

# **Weak-form Market Efficiency of Shanghai Stock Exchange: An Empirical Study**

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# Abstract

This paper investigates the weak-form efficient market hypothesis in Shanghai Stock Exchange using the data from April, 1996 to April, 2002. A set of tests based on the CAPM and another set of tests on the trading strategies are used. We propose the tests of the CAPM on two methodologies, which are a preliminary test and the Fama-MacBeth regressions. The first one is based on the CAPM's assumption that the stock with higher risk should obtain greater return than that with lower risk. In the second approach, we attempt to predict the future rates of return to the portfolios on the basis of risk variables estimated in previous periods. The empirical results suggest that there is no positive or linear relation existing between the individual stocks' returns and their market betas, and that non-beta risks also affect expected returns. Though we test the CAPM under several auxiliary assumptions, no evidence seems favorable to the proposition that the CAPM holds. The empirical tests of the CAPM do not provide any support for the weak-form efficient market hypothesis. This paper further documents the significantly abnormal returns generated by the contrarian strategies, which buy the stocks that have performed poorly in the past and sell the stocks that have performed well in the past. The profitability of the contrarian strategies indicates that investors can get positive returns using the trading strategies. Using an autocorrelation function, the returns of the industry portfolios are found to be negatively auto-correlated. These results add evidence that is not favoring the weak-form efficient market hypothesis. In sum, our evidence does not provide any support for the proposition that the Shanghai

Stock Exchange is a weak-form efficient market.

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# 1. Introduction

A few studies have been conducted on the test of efficient market hypothesis (EMH) in emerging markets compared to the volume of studies published on the developed markets. In the recent literature the investigation of the EMH in emerging stock markets has received more attention. Harvey (1995) concludes that developed markets are more efficient than emerging markets and investors' portfolios can obtain higher returns and lower risks in emerging markets. It is crucial for an investor to identify whether the market is efficient or not because a professional investor cannot make any excess returns in an efficient market. It is also desirable to understand major factors affecting return behaviors.

In the last decade, the fast growing stock markets and great potentials attract international investors to China. The lack of knowledge of the markets becomes one concern of these investors. However, there are few quantitative studies of market efficiency on China's stock markets. Since it is usually believed that the emerging markets are not efficient in semi-strong form or strong form, the purpose of this study is to examine the weak-form efficient market hypothesis in Shanghai Stock Exchange. Two methodologies are used: one is the test of CAPM; the other is the implementation of the trading strategies (contrarian and momentum strategies).

The test of CAPM is to check the relation between return and risk. If the CAPM follows in the market, the stocks are priced on the basis of the information in the past returns, and the market is efficient in weak form. Thus examining whether the CAPM holds is one approach to test for weak-form market efficiency. A number of studies

examine the CAPM and the findings in many stock markets are not in favor of the proposition that CAPM holds in the markets. Fama and French (1992) find that the relation between beta and average returns is flat in America. Ho, Strange and Piesse (2000) claim that the CAPM is miss-specified and does not correctly and adequately describe price behavior in Hong Kong stock market. However, Su (1999) uses the CAPM to examine the ownership restrictions in China's stock markets and argues that the empirical results are consistent with the CAPM.

Recently contrarian strategies and momentum strategies have obtained a lot of attention. The existence of reversal and momentum in stock prices has been recognized as a new puzzle for empirical research on capital markets. The momentum strategy is based on price continuations, which buys past winners and sells past losers. The contrarian strategy relies on price reversals, which buys past losers and sells past winners. If the market is efficient, a specific trading strategy could not produce excess returns. Thus to identify the profitability of trading strategies is another way to examine the EMH. DeBondt and Thaler (1985, 1987) find that stocks prices overreact to information suggesting that contrarian strategies achieve abnormal returns. Jagadeesh and Titman (1993) documents that momentum strategies generate significant positive returns over 3- to 12-month holding periods on the NYSE. Rouwenhorst (1997) argues that momentum strategies are profitable for equities in European, and Rouwenhorst (1999) reports that emerging market stocks exhibit momentum.

The previous findings evidence that the developed markets are generally weak form efficient. However, the research results on emerging markets are controversial.

There are two different findings. Chan, Gup and Pan (1992) prove the weak-form efficiency in major Asian markets, and Ojah and Karemera (1999) document the same result in four Latin American countries market. On the other hand, Cheung, Wong and Ho (1993) evidence that the stock markets of Korea and Taiwan are not efficient in weak form. Claessens, Dasgupta and Glen (1995) report significant serial correlation in equity returns from 19 emerging markets and suggest that stock prices violates weak form EMH. We question the first results for the following reasons. Firstly, since the emerging markets are commonly small markets, large investors can easily speculate the markets. Secondly, as a less organized market without timely available information, there usually remains a possibility to make profit by large investors and insiders, who can predict stock price changes based on a given set of information. The greater the predictability of the changes, the lower the market efficiency.

The previous studies on the market efficiency of China's stock markets have provided completely different results as other emerging markets. Liu, Song and Romilly (1997) assert that the two stock markets (the Shanghai Stock Exchange and the Shenzhen Stock Exchange) are individually efficient by following a random walk approach based on daily price data from May, 1992 to December, 1995. One of the findings of Long, Payne and Feng (1999) is that both Class A and Class B shares follow a random walk, thus supporting the EMH for Shanghai. However, the study conducted by X. Li and W. Li (2000) using the GARCH model proves that China's stock markets are not efficient given daily price data from May, 1992 to March, 2000.

The previous works mainly examine the time series behavior of stock prices in

China's stock markets, while this paper focuses on a different perspective regarding Shanghai Stock Exchange's market efficiency. The CAPM and trading strategies—the contrarian and momentum strategies—are used, instead of the methodologies mentioned above. The CAPM investigates the relation between return and risk, while the contrarian and momentum strategies take into account the serial correlation in the returns.

Firstly, two methodologies are used to test whether the CAPM holds in SSE. One is a preliminary test of CAPM; another is the cross-sectional regression approaches of Fama and MacBeth (1973). Both of them show that there is no relation between expected returns and expected risk as predicted by CAPM. In the tests, we consider the stock index as the market portfolio, and assume that the  $\beta$  is constant over time and the historical  $\beta$  is a good estimate of true  $\beta$ . However, the market portfolio contains every asset in the international economic system, and the stock index is never a good market portfolio. Also  $\beta$  is very difficult to be calculated precisely. Though we test the CAPM under several assumptions, the results could not be interpreted as evidence in favor of the proposition that CAPM holds. The empirical tests of the CAPM do not provide any support for the weak-form EMH, since the stock seems not to be priced on the basis of the information in the past returns. Secondly, the contrarian and momentum strategies are implemented, and it is found that the contrarian portfolios produce significant profits indicating that serial correlations exist in the stock returns. Furthermore, using an autocorrelation function, the returns of the industry portfolios are found to be negatively auto-correlated. The evidence also does not support the weak-form EMH in SSE.

The rest of this paper is organized as follows: Section 2 is concerned with the methodologies. Section 3 describes the data and Section 4 shows the empirical results. Section 5 concludes.

## 2. Methodologies

One way to measure the efficiency of the market is to ask what types of information, encompassed by the total set of all available information, are reflected in securities prices. There are three forms of the efficient market hypothesis: weak form, semi-strong form and strong form. Under each, different types of information are assumed to be reflected in the prices. The tests of semi-strong form and strong form efficiency are very rare in less developed markets because of absence of sufficient data, inadequate regulations, and lack of administrative loose in the implication of existing rules. Only the weak form efficiency is considered here. Under the weak form of the EMH, stock prices are assumed to reflect any information that may be contained in the past history of the stock price itself.

The research methodologies on market efficiency can be divided into two categories: one is technical analysis, which tests for availability of exploitable information in past stock prices; the other is fundamental analysis, which examines the assumption that factors other than the past prices are the determinations of the future prices. The first category has two sub approaches: one is to determine the existence of predictability using information based on past prices; another is to exploit the profitability of trading strategies. Most of the studies about the China's stock markets following the first sub approach that price changes are random, obtain empirical results favorable to the proposition that this market is efficient. In place of this methodology, both of the two sub approaches are used here: one is the test of CAPM which exploits the relation between return and risk to check the determination of past price information, the other is the implementation of trading strategies which take into account the serial

correlation in returns.

## 2.1 Tests of CAPM

In a weak-form efficient market, if a professional investor calculates the stock's  $\beta$  based on the past stock prices, he will find that each stock has an expected return consistent with its  $\beta$  and the CAPM. The risk-return relationship is perfectly crisp and clean in this market. The stock is priced on the basis of the information in the past returns, and the market is pricing efficient in weak form.

If investors can borrow and lend at a risk-free rate, the security market line is given by

$$E(r_j) = r_f + [E(r_m) - r_f]\beta_j, \quad (1)$$

where  $E(r_j)$  is the expected return of stock  $j$ ,  $r_f$  is the risk-free rate,  $E(r_m)$  is the expected return of the market portfolio, and  $\beta_j$  is the risk of stock  $j$ . In the equation,  $\beta_j$  is linearly correlated with  $E(r_j)$  and  $\beta_j$  is the only factor that affects expected return. The positive slope ( $E(r_m) - r_f$ ) of the line implies that the stock with higher risk ( $\beta$ ) should obtain greater return than that with lower risk.

The CAPM makes the following assumptions: (1) the relation between return and  $\beta$  should be linear; (2) no systematic risk affects the expected return; (3) positive expected return-risk tradeoff exists.

Two methodologies are introduced in the tests of CAPM: one is a preliminary test; the other is the Fama-MacBeth regressions.

The risk measure ( $\beta$ ) of stock is calculated as

$$\beta_i = \frac{COV(R_i, R_m)}{\sigma^2(R_m)}, \quad (2)$$

where  $R_i$  and  $R_m$  denote the returns on stock and the stock index respectively.

### 2.1.1 A Preliminary Test

Given the market portfolio is efficient by definition, it follows automatically that a linear, positively sloped relationship exists between  $\beta$  and expected return. This empirical analysis is designed to examine whether risk ( $\beta$ ) and return are positively correlated.

The empirical procedure is as follows. All the stocks available are separated into five divisions on the basis of ranked  $\beta_i$ s, and five portfolios ( $P_j, j = 1, 2, 3, 4$  and  $5$ ) are formed that equally weigh the stocks in each division. The top portfolio ( $P_1$ ) consists of the stocks with the lowest  $\beta_i$ s and the bottom portfolio ( $P_5$ ) consists of the stocks with the highest  $\beta_i$ s. Repeat the process annually, a series of  $P_j$ s are obtained. Then construct five portfolio return groups, which comprise 12-month returns of  $P_j$ s respectively after the formation time of the portfolios. The difference between the means of the two return groups ( $P_1$ s and  $P_5$ s) is compared based on a paired  $t$ -test.

The CAPM predicts that there is a positive tradeoff between return and risk.

Therefore, the mean of the return group of  $P_1$  s should be higher than that of return group of  $P_5$  s.

### 2.1.2 Fama-MacBeth Regressions

Fama and Macbeth (1973) attempt to predict the future rates of return to the portfolios on the basis of risk variables estimated in previous periods. They use three regression models to examine the relation between risk and return, which are

$$R_{pt} = \gamma_{0t} + \gamma_{1t}\beta_{p,t-1} + \eta_{pt}, \quad (3)$$

$$R_{pt} = \gamma_{0t} + \gamma_{1t}\beta_{p,t-1} + \gamma_{2t}\beta_{p,t-1}^2 + \eta_{pt}, \quad (4)$$

$$R_{pt} = \gamma_{0t} + \gamma_{1t}\beta_{p,t-1} + \gamma_{2t}\beta_{p,t-1}^2 + \gamma_{3t}s(\varepsilon_{p,t-1}) + \eta_{pt}. \quad (5)$$

In these equations, the terms on the left-hand side represent that the return on the ranked portfolio ( $p$ ). The term  $\beta_{p,t-1}$  is the estimate of the beta for the portfolio. As compared with equation (3), an additional term ( $\beta_{p,t-1}^2$ ) is added to (4). It is the square of the beta, which determine whether there exhibits an evidence of non-linearity between risk and return. The CAPM also predicts that systematic risk ( $\beta$ ) is the only determinant of expected returns. The term involving  $s(\varepsilon_{p,t-1})$  in (5) is meant to be some measure of the risk that is not deterministically related to  $\beta_{p,t-1}$ . This variable is computed as the standard deviation of the least-square residuals  $\varepsilon_{pt}$  from

$$R_{pt} = \alpha_p + \beta_p R_{mt} + \varepsilon_{pt}, \quad (6)$$

where  $R_{mt}$  denotes the return obtained from the stock index.

In this paper, since the sample size is not large enough to form 20 portfolios, we consider the return,  $\beta$  risk and non- $\beta$  risk of individual security instead.

We begin our study by computing the  $\beta_i$  for every stock that was listed on the SSE in the period April, 1996 through April, 1998, and they are recalculated month by month. Then use these  $\beta_i$ s and  $\beta_i^2$ s (the square value of the  $\beta_i$ ) to predict the stock returns in the subsequent months of the period May,1998 through March, 2002 as equation (3) and (4).  $s(\varepsilon_i)$  is computed from data for the same period as the component  $\beta_i$ , and then explain differences in the month's return for the stocks with three variables by equation (5).

In the regressions, two kinds of indexes are used: one is the Shanghai-A share Index (a value-weighted average of the returns on all stocks listed in SSE); the other is the index defined as an equally weighted average of the returns on all stocks listed in SSE.

The  $t$ -statistics for testing the hypothesis  $\bar{\gamma}_j = 0$  ( $\bar{\gamma}_0, \bar{\gamma}_1, \bar{\gamma}_2, \bar{\gamma}_3$ ) are calculated from

$$t(\bar{\gamma}_j) = \frac{\bar{\gamma}_j}{s(\gamma_j)/\sqrt{n}}, \quad (7)$$

where  $n$  denotes the number of the regressions.

## 2.2 Trading Strategies

If the market is efficient, there should be no way to discriminate between profitable and unprofitable investments based on information that is currently available. This condition is violated when the trading strategies produce profitable rate of return.

### 2.2.1 Contrarian and Momentum Strategies

If the market is efficient, security prices should respond to the information as soon as it is received. If stock prices either overreact or underreact to information, profitable trading strategies will exist, which select stocks based on their past returns. Jagadeesh and Titman (1993) examine a variety of momentum strategies ( $J$ -month/ $K$ -month) on the NYSE/AMEX, and they find that strategies based on 3- to 12-month returns are profitable. Their strategies select stocks on the basis of past  $J$ -month returns and hold stocks for  $K$ -month.

To increase the power of the test, the portfolios with overlapping holding period are included in the examination. Therefore, in any given month  $t$ , a series of stocks are hold in the strategies, which are selected in the previous  $K-1$  months as well as in the current month. The  $J$ -month/ $K$ -month strategy is constructed as following. At the beginning of each month  $t$ , rank the stocks in ascending order on the basis of the past returns, and separate them into 10 decile. Accordingly 10 equally weighted portfolios are formed. The top portfolio is called the loser portfolio, and the bottom portfolio is called the winner portfolio. In the month  $t$ , the contrarian strategies suggest to buy the loser and sell the winner; while the momentum strategies suggest to buy the winner and sell the loser. Each portfolio is held for  $K$  months. The position is closed out in the

strategy, which is initiated in month  $t - k$ .

In our paper, since the number of stocks in SSE is not large enough to form 10 portfolios, we separate all available stocks into 5 divisions and form 5 portfolios accordingly. Our trading strategies select stocks based on their returns over the past 3, 6, 9, 12 months and the holding periods of the portfolios vary in 3, 6, 9, 12 months. This generates a total of 16 strategies.

### 2.2.2 Autocorrelation Function

Lo and MacKinlay (1990) argue that momentum profits might be caused by autocorrelation in returns, lead-lag relations (cross-serial correlations) among stocks. Thus an autocorrelation function is used to explore whether a portfolio's monthly returns is correlated with its own returns for up to 12 months in the future.

Lewellen (2002) documents that the returns of the industry, size and B/M portfolios are negatively autocorrelated on the NYSE. Therefore, in this subsection the monthly returns of industry portfolios are checked with

$$\rho_l = \frac{Cov(r_t, r_{t-l})}{Var(r_t)}, \quad (8)$$

where  $r_t$  and  $r_{t-l}$  denote the return in the month  $t$  and the month  $t-l$  respectively. The autocorrelations are estimated when  $l$  varies from 1 to 6 months and from 1 to 12 months.

## 3. Data

### 3.1 Introduction of SSE

There are two stock markets in China: the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SHSE). SSE was inaugurated in December 1990, listing eight A-share stocks. SHSE was inaugurated in April 1991, listing six A-share stocks. A-share stocks can only be purchased and traded by domestic investors. However, when stock markets were opened to foreign investors in February 1992, B-share stocks were listed. This class of stocks was only available for foreign investors. Subsequently, however, this rule was relaxed, and in 2001 domestic investors were also allowed to purchase the B-share stocks.

Concurrent with the development of China's economy, the stock markets expanded quickly. In 1993 the total market capitalization of SSE was 29.3 billion US dollars, but it increased to 439.5 billion US dollars, reflecting 28.7% of the country's GDP in 2001. At the end of 2001, there are 690 A-Share stocks listed and 54 B-share stocks listed in SSE. The total market value of the A-share stocks is 426.9 billion US dollars and the B-share stocks value is 12.6 billion US dollars. Because the B-share stocks take only a small percentage of the total market capitalization, this paper considers only A-share stocks.

### 3.2 Data Description

The monthly price files for the common A-share stocks in SSE and the Shanghai A-share index (value-weighted) are obtained from the QUICK/IS Data Source. The sample period is from April, 1996 to April, 2002. The monthly return of the stock is

calculated as

$$R_t = \frac{P_{t+1} - P_t}{P_t}, \quad (9)$$

where  $P_{t+1}$  and  $P_t$  denote the prices at month  $t$  and  $t-1$  respectively.

In order to calculate the market  $\beta$ s, the return series must be taken long enough so that only the stocks whose lengths are greater than 24 months are considered. At first, the number of stocks is 198 and it climbs to 365 later.

## 4. Empirical Results

### 4.1 Empirical Results of the CAPM

#### 4.1.1 Results of the Preliminary Test

Table 1 lists the  $\beta_p$ s of the  $P_j$ s formed from 1998 to 2001. The lowest  $\beta_p$  of  $P_1$ s is 0.40 while the highest  $\beta_p$  of  $P_5$ s is 1.77, suggesting an obvious difference in  $\beta$  between these two kinds of portfolios.

Table 2 reports the basic statistical results of the five portfolio return groups, as well as the  $t$ -statistics and the null hypothesis stating that the means of the two groups ( $P_1$ s and  $P_5$ s) are the same. The mean of the  $P_1$ s' return group is 1.1%, which is larger than that of the  $P_5$ s' group (0.4%). The  $t$ -statistics is equal to -2.07, indicating that there is a significant difference between the means of the  $P_1$ s' returns and the  $P_5$ s'. Furthermore, the negative  $t$  value shows that the portfolio with lower  $\beta_p$  has higher return than the portfolio with higher  $\beta_p$ . Thus it appears that positive tradeoff does not exist between risk and return.

For each year (1998-2001), five portfolios could be constructed from the above method. A simple cross-sectional regression can be run. The dependent variable is the portfolios' mean returns and the independent variable is their  $\beta_p$ s. Figure 1 is the scatter diagrams of the portfolios' returns and their  $\beta_p$ s. The CAPM assumes that the fitted lines have positive slopes. In Figure 1, only the line of portfolios in 1999 has a positive slope; while the others have negative slopes, which violates the assumption of

**Table 1: The  $\beta_p$ s of the  $P_j$ s**

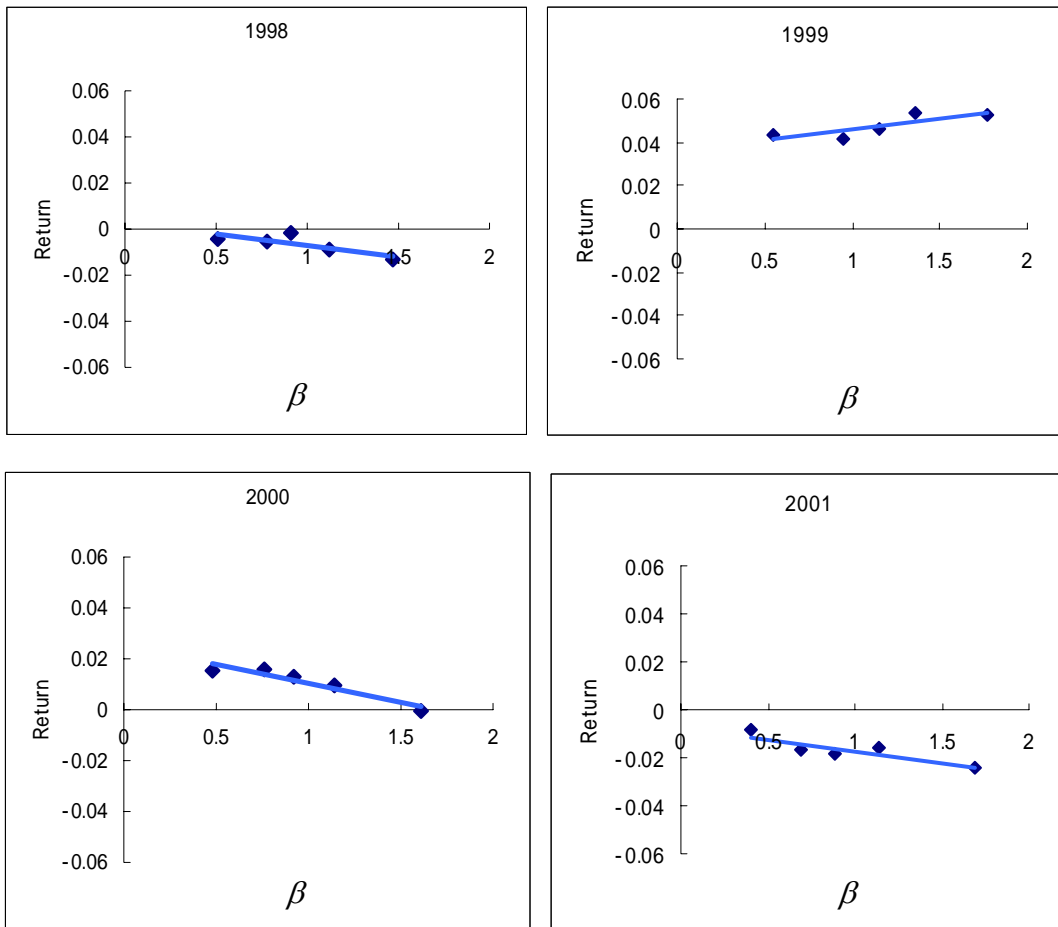
In every year, all stocks available are separated into five divisions on the basis of their ranking  $\beta_i$ s. Five portfolio ( $P_j$ ) are constructed, which equally weight the stocks in every division.  $P_1$  comprises the stocks with the lowest  $\beta_i$ s and  $P_5$  consists of the stocks with the highest  $\beta_i$ s. A series of  $P_j$ s are obtained. The  $\beta_p$ s of the  $P_j$ s are reported here.

$\beta_p$	1998	1999	2000	2001
$P_1$ s	0.51	0.58	0.48	0.40
$P_2$ s	0.78	0.95	0.76	0.69
$P_3$ s	0.91	1.15	0.92	0.88
$P_4$ s	1.12	1.36	1.14	1.14
$P_5$ s	1.47	1.77	1.61	1.69

**Table 2: Statistical Results of the Five Return Groups and the Paired  $t$ -test**

A series of  $P_j$ s are obtained as showed in Table 2. Then construct five portfolio return groups, which comprise 12-month returns of  $P_j$ s respectively after the formation time of the portfolios. The difference between the means of the two return groups ( $P_1$ s and  $P_5$ s) is compared based on a paired  $t$ -test. The basic statistical results of the five return groups are presented in the table as well as the  $t$ -statistics of the paired  $t$ -test.

Return	$P_1$ s	$P_2$ s	$P_3$ s	$P_4$ s	$P_5$ s
Mean	0.011	0.009	0.008	0.005	0.004
Median	0.006	0.005	0.005	-0.000	-0.002
Std Dev	0.08	0.09	0.07	0.10	0.08
Kurtosis	3.18	2.76	3.34	2.95	2.63
Skewness	1.01	1.32	1.00	1.21	1.01
Range	0.44	0.40	0.44	0.45	0.46
Min	-0.12	-0.16	-0.14	-0.14	-0.15
Max	0.32	0.34	0.30	0.31	0.31
Paired $t$ -test					-2.07
H0: The means of the two return groups ( $P_1$ s and $P_5$ s) are equal.					



The diamonds are the scatter points of the portfolios and the solid lines are the fitted lines.

**Figure 1: The Scatter Diagrams of the Portfolios' Returns and Their  $\beta_p$ s (1998-2001)**

the CAPM. (Asian Financial Crisis began to affect Chinese economics in the second half of year 1998.) The results indicate that there is a negative tradeoff between the portfolios' risks and returns in SSE.

#### 4.1.2. Results of the Fama-MacBeth Regressions

The major results of the implications are presented in Table 3 (value-weighted index) and Table 4 (equal-weighted index).  $\bar{\gamma}_j$  ( $\bar{\gamma}_0, \bar{\gamma}_1, \bar{\gamma}_2, \bar{\gamma}_3$ ) is the average of the month by month regression coefficient estimates;  $\bar{r}^2$  and  $s(\bar{r}^2)$  are the mean and standard deviation of the month-by-month coefficients of the determinations.

In Table 3 and 4,  $\bar{\gamma}_2$ s are not equal to zero, which yields some ground to argue that the relation between the risk ( $\beta$ ) and the return is not linear. The non-zero value of  $\bar{\gamma}_3$  could be interpreted as evidence against the hypothesis, which says that no measure of risk, in addition to  $\beta$ , affects expected returns.  $\bar{\gamma}_1$ s are not significantly positive. Therefore, it appears that there is no positive tradeoff between the expected risk and the return. The means of determinations ( $\bar{r}^2$ ) are too small, suggesting that the models do not provide explanatory power for the cross section of stock returns. The above results indicate that there is no positive or linear relation existing between the expected returns and the risks, and that no measure of risk, in addition to  $\beta$ , systematically affects the returns.

#### 4.1.3 CAPM and EMH

In the tests, we consider the stock index as the market portfolio, and assume that the  $\beta$  is constant over time and the historical  $\beta$  is a good estimate of true  $\beta$ . However, the market portfolio contains every asset in the international economic system, and the stock index is never a good market portfolio. Also  $\beta$  is very difficult to be calculated precisely. Though it could not be concluded that CAPM does not hold, the preceding results do not yield any ground on which to argue that CAPM follows in SSE. This conclusion is different from the findings of Su (1999), which documents the

**Table 3: Results of Fama-MacBeth Regressions (Value-weighted Index)**

The means of the coefficients in the three regressions are presented in the table as  $\bar{\gamma}_j$ .  $\bar{r}^2$  and  $s(\bar{r}^2)$  denote the mean and standard deviation of R-square respectively. In the regressions the value-weighted index (Shanghai A-share Index) is used. The  $t$  statistics are shown in the parentheses.

Model	$\bar{\gamma}_0$	$\bar{\gamma}_1$	$\bar{\gamma}_2$	$\bar{\gamma}_3$	$\bar{r}^2$	$s(\bar{r}^2)$
7	0.01 (1.19)	-0.01 (-1.49)			0.01	0.01
8	0.01 (0.76)	0.01 (0.74)	-0.01 (-1.61)		0.02	0.02
9	0.05 (2.07)	-0.01 (-0.91)	-0.00 (-0.54)	-0.40 (-1.97)	0.03	0.02

**Table 4: Results of Fama-MacBeth Regressions (Equal-weighted index)**

$\bar{\gamma}_j$ ,  $\bar{r}^2$  and  $s(\bar{r}^2)$  denote the same as Table 3. In the regressions the equal-weighted index is used.

The  $t$  statistics are shown in the parentheses.

Model	$\bar{\gamma}_0$	$\bar{\gamma}_1$	$\bar{\gamma}_2$	$\bar{\gamma}_3$	$\bar{r}^2$	$s(\bar{r}^2)$
7	0.01 (0.95)	-0.01 (-1.34)			0.01	0.01
8	0.01 (0.51)	0.05 (0.65)	0.02 (-1.87)		0.02	0.02
9	0.04 (1.94)	-0.03 (-0.76)	-0.04 (-0.38)	-0.25 (-2.01)	0.02	0.01

empirical results consistent with the CAPM in China's stock markets. The discrepancy may be attributed to the different sample size. Su (1999) only uses the weekly stock prices for 47 firms from April, 1994 to September, 1996, while the sample of this paper is more complete which consists of monthly prices for 197-365 firms from April, 1996 to April, 2002.

From the tests of the CAPM, the relation between the expected returns and the risks is not found as predicted by the CAPM under several assumptions. In other words, it seems that the stocks are not priced on the basis of the information in the past prices. Therefore, our evidence does not provide support for EMH in weak form.

## 4.2 Serial Correlation Patterns

### 4.2.1 Returns of the Trading Strategies

When the trading strategies are used in SSE, the majority of contrarian portfolios yield positive returns, while the momentum portfolios obtain negative returns. Table 5 reports the average returns of the buy and sell portfolios as well as the zero-cost (buyers minus losers portfolio) for the 16 contrarian strategies described in Section 2.

All of the buyer portfolios have positive returns, and some of the seller portfolios generate negative returns. The returns of all the zero-cost portfolios are positive. In the 16 separate tests for zero-cost portfolios the  $t$ -statistics vary from 4.02 (12-month/3-month) to 6.44 (9-month/9-month), which are sufficiently large to be significant in all strategies. Thus the contrarian strategies perform well in SSE.

**Table 5: Returns of Contrarian Portfolios**

The contrarian portfolios are formed on the basis of their returns in the past  $J$  months and held for  $K$  months. In the first column and row the values of  $J$  and  $K$  for the different strategies are indicated respectively. The stocks are ranked in ascending order based on their past  $J$  months and five equally weighted portfolios are formed. The top portfolio is called the loser portfolio, and the bottom portfolio is called the winner portfolio. Buy the loser and sell the winner. The average monthly returns of the portfolios are presented. The  $t$  statistics are shown in the parentheses.

J	K=3	6	9	12
3 buy	0.02	0.01	0.01	0.01
	(2.89)	(3.33)	(4.18)	(5.03)
3 sell	0.00	-0.00	-0.00	-0.01
	(0.47)	(-0.49)	(-1.04)	(-2.09)
3 buy-sell	0.02	0.01	0.01	0.01
	(6.22)	(4.58)	(4.93)	(4.44)
6 buy	0.01	0.01	0.01	0.01
	(1.91)	(2.53)	(3.22)	(4.34)
6 sell	0.00	0.00	0.00	-0.00
	(0.61)	(0.33)	(0.07)	(-1.17)
6 buy-sell	0.02	0.01	0.01	0.01
	(4.43)	(4.96)	(5.55)	(5.50)
9 buy	0.01	0.01	0.01	0.01
	(1.63)	(2.10)	(3.04)	(4.65)
9 sell	0.01	0.00	0.00	-0.00
	(0.87)	(0.76)	(0.29)	(-0.92)
9 buy-sell	0.02	0.01	0.01	0.01
	(4.92)	(5.14)	(6.44)	(6.43)
12 buy	0.01	0.01	0.01	0.01
	(1.32)	(2.22)	(3.36)	(4.72)
12 sell	0.01	0.00	0.00	-0.00
	(1.24)	(0.88)	(0.28)	(-0.61)
12 buy-sell	0.02	0.01	0.01	0.01
	(4.02)	(5.18)	(6.13)	(6.18)

If the market is efficient, all strategies should fail considering opportunity costs. The above analysis implies that investors can get positive returns by selling the winner stocks and buying loser stocks. The results should be interpreted cautiously because we do not know the exact source of contrarian returns and the costs have not been taken into account in this study. Though the findings do not necessarily mean market inefficiency, it could be considered as evidence against the EMH.

#### 4.2.2 Autocorrelation in Returns

Table 6 summarizes the autocorrelation results for the industry portfolios. The means of the  $\rho_t$ s are reported. The autocorrelations are almost entirely negative. Across all the portfolios, the average autocorrelation equals -0.03 in 6 months and -0.02 in 12 months. Thus the stock returns are negatively auto correlated, which is consistent with the implication of the contrarian strategies. Though the possible autocorrelation find in return series not necessarily means that returns are predictable (Cuthberston, 1996), it does not provide support for the EMH.

#### 4.3 Further Discussion and Comparison with Previous Study

Overall, both the tests of the CAPM and the serial correlation patterns do not provide evidence favoring weak-form EMH in SSE. Similar findings are reported by Claessens, Dasgupta and Glen (1995), and Harvey (1994) for most emerging markets. A lower degree of efficiency on emerging markets might be due to: the common characteristics of loose disclosure requirements, thinness and discontinuity in trading (Errunza and Losq, 1985); the institutional factors such as illiquidity, market fragmentation, trading and reporting delays and absence of official market makers

**Table 6: Industry Portfolios' Autocorrelation Results**

The table presents the averages of autocorrelations for the 7 equally weighted industry portfolios ( $P_j, j = 1, 2, \dots, 7$ ). Autocorrelation equals the correlation between a portfolio's monthly return and its past 12-month return. The industry portfolios' autocorrelations are estimated when  $l$  varies from 1 to 6 months and from 1 to 12 months.

$mean(\rho_l)$	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$P_6$	$P_7$
$l = 1 - 6$	-0.04	-0.04	-0.03	-0.05	-0.01	-0.02	-0.05
$l = 1 - 12$	-0.03	-0.04	-0.03	-0.03	-0.01	-0.01	-0.02

(Butler and Malaikah, 1992). The SSE also shares these problems, especially the market fragmentation and the absence of official market makers.

A number of findings in this study are worth reiterating. Firstly, in the tests of CAPM, it seems that a negative tradeoff exists between risks and returns. This is an interesting result since a number of similar US studies have documented a positive relation between risks and returns, though not significantly. The difference in results may be caused by the investors in China, who are more irrational than those in US. The majority of market participants in SSE may be irrational noise traders, since the information publication and accounting systems are not perfect in China. Black (1986) believes that noise traders, with no access to inside information, irrationally act on noise as if it were information that would give them an edge. Secondly, the contrarian strategies are more profitable than the momentum strategies. Again, this evidence is inconsistent with the results in other similar studies especially US studies. One possible

explanation is that the institutional traders usually manipulate the market. They buy a stock with small capitalization value, and the price will go up slowly. After the personal traders follow in, these institutional traders will sell the stock immediately.

Our propositions are inconsistent with the findings of Liu, Song and Romilly (1997), but consistent with the empirical work of X. Li and W. Li (2000) concerning market efficiency for China's stock markets. The different results may in part be explained by the sample bias. The sample in Liu, Song and Romilly (1997) consists of daily price data from May 21, 1992 to December 18, 1995, while the sample in X. Li and W. Li (2000) consists of data from May 21, 1992 to March 1, 2000. The former one is very small compared with the latter one and the present paper.

## 5. Conclusion

In sum, our results do not support the weak-form efficient market hypothesis in Shanghai Stock Exchange through the examination of the CAPM and the serial correlations using the data from April, 1996 to April, 2002.

We propose the test of the CAPM based on two methodologies, which are a preliminary test and the Fama-MacBeth regressions. It is found that no positive tradeoff exists between return and risk measured from the viewpoint of individual security. And there is not a linear relation between a stock's risk and its expected return. Furthermore, we can not reject the hypothesis that no measure of risk, in addition to stock risk, affects return. Though we test the CAPM under several auxiliary assumptions, no evidence seems favorable to the proposition that the CAPM follows in SSE, which contrasts with the findings of Su (1999). The empirical tests of the CAPM do not provide any support for the weak-form EMH since the stocks are not priced on the basis of the information in the past returns.

This paper further documents the significantly abnormal returns generated by the contrarian strategies, which buy the stocks that have performed poorly in the past and sell the stocks that have performed well in the past. The profitability of the contrarian strategies indicates that investors can get positive returns using the trading strategies. Using an autocorrelation function, the returns of the industry portfolios are found to be negatively auto-correlated. These results add evidence that is not favor of the weak-form EMH.

On the basis of the above results we may come to the overall conclusion that there seems to be no evidence supporting weak-form EMH in SSE. This finding is inconsistent with the proposition of Liu, Song and Romilly (1997), while accord with the earlier empirical work of X. Li and W. Li (2000). It seems that the discrepancy may in part be due to the different sample size used in these papers.

The main implications of this study can be pointed out as follows. Firstly, the predictive ability is interesting for investors to beat the market using the contrarian strategies. Secondly, this study provides the serial correlation patterns of a less developed market.

In the present paper, only the weak-form EMH is considered while the semi-strong EMH would be the concern of future research.

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