2743*	-1.4036	-1.6400	-0.8106	0.1750	-0.4830
J=4	Winner	0.0027	0.0021	0.0020	0.0029	0.0034	0.0043	0.0052	0.0056
	Loser	0.0044	0.0048	0.0050	0.0042	0.0044	0.0047	0.0050	0.0055
	W-L	-0.0017	-0.0027	-0.0030	-0.0013	-0.0010	-0.0004	0.0002	0.0000
	t value	-1.2806	-2.9325**	-4.0869**	-2.6703**	-2.7336**	-1.3607	0.9624	0.0758
J=8	Winner	0.0027	0.0023	0.0024	0.0027	0.0031	0.0043	0.0052	0.0055
	Loser	0.0045	0.0045	0.0045	0.0041	0.0042	0.0044	0.0047	0.0053
	W-L	-0.0018	-0.0021	-0.0022	-0.0014	-0.0011	-0.0001	0.0005	0.0002
	t value	-1.2529	-2.0648*	-2.8853**	-2.6608**	-2.6766**	-0.1951	1.7952	0.7772
J=13	Winner	0.0033	0.0032	0.0030	0.0032	0.0036	0.0048	0.0057	0.0059
	Loser	0.0052	0.0053	0.0048	0.0041	0.0043	0.0043	0.0047	0.0054
	W-L	-0.0018	-0.0021	-0.0018	-0.0009	-0.0007	0.0005	0.0010	0.0005
	t value	-1.2057	-1.8600	-2.0970*	-1.7246	-1.5359	1.5295	3.2038**	1.7865
J=26	Winner	0.0034	0.0034	0.0035	0.0041	0.0047	0.0057	0.0059	0.0063
	Loser	0.0040	0.0040	0.0040	0.0037	0.0039	0.0042	0.0049	0.0059
	W-L	-0.0007	-0.0007	-0.0005	0.0004	0.0008	0.0015	0.0010	0.0004
	t value	-0.4341	-0.5781	-0.5500	0.7058	1.5731	4.2357**	2.8962**	1.2782
J=39	Winner	0.0048	0.0044	0.0046	0.0050	0.0049	0.0052	0.0057	0.0064
	Loser	0.0042	0.0040	0.0040	0.0037	0.0041	0.0047	0.0054	0.0061
	W-L	0.0006	0.0004	0.0005	0.0013	0.0008	0.0004	0.0003	0.0003
	t value	0.3609	0.3806	0.5861	2.1223*	1.5511	1.0882	0.9065	1.1138
J=52	Winner	0.0039	0.0038	0.0041	0.0042	0.0044	0.0052	0.0060	0.0066
	Loser	0.0050	0.0050	0.0049	0.0042	0.0046	0.0054	0.0058	0.0066
	W-L	-0.0011	-0.0012	-0.0008	0.0000	-0.0002	-0.0002	0.0002	0.0000
	t value	-0.6676	-0.9325	-0.8305	-0.0221	-0.3855	-0.5310	0.5476	-0.0381

** is significant at the 0.01 level.

* is significant at the 0.05 level.

Table 3. Results of unit root test

	ADF (+constant)
R_1	-9.8634**
R_{m1}	-9.3351**
R_{26}	-3.9439**
R_{m26}	-8.6751**

Table 4. Results of intercepts

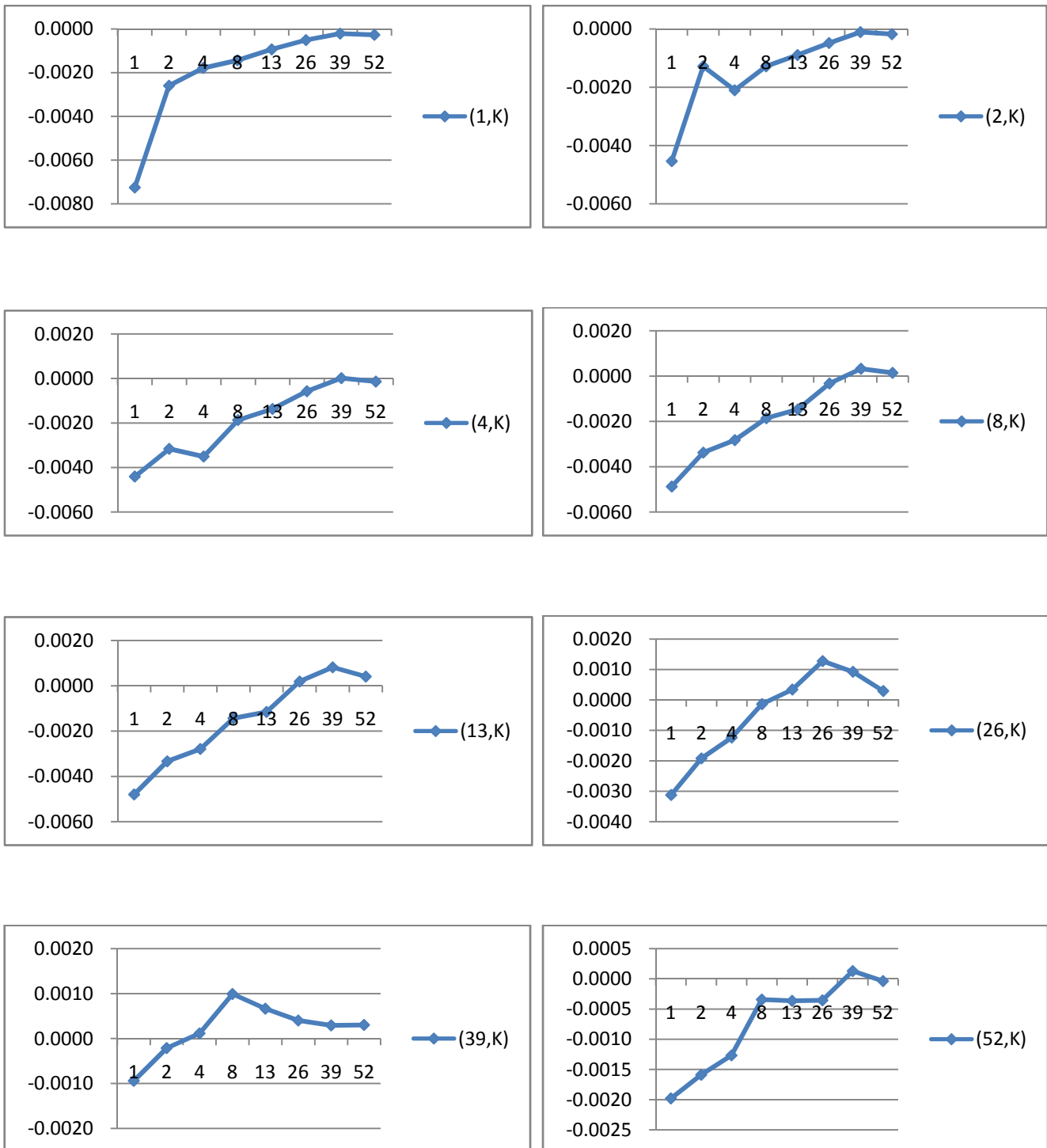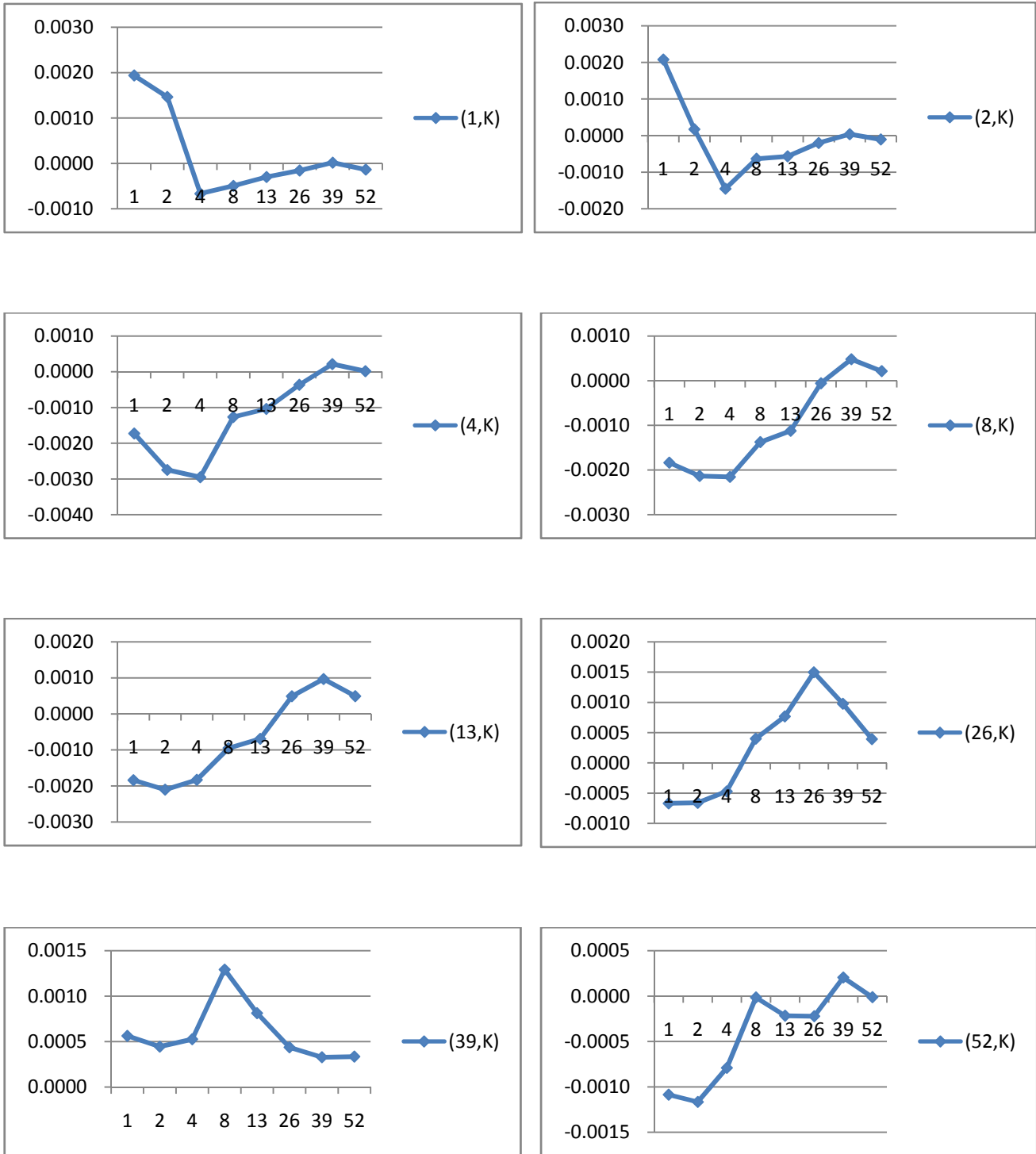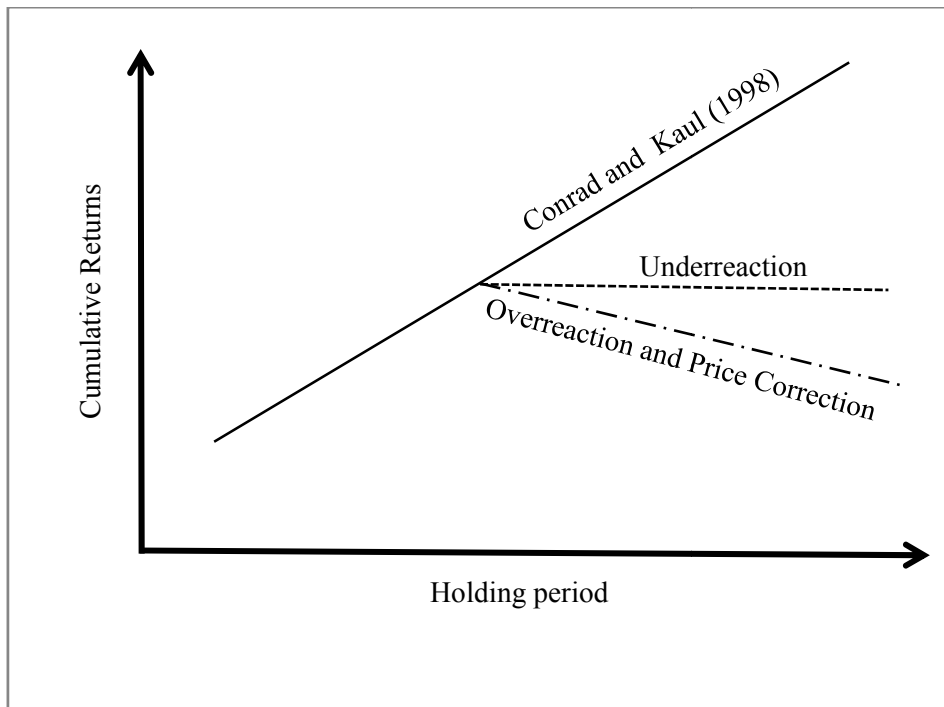| Trading strategy (1,1)		Trading strategy (26,26)	
Intercept (α)	p-value	Intercept (α)	p-value
-0.030581	0.0000	0.008420	0.05176

Figure 1. The returns of portfolio W-L with holding period immediately after ranking period

Figure 2. The returns of portfolio W-L with holding period one week after ranking period

Figure 3. Long Horizon Momentum Profits Under Different Hypothesis

Appendix C:

The Matlab codes of constructing the relative strength portfolio W-L

```
% load stockdata;

stockdata = xlsread('data.xlsx','final','B2:OR511');

stockid= xlsread('data.xlsx','final','B1:OR1');

[totalweeks,totalstocks] = size(stockdata);

period1 = [1,2,4,8,13,26,39,52];

period2 = [1,2,4,8,13,26,39,52];

startweek = 14;


%get the number of stocks for each week

for i=1:totalweeks

  nbrstocks(i) = totalstocks - sum(isnan(stockdata(i,:)));

end


for i = 1:length(period1)

for j = 1:length(period2)

for n = 1:2


    p1 = period1(i);

    p2 = period2(j);


% initialize

    Rwinner = zeros(totalweeks,1);

    Rloser = zeros(totalweeks,1);

    idwinner = zeros(totalweeks,round(max(nbrstocks)*0.1));
```

```matlab
    idloser = zeros(totalweeks,round(max(nbrstocks)*0.1));


for k = startweek:totalweeks+1-p1-p2-(n-1)
    start1 = k;
    stop1 = start1+p1-1;
    orderweeks = start1:stop1;


    start2 = stop1+1+(n-1);
    stop2 = start2+p2-1;
    holdweeks = start2:stop2;


    nstocks = nbrstocks(k);


% order R for the ordering weeks
    data1 = stockdata(orderweeks, 1:nstocks);


    R1 = ones(1,nstocks);
for m = 1:length(orderweeks)
    R1 = R1.*data1(m,:);
end
    R1 = R1-1;


% select for the winners and losers
    [B,idx] = sort(R1,'descend');
    ncandidates = round(nstocks*0.1);
    idwinner(k,1:ncandidates) = stockid(idx(1:ncandidates));
    idloser(k,1:ncandidates) = stockid(idx(end-ncandidates+1:end));
```

% caculate the R for winners and losers in holding weeks

```
    data2winner = stockdata(holdweeks, idx(1:ncandidates));

    data2loser = stockdata(holdweeks, idx(end-ncandidates+1:end));

    R2w = ones(1,ncandidates);

    R2l = ones(1,ncandidates);


for m = 1:length(holdweeks)

     R2w = R2w.*data2winner(m,:);

     R2l = R2l.*data2loser(m,:);
end

    R2w = R2w-1;

    R2l = R2l - 1;

    Rwinner(k) = mean(R2w);

    Rloser(k) = mean(R2l);
end


    xlswrite(fullfile(['strategy_' num2str(p1) '_' num2str(p2) '_' num2str(n)
'.xlsx']),Rwinner,'Rwinner');

    xlswrite(fullfile(['strategy_' num2str(p1) '_' num2str(p2) '_' num2str(n)
'.xlsx']),Rloser,'Rloser');

    xlswrite(fullfile(['strategy_' num2str(p1) '_' num2str(p2) '_' num2str(n)
'.xlsx']),idwinner,'idwinner');

    xlswrite(fullfile(['strategy_' num2str(p1) '_' num2str(p2) '_' num2str(n)
'.xlsx']),idloser,'idloser');
end

end

end
```