AN EXPLORATION OF THE EFFICIENCY OF THE CHINESE STOCK MARKET

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DISCUSSION PAPER 01.13

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Abstract

This paper has explores weak and semi-strong efficiency for both A and B shares traded on the Shanghai and Shenzhen stock exchanges using daily data for seven indexes for the period 1992-2001. We find evidence of departures from weak efficiency in the form of predictability or returns on the basis of their own past values. Over the period as a whole this was most marked for the B shares in both the exchanges and absent altogether in the index for the 30 leading stocks on the Shanghai market, suggesting that previously reported predictability simply reflects thin trading. We also find evidence that efficiency suffered when banks were excluded from the stock market in 1996 and efficiency improved when they were re-admitted in early 2000. We also find widespread evidence of the day-of-the-week effect as others have before us. Interestingly, we found this effect to have completely disappeared after 1999. In the area of semi-strong market efficiency, we found predictability from the predictability from the A to the B board returns in Shanghai but no evidence of cross-board causality in Shenzhen.

1. Introduction

China's stock market is a relatively new player in the economy. The two official stock exchanges, the Shanghai Exchange and the Shenzhen Exchange, were established in December 1990 and July 1991, respectively. Since their establishment, the two exchanges have expanded rapidly. China's stock market is now the second largest in Asia, behind only Japan. The speculation is that China's securities market has the potential to rank among the top four or five in the world within the coming decade (Ma and Folkerts-Landau 2001). Yet little is known about this relatively young player in the global community.

In this paper we add to the recent but expanding empirical literature on the Chinese stock market by focussing n tests of market efficiency in both weak and semi-strong forms. While numerous studies have addressed issues in this area in the recent past, we extend the existing studies in several ways. First, this study is based on a much more extensive database. Previous studies focussed on the initial years immediately after China's two stock markets were established in 1991 and often analysed relatively few indexes. We analyse daily data for seven share price indexes over the period 1992-2001. This large sample provides us with a greater variety of information and should reflect the dramatic changes that have taken place in China's securities sector in the past decade. An interesting component of our data set is the index for the 30 leading shares on the Shanghai exchange, the analysis of which allows us to throw interesting light of the question of the influence of thin trading on efficiency tests. Second, we test whether changes in regulations which importantly affected the role of banks in the stock market influenced the efficiency of the market.

Tests of weak efficiency include autocorrelation tests and autoregressive models which are extended to include "day-of-the-week" effects and holiday effects. We also explore the effects of longer return horizons since these have been found to be crucial in the literature on long-term mean reversion. We also test the random-walk version of the weak efficient markets hypothesis (WEMH) by testing the log of the share price indexes for stationarity.[1] Our analysis of the semi-strong efficient markets hypothesis (SSEMH) involve an examination of whether the returns to shares

[1] An interesting alternative approach to examining efficiency is that of Ang and Ma (1999) who interpret forecastability of earnings are a measure of transparency of the market and hence of the efficiency with which the market discloses and digests information.

on one board of an exchange can help predict the returns on the other. We use tests of Granger-causality between the returns to A and B shares on the same exchange as well as tests of cointegration of the logs of the prices on the two boards.

In the rest of the paper we begin with a brief literature review and description of the structure of the markets(s) in section 2, we set out the modelling issues in section 3 before going on to present results of an investigation of the weak and semi-strong efficiency in sections 4 and 5. Conclusions are set out in section 6.

2. Stock Market Development in China

The Chinese stock market has some unique features. Two types of shares, A and B shares, are listed in the Shanghai and Shenzhen exchanges (Table 1).[2] A shares are denominated in the local currency (RMB or Renminbi). Foreign individuals or institutions are not allowed to buy and sell A shares. B shares are denominated in US dollars on the Shanghai Exchange and Hong Kong dollars on the Shenzhen Exchange. Only offshore investors are permitted to trade B shares. This restriction was, however, relaxed in early 2001 when it became permissible for individuals and legal persons in China to buy and sell B shares. Thus, for about a decade, the Chinese markets and investors have been divided into two classes. As a result, B share markets have not expanded as rapidly as A share markets. The market capitalisation of A shares has been much greater than that of B shares (Table 1). It has been argued by Chen, Lee and Rui (2001) that A shares are over-priced and that the returns to B shares move more closely with market fundamentals than do those for A share prices.[3]

Table 1: Summary Statistics of China's Stock Exchanges (as at the end of 2000)

	Shanghai	Shenzhen
A shares		
Date of establishment	December 19, 1990	April 3, 1991
Capitalisation (bn yuan)	2660	2086
Turnover (bn bn yuan)	3103	2925
No. of companies listed	559	499
B shares		
First listing	February 1992	February 1992
Capitalisation (bn yuan)	33	30
Turnover (bn yuan)	34	20
No. of companies listed	55	38

Note: yuan is the Chinese currency unit. In 2000, US$1 = 8 yuan app.
Source: Ma and Folkerts-Landau (2001), appendix, pp.15 and 18.

[2] Qi, Wu and Zhang (2000) distinguish 5 types of shares by further sub-dividing the A and B share according to ownership restrictions.

[3] Chakravarty *et al.* (1998) also investigate the determinants of the A share premium but in terms of informational asymmetry and market segmentation. Su and Fleisher (1999) analsye the difference in volatility across the two boards.

As more data becomes available, various authors have reported their studies of the Chinese stock markets (see Table 2). Earlier studies include Bailey (1994), Ma (1996), Chui and Kwok (1998) and Mookerjee and Yu (1999). Both Bailey and Ma used individual share-price data for the early 1990s. Bailey examined share prices of nine companies listed in Shanghai and Shenzhen exchanges and found little evidence for a link between China's B share returns and international stock returns. According to Bailey, during March 1992 and March 1993, there were significant associations between B share returns and lagged values of global financial indicators, implying some commonalities between global and B share returns. Ma (1996) used share price data for 38 companies that had both A and B shares listed in the two exchanges during the period of 1992-1994. Ma found that cross-sectional differences between prices of A shares and B shares are correlated with investors' attitudes toward risk. He also argued that regulatory changes might explain part of the variability of B shares' discounts over time.

Table 2 Selected Studies of Chinese Stock Markets

Study	**Sample**	**Comments**
Bailey (1994)	1992-93	Link between B share and international stock returns
Ma (1996)	1992-94	Relationship between A and B share prices and between B share and international share prices
Chui and Kwok (1998)	1993-96	Cross-autocorrelations between A and B shares
Mookerjee and Yu (1999)	1991-93	Market efficiency
Huang, Yang and Hu (2000)	1992-97	Cointegration between Shanghai and Shenzhen stock prices
Yeh and Lee (2000)	1992-96	Interaction between stock markets in Greater China
Ma (2000)	1992-98	Tests of time-varying returns
Sjoo and Zhang (2000)	1993-97	Information diffusion between A and B shares
Xu (2000)	1993-95	Stock returns and its volatility in Shanghai
Chen, Kwok and Rui (2001)	1992-97	Day-of-the-week effects
Chen, Lee and Rui (2001)	1992-97	Relationship between A and B share prices

Chui and Kwok (1998) examined the cross-autocorrelation between A shares and B shares listed on the two exchanges during the period of 1993-1996. They found that prior price movements affect price changes in the A and B share markets. The direction of information flow is mainly from the B share markets to the A share markets. However, according to Sjoo and Zhang (2000), this relationship holds only for the Shanghai market. Mookerjee and Yu (1999) applied 1991-1993 share price indices released by the Shanghai and Shenzhen stock exchanges to test market efficiency. They found the existence of significant inefficiency and weekend and holiday effects in China's two stock markets.

Recent studies include Huang, Yang and Hu (2000), Yeh and Lee (2000) and Ma (2000). Huang, Yang and Hu (2000) have shown that the Shanghai and Shenzhen stock markets are statistically cointegrated. Yeh and Lee (2000) presented a study of the interaction between stock markets in the Greater China regions. They found no direct link between A share markets in Mainland China and markets in Hong Kong and Taiwan. Their results have, however, shown that the Hong Kong stock market does have both contemporaneous and intertemporal effects on the B share markets in Shanghai and Shenzhen. Ma (2000) undertook a comprehensive study of informational efficiency of China's stock market. He found evidence of the day-of-the-week and the month-of-the-year effects in the Chinese stock markets.

More recently, Chen, Kwok and Rui (2001) investigated the day-of-the-week effect in China's two stock markets. They found negative returns on Tuesdays during 1992-1997 and argued that this Tuesday anomaly may be due to the spillover effect from the Americas. Their finding, however, contradicts those of Xu (2000) who found no day-of-the-week effect in returns in the Shanghai stock market.

3. Modelling Issues

Market efficiency has traditionally been associated with the absence of predictability of returns on the grounds that if returns are predictable, profit opportunities exist which profit-maximising investors will exploit until the predictability disappears. This argument ignores transactions costs since in their presence not all predictability is exploitable. Some authors, therefore, qualify their definition of efficiency to account for this aspect; see, e.g., Fama (1991). A further qualification arises from the potential predictability of the "required return" component of share returns, so that the definition may be couched in terms of predictability of "excess" or "abnormal" returns.

In practice, however, transactions costs and predictability of required returns are typically ignored in tests of the EMH and, for the most part, the work reported below follows this pattern. The relationship between the EMH and tests for predictability is developed using Sharpe's (1983) formulation.

Write the one-period return to an asset, R_t, as the sum of two components, the equilibrium return expected last period (the "required return"), $E_{t-1}(R^e)$, and an unexpected or "abnormal" component, Z_t, i.e.

(1) $$R_t = E_{t-1}(R_t^e) + Z_t$$

where

(2) $$E_{t-1}(R_t^e) = E(R_t^e / \Psi_{t-1})$$

where Ψ_{t-1} denotes the set of information available to agents at period t - 1. The condition for market efficiency is then:

(3) $$E(Z_t / \Psi_{t-1}) = 0$$

If Ψ_{t-1} contains only past returns, (3) becomes

(4) $$E(Z_t / R_{t-1}, \ldots, R_{t-n}) = 0$$

and the market is said to be weakly efficient. If Ψ_{t-1} also contains other publicly available information, X (which excludes R), then (3) becomes a statement of semi-strong efficiency:

(5) $$E(Z_t / R_{t-1}, \ldots, R_{t-n} \; ; \; X_{t-1}, \ldots, X_{t-n}) = 0$$

Finally, if Ψ_{t-1} also contains information, *I*, which is not publicly available the market is called strongly efficient and (3) is written as

(6) $$E(Z_t / R_{t-1},\dots,R_{t-n}\ ;\ X_{t-1},\dots,X_{t-n}\ ;\ I) = 0$$

This paper reports tests of both weak and semi-strong efficiency. Consider tests of weak efficiency first. Equation (4) suggests an investigation of the relationship between Z_t and past returns. However, Z_t is unobservable, being defined in terms of the unobservable $E_{t-1}(R^e)$ and, as frequently pointed out, all tests of efficiency are necessarily joint tests of a theory of $E_{t-1}(R^e)$ and the EMH. A common and convenient assumption is that $E_{t-1}(R^e) = c$, a constant which enables (4) to be written as:

(7) $$E(R_t - c / R_{t-1},\ R_{t-2},\dots,R_{t-n}) = 0$$

This suggests tests of the weak EMH based on an investigation of the intertemporal properties of the series R_t, R_{t-1} ,..., R_{t-n}. We present the results of two such tests which are in essence equivalent. The first involves the autocorrelations of the R process – we report both individual autocorrelations and the Box-Pierce-Ljung portmanteau test that the first p autocorrelations of the R_t process are zero. The second test is based on the regression of R_t on R_{t-1} ,..., R_{t-p}. Both approaches address the question of whether past returns are useful in predicting the current return and therefore clearly fall in Fama's (1991) category of "tests for return predictability". Within the regression framework we also test the "day-of-the-week" effect and the holiday effect since these are common sources of return predictability.

An alternative test of the weak EMH is based on the random-walk property of share prices implied by the EMH and the assumption of constant expected returns.[4] Equation (7) allows the model generating R_t to be written:

(8) $$R_t = c + \varepsilon_t$$

Where ε_t is a random error term with $E_{t-1}(\varepsilon_t) = 0$. Writing R_t as the log difference of the price index, P_t, (8) becomes:

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[4] LeRoy (1989) has pointed out the inaccuracy of the term "random walk" in this framework since the theory implies a weaker restriction, viz. a martingale. Moreover, in the presence of dividends it is not the (log) share price but the value of a particular type of mutual fund which satisfies the martingale restriction. In our case, these qualifications are not serious since only the martingale property is being tested and the data used in the tests ignores dividends. We therefore retain the conventional terminology.

(9) $$\ln P_t = \ln P_{t-1} + \varepsilon_t$$

which, if we further assume that ε_t is white noise, is simply a random walk with drift and suggests the use of a test for a unit root in the ln P_t process. Two such tests are reported: the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test[5] which differ only in the way in which they adjust for autocorrelation in the error process of the "Dickey-Fuller equation". We test both a random walk against a stationary alternative and a random walk with drift against the alternative of a trend-stationary process. In the first case we maintain $\beta_2 = 0$ under both H_0 and H_A and test H_0:β_1=0 and in the second case we test $H_0 : \beta_1 = 0$ and $\beta_2 = 0$ in:

(10) $$\Delta \ln P_t = \beta_0 + \beta_1 \ln P_{t-1} + \beta_2 t + \varepsilon_t$$

Consider now the semi-strong form of the EMH. The definitional framework set out above does not provide guidance as to the variables in the X vector in equation (5) so that in practice the choice of variables is rather *ad hoc* and is often determined largely by data availability. In the present paper we investigate semi-strong efficiency by estimating the relationship between indexes. We restrict our attention to the relationship between the two pairs of indexes: Shanghai A and B and Shenzhen A and B. This allows us to use daily data throughout.

The tests used parallel the first two single-country tests described above. First, a simple two-equation VAR model is estimated for rates of return for each pair of indexes and used to test for Granger causality, a test similar to the regression-based test of weak efficiency. Second, a test similar to the unit-root test for a single series is carried out. The test is based on the notion of cointegration. The Granger Representation Theorem[6] states that two variables which are cointegrated can be validly represented by an error-correction model, an implication of which is that at least one of the variables must cause the other. This, in turn, is inconsistent with market efficiency. Hence two price indexes from efficient share markets must not be cointegrated. Cointegration of the (logs of the) two price series is tested using the Engle-Granger two-step procedure as well as by the Johansen eigenvalue and trace tests.[7]

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[5] See Dickey and Fuller (1981) and Phillips and Perron (1988).
[6] See Engle and Granger (1987).
[7] See Johansen (1988).

4. The Data

The data used in this study are share-price index data for Chinese stock exchanges in Shanghai and Shenzhen. In particular, we use daily data for closing prices for the following indexes for the indicated sample periods:

(a) Shanghai A board (PSAA), 2/1/1992 – 28/2/2001

(b) Shanghai B board (PSAB), 2/1/1992 – 28/2/2001

(c) Shanghai 30 Leaders (PSA30), 1/7/96 – 28/2/2001

(d) Shanghai Composite (PSAC), 3/5/1993 – 28/2/2001

(e) Shenzhen A board (PSEA), 4/10/1992 – 28/2/2001

(f) Shenzhen B board (PSEB), 6/10/1992 – 28/2/2001

(g) Shenzhen Composite (PSEC), 20/7/1994 – 28/2/2001

The logs of the price indexes are denoted LPSAA, PSAB, …; returns are computed as continuously compounded and denoted RSAA, RSAB,… Observations for non-trading days are dropped.

Summary statistics for returns are reported for each of the indexes in Table 1.

Table 1: Summary statistics for returns

Variable	Mean (% daily)	SD (% daily)	Skewness	Excess Kurtosis	Normality (GF)
RSAA	0.07964	3.4870	103.2563	992.4011	1169.1472
RSAB	-0.01392	2.3150	7.7457	49.9392	872.0143
RSEA	0.04255	2.7790	17.0353	133.749	557.5302
RSEB	0.04022	2.4000	8.4731	71.0714	1762.5728
RSA30	0.05835	1.9630	-1.6502	32.7960	327.1039
RSAC	0.0208	2.8920	29.1928	190.6270	874.5896
RSEC	0.0953	2.7860	13.3822	92.9406	498.6027

Notes: The Skewness and Excess Kurtosis statistics are standard-normally distributed under the null of normally distributed returns. The GF statistic is a goodness-of-fit statistic for a test of normality. It is χ^2 distributed with 57 degrees of freedom. The 5% critical value is 79.0819.

There is considerable variation in average returns across the indexes. Comparing the returns to the two Shanghai boards, RSAA and RSAB, the first is relatively high while the second is actually negative – the index was lower at the end of the sample than it was at the beginning. The higher return to A share has been commonly observed and various studies have focussed on explaining this difference – see, e.g., Chakravarty *et al.* (1998) and Chen, Lee and Rui (2001). In contrast, the two Shenzhen boards have approximately equal mean returns of about 0.04 % per day, with the A returns actually marginally smaller than the return to the B shares. It is interesting that the Shanghai 30 index has a considerably lower mean return than the full A board for Shanghai suggesting that an important part of the return computed for the Shanghai A board is for small (infrequently traded) shares. This also suggests that the risk (in terms of the standard deviation) associated with these small shares is higher since the standard deviation for RSAA is considerable higher than that for RSA30. We ought to keep in mind, however, that the sample period for the 30 leaders index for Shanghai is considerably shorter than that for the full A board. If we recompute the mean return and standard deviation for the RSAA for the shorter (RSA30) sample period, we obtain a mean of 0.0848 per cent per day and a standard deviation of 1.8891. So over the common sample period, the full board has a considerably higher mean return and lower standard deviation that the 30 leaders.

The remainder of the columns in Table 1 relate to tests of normality of the returns. The skewness and excess kurtosis statistics are standard-normally distributed. All but RSA30 show evidence of significant positive skewness and all returns are leptokurtic. It is not surprising that the GF statistic for normality shows that all the returns are non-normal. This is a common feature of financial data.

5. Testing the EMH

5.1 The Weak EMH

We start with the weak form of the EMH and begin our examination by presenting the first five autocorrelations (ρ_i) for the returns computed from each of the indexes. They are reported in Table 2.

Table 2: Autocorrelations

Return	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	Q(5)
RSAA	0.05 (0.02)	0.05 (0.02)	0.04 (0.02)	0.03 (0.02)	0.04 (0.02)	20.99 (0.001)
RSAB	0.19 (0.02)	0.00 (0.02)	0.05 (0.02)	0.01 (0.02)	-0.01 (0.02)	87.69 (0.000)
RSEA	0.02 (0.02)	0.05 (0.02)	0.01 (0.02)	0.05 (0.02)	0.03 (0.02)	14.69 (0.012)
RSEB	0.20 (0.02)	0.07 (0.02)	0.11 (0.02)	0.09 (0.02)	0.05 (0.02)	135.40 (0.000)
RSA30	0.02 (0.03)	-0.01 (0.03)	0.02 (0.03)	0.04 (0.03)	0.01 (0.03)	2.80 (0.73)
RSAC	-0.02 (0.02)	0.03 (0.02)	0.03 (0.02)	0.02 (0.02)	0.03 (0.02)	6.23 (0.284)
RSEC	0.06 (0.02)	0.04 (0.02)	0.03 (0.02)	0.01 (0.02)	0.07 (0.02)	18.57 (0.002)

Note: the numbers under the autocorrelations are standard errors and under the Q statistics are prob values.

Clearly there is significant autocorrelation in the returns although there is considerable variety amongst the indexes. Only in the 30 Leaders index is there no evidence of autocorrelation presumably reflecting the high liquidity of these stocks. The two A board returns show some evidence of autocorrelation but it is relatively weak with the autocorrelation coefficient never exceeding 5%. The B board returns, on the other hand, show much stronger evidence of autocorrelation with the correlation at the first lag being approximately 20% for both indexes. There is further autocorrelation at longer lags particularly for the Shenzhen index. Finally, the two composite indexes exhibit autocorrelation behaviour similar to that of the A boards as one would expect given that the composite indexes cover stocks on both boards. A comparison of the results suggests that the autocorrelation could well be the result of thin trading since it is most evident in the indexes for the most illiquid boards (the two B boards) and absent altogether for the 30 leaders on the Shanghai exchange.

The autocorrelations reported above are generally considerably smaller than those reported for the US and Asian countries by Bailey et al. (1990) where first-order autocorrelations in daily data of the order of 0.1 to 0.3 are common although these were for an earlier time period and for shorter periods.

The autocorrelations reported in Table 2 are confirmed by the regression results in Table 3 where we report the results of estimating an AR(5) model for each of the returns.

Table 3: Regressions

	Dependent Variable						
Regressor	**RSAA**	**RSAB**	**RSEA**	**RSEB**	**RSA30**	**RSAC**	**RSEC**
Lag 1	0.0471 (2.22)	0.2025 (9.50)	0.0152 (0.69)	0.1814 (8.20)	0.0116 (0.39)	-0.0177 (0.78)	0.0573 (2.31)
Lag 2	0.0464 (2.18)	-0.0504 (2.32)	0.0487 (2.21)	0.0106 (0.47)	-0.0110 (0.37)	0.0193 (0.85)	0.0362 (1.46)
Lag 3	0.0335 (1.57)	0.0616 (2.84)	0.0069 (0.31)	0.0822 (3.67)	0.0080 (0.27)	0.0283 (1.25)	0.0229 (0.93)
Lag 4	0.0180 (0.82)	-0.0063 (0.29)	0.0490 (2.22)	0.0482 (2.14)	0.0421 (1.43)	0.0145 (0.64)	-0.0025 (0.10)
Lag 5	0.0321 (1.51)	-0.0054 (0.25)	0.0319 (1.45)	0.0211 (0.95)	0.0042 (0.14)	0.0301 (1.33)	0.0704 (2.85)
Constant	0.0006 (0.88)	-0.0001 (0.16)	0.0004 (0.59)	0.0003 (0.57)	0.0004 (0.69)	0.0003 (0.49)	0.0008 (1.11)
Sum	0.1771 (4.09)	0.2020 (5.03)	0.1517 (3.26)	0.3436 (8.78)	0.0549 (0.85)	0.0744 (1.50)	0.1843 (3.61)
R^2	0.0080	0.0417	0.0066	0.0506	0.0022	0.0026	0.0109

Notes: figures in parentheses under the estimated coefficients are absolute values of the standard errors. The figure in the "Sum" row is the sum of the lag coefficients and its t-statistic relates to a test of the hypothesis that the sum of these coefficients is zero.

As with the autocorrelations, there is by far the most predictability in the returns for the B boards – both RSAB and RSEB have coefficients of around 0.2 on the first lagged value with very high t-ratios and in both cases at least one subsequent lag is significant. Despite this, the value of R^2 is quite low at about 5%. There is some evidence of significant predictability for the A board returns but both the estimated lag coefficients and the values of R^2 are lower. There is no evidence of predictability in the return for the 30 leaders on the Shanghai A board. The sum of the lag coefficients is significant for all but the 30 leaders index and (surprisingly) the composite index for the Shanghai exchange. Regressions with longer lags show very similar results – most of the predictability appears to occur at short lags.

A common violation of the weak EMH is the presence of a "day-of-the-week effect" (DoW effect) and the next question we address is whether there is a DoW effect for any of our seven indexes. We do this by adding DoW dummy variables to the regressions reported in Table 3. The DoW dummy variables are defined as: "Monday" =1 on Mondays and 0 otherwise etc. Since Wednesday is left out, all measure the intercept relative to Wednesday.

Table 4: Day-of-the-Week Effect

Regressor	Dependent Variable						
	RSAA	RSAB	RSEA	RSEB	RSA30	RSAC	RSEC
Lag 1	0.0471	0.2037	0.0173	0.1823	0.0195	-0.0138	0.0634
	(2.22)	(9.54)	(0.78)	(8.23)	(0.65)	(0.61)	(2.56)
Lag 2	0.0501	-0.0496	0.0496	0.0125	-0.0131	0.0190	0.0350
	(2.36)	(2.28)	(2.25)	(0.56)	(0.44)	(0.83)	(1.40)
Lag 3	0.0363	0.0619	0.0065	0.0854	0.0061	0.02690	0.0221
	(1.71)	(2.85)	(0.29)	(3.80)	(0.21)	(1.19)	(0.90)
Lag 4	0.0172	-0.0055	0.0507	0.0487	0.0486	0.0187	0.0018
	(0.81)	(0.25)	(2.30)	(2.16)	(1.64)	(0.82)	(0.07)
Lag 5	0.0256	-0.0083	0.0277	0.0148	-0.0057	0.0239	0.0630
	(1.20)	(0.39)	(1.26)	(0.66)	(0.19)	(1.06)	(2.55)
Monday	-0.0044	-0.0008	-0.0028	0.0012	-0.0031	-0.0047	-0.0025
	(1.88)	(0.53)	(1.44)	(0.76)	(1.71)	(2.29)	(1.16)
Tuesday	-0.0063	-0.0024	-0.0050	-0.0038	-0.0051	-0.0054	-0.0057
	(2.70)	(1.61)	(2.62)	(2.35)	(2.81))	(2.63)	(2.66)
Thursday	-0.0006	-0.0014	-0.0025	-0.0004	-0.0045	-0.0046	-0.0050
	(0.24)	(0.92)	(1.29)	(0.25)	(2.46)	(2.24)	(2.31)
Friday	0.0017	0.0015	-0.0003	0.0017	-0.0008	-0.0004	0.0010
	(0.71)	(0.98)	(0.13)	(1.03)	(0.45)	(0.17)	(0.43)
Constant	0.0026	0.0006	0.0025	0.0006	0.0031	0.0034	0.0033
	(1.58)	(0.54)	(1.84)	(0.51)	(2.44)	(2.31)	(2.14)
Sum	0.1763	0.20220	0.1518	0.3438	0.0553	0.0746	0.1851
	(4.08)	(5.03)	(3.27)	(8.81)	(0.86)	(1.50)	(3.64)
R^2	0.0150	0.0450	0.0110	0.0570	0.0128	0.0091	0.0198

Notes: figures in parentheses under the estimated coefficients are absolute values of the standard errors. The figure in the "Sum" row is the sum of the lag coefficients and its t-statistic relates to a test of the hypothesis that the sum of these coefficients is zero.

From the table it is clear that the introduction of the DoW variables has had little effect on the lag coefficients – the sum of the lagged coefficients and their t-statistics seem to have been little altered by the addition of the DoW dummies and the individual coefficients are similar across the two tables. The R^2 figures have increased only marginally. Generally, both the Monday and Tuesday dummy variables are significant although the former only weakly in most cases. Rather surprisingly, the DoW effect seems to be weaker for the B boards than for the A boards and the effect for the 30 leaders index is about the same as that for the Shanghai A board as a whole. So, there is clear evidence of a widespread DoW effect but it is not the common weekend effect since it occurs most strongly on Tuesdays. The results are, however, consistent with earlier work reported for China by Xu (2000) although his results are statistically weaker than ours. This may be due to his shorter and earlier sample period as we show below when we repeat some of these tests for sub-periods.

As discussed in our introductory section, another source of predictability in share returns is the holiday effect where returns are predictably difference before or after a public holiday. We identified four main holidays affecting the stock exchanges – the Chinese New Year in January or February, the May Day holiday in early May, the National Day holiday in early November and the New Year holiday. We experimented with various forms of dummy variables which we used to capture the holiday effects – separate dummy variables before and after each holiday period, a single dummy variable for each holiday, a single dummy variable for all holidays combined and two dummy variable, one before all holidays and one after all holidays. The results of the investigation (which we have at this stage carried out only for the Shanghai A returns) are that the holiday effect is very weak, if present at all – only when a dummy variable combined the before and after effects of the Chinese New Year holiday was it significant; all other variables and combinations were insignificant. These results are consistent with those obtained by Mookerjee andYu (1999) for Shanghai although they used data only for the early 1990s.

An alternative test for the WEMH is to test the (log) share price index for a unit root. The random walk version of the WEMH requires the variables to be I(1). In Table 5 we report ADF and PP tests of a unit root in the log share price indexes. Tests are reported both with and without a trend in the "Dickey-Fuller equation". In the equation without a trend the null hypothesis is that the log price process has a unit root and the alternative is that the process is stationary while in the case where a trend is included we test trend-stationarity against difference-stationarity. The equation with trend seems more sensible given the strong upward trend present in most share price indexes. Tests are reported for five lags. Since results are occasionally sensitive to lag length, we also re-ran some of the tests with longer lags. They are not reported but produce the same conclusions.

Table 5: Unit Roots Tests

Variable	Without Trend		With Trend	
	ADF	PP	ADF	PP
LPSAA	-2.70	-2.56	6.88	5.93
LPSAB	-2.19	-2.30	2.42	2.71
LPSEA	-0.97	-0.82	3.01	2.86
LPSEB	-1.23	-0.62	1.72	2.16
LPSA30	-2.24	-2.96	2.81	4.56
LPSAC	-1.27	-1.20	9.18	10.44
LPSEC	-1.73	-1.65	2.19	1.85

Notes: the tests without trend are t-tests and have a 10% critical value of –2.57; the tests with trend are for trend stationarity against difference stationarity and have a 10% critical value of 5.34.

Generally the results are consistent with the hypothesis of a unit root in the log price process and therefore with weak efficiency of the share market. The main exception to this finding is the Shanghai A board where three of the four reported results suggest stationarity. This is rather surprising in view of the earlier results that show little evidence of predictability of the returns for the Shanghai exchange.

We conclude that there is some evidence that the weak form of the EMH is violated although the strongest evidence is for the two B boards which are the least liquid so that the predictability may be spurious and reflect stale prices. This view is reinforced by the finding that there is no evidence of predictability for the 30 leaders index for the Shanghai exchange.

5.2 The Weak EMH: The Effects of Regulatory Changes

The Chinese financial system has traditionally been dominated by the state banks and when stock exchanges were established in the early 1990s, the banks were dominant in share trading. Until 1996 banks had a dominant influence on the stock market. before 1994 most Chinese banks served as brokers since these had yet to appear on the Chinese financial scene. Banks were allowed to set up departments or subsidiaries as brokers but as the Chinese stock markets expended, the direct involvement of banks became risky and was considered inappropriate. Thus, in 1994 banks were required to quit their direct involvement in the stock market and bank stock-broking departments and subsidiaries became independent broker houses. However, banks continued to funnel large amounts of funds into the stock market thus providing substantial part of liquidity. In 1996 regulations were further tightened by preventing banks from offering loans for stock transactions. The aim of these was to encourage independent competitive firms as brokers and sources of funds such as mutual funds independent of the banks. In early 2000 the 1996 regulations were reversed and banks resumed their positions as important sources of funds for stock investment.

Given the traditional importance of the banks in the Chinese financial system it is likely to that these changes would have significant effects on the efficiency of the market although it is not clear whether the changes would have enhanced efficiency or not. It is likely that in the long run, a competitive financial system not dominated by relatively few powerful banks would enhance the efficiency of the market while the loss of liquidity when the banks were forced to withdraw might reduce efficiency, at least in the short run. We investigated these questions by re-running our WEMH predictability tests for the Shanghai A and B shares and the Shenzhen A and B shares for the following sub-periods: 6/10/1992 – 30/6/1996, 1/7/1996 – 31/12/1999 and 1/1/2000 – 28/2/2001. The results for Shanghai are reported in Table 6 and the results for Shenzhen are reported in Table 7.

The results for Shanghai are mixed. The Q statistic shows a progressive decline over the three sub-periods, suggesting a fall in autocorrelation of the returns consistent with increasing efficiency as the market rules are changed. On the other hand, the value of R^2 increases progressively over the periods suggesting increased predictability. However, R^2 is not strictly comparable across the three sub-periods and if we look at the individual autocorrelation and regression statistics, there appears some evidence that efficiency improved after 1999 when banks were permitted to re-enter the stock market in 2000. The DoW dummy variables are stronger for the middle period of 1996-1999. It is interesting that the DoW effect seems to have completely disappeared in the post 1999 period.

Table 6: Weak Efficiency: The Effects of Regulatory Change: Shanghai

Variable/ Statistic	21/2/1992 – 28/2/2001	21/2/1992 – 30/6/1996	1/7/1996 – 31/12/1999	1/1/2000 – 28/2/2001
ρ_1	0.05 (0.02)	0.06 (0.03)	-0.01 (0.03)	0.08 (0.06)
ρ_2	0.05 (0.02)	0.06 (0.03)	0.01 (0.03)	0.04 (0.06)
ρ_3	0.04 (0.02)	0.04 (0.03)	0.09 (0.03)	-0.06 (0.06)
ρ_4	0.03 (0.02)	0.02 (0.03)	0.04 (0.03)	-0.03 (0.06)
ρ_5	0.04 (0.02)	0.04 (0.03)	0.03 (0.03)	-0.07 (0.06)
Q(5)	20.99 (0.001)	12.11 (0.033)	8.57 (0.128)	5.00 (0.415)
RSAA (-1)	0.0471 (2.22)	0.0553 (1.83)	-0.0150 (0.44)	0.0449 (0.73)
RSAA (-2)	0.0464 (2.18)	0.0518 (1.71)	0.0180 (0.52)	0.0114 (0.19)
RSAA (-3)	0.0335 (1.57)	0.0274 (0.90)	0.0869 (2.54)	-0.0782 (1.29)
RSAA (-4)	0.0180 (0.85)	0.0154 (0.51)	0.0423 (1.23)	-0.0257 (0.42)
RSAA (-5)	0.0321 (1.51)	0.0358 (1.18)	0.0239 (0.70)	-0.0613 (1.20)
R^2	0.0080	0.0093	0.0104	0.0146
MON	-0.0044 (1.88)	-0.0068 (1.55)	-0.0026 (1.21)	0.0010 (0.38)
TUES	-0.0063 (2.70)	-0.0074 (1.69)	-0.0060 (2.76)	-0.0016 (0.64)
THURS	-0.0006 (0.24)	0.0032 (0.73)	-0.0052 (2.33)	-0.0011 (0.42)
FRI	0.0017 (0.71)	0.0041 (0.93)	-0.0012 (0.53)	0.0014 (0.53)

Notes: ρ_i = autocorrelation for lag i. (standard errors in parentheses);

$\varphi(5)$ = Box-Pierce-Ljung portmanteau test for first- to fifth- order autocorrelation (prob-value in parentheses);

RSAA (-i) = coefficient of RSAA lagged i periods in a regression of RSAA on five lagged values of itself and a constant (absolute value of the t-ratio in parentheses);

R^2 relates to the regression of RSAA on five lags of itself and a constant; and

MON, TUES, WED, THURS are DoW dummy variables in a regression including five lags of RSAA and a constant (absolute values of the t-ratio in parentheses).

Table 7: Weak Efficiency: The Effects of Regulatory Change: Shenzhen

Variable/ Statistic	6/10/1992 – 29/3/2001	6/10/1992 – 30/6/1996	1/7/1996 – 31/12/1999	1/1/2000 – 29/3/2001
ρ_1	0.02 (0.02)	0.01 (0.03)	0.02 (0.03)	0.05 (0.06)
ρ_2	0.05 (0.02)	0.05 (0.03)	0.05 (0.03)	0.02 (0.06)
ρ_3	0.01 (0.02)	-0.03 (0.03)	0.12 (0.03)	-0.04 (0.06)
ρ_4	0.05 (0.02)	0.06 (0.03)	0.04 (0.03)	0.00 (0.06)
ρ_5	0.03 (0.02)	0.04 (0.03)	0.03 (0.03)	-0.04 (0.06)
Q(5)	14.69 (0.012)	8.31 (0.140)	16.32 (0.007)	2.04 (0.84)
RSEA (-1)	0.0152 (0.69)	0.0134 (0.40)	0.0036 (0.11)	0.0281 (0.47)
RSEA (-2)	0.0487 (2.21)	0.0500 (1.50)	0.0489 (1.43)	0.0586 (0.99)
RSEA (-3)	0.0069 (0.31)	-0.0331 (1.00)	0.1153 (3.38)	-0.0252 (0.43)
RSEA (-4)	0.0489 (2.20)	0.0569 (1.71)	0.0394 (1.15)	0.0103 (0.18)
RSEA (-5)	0.0319 (1.45)	0.0458 (1.37)	0.0159 (0.47)	-0.0423 (0.73)
R^2	0.0066	0.0091	0.0186	0.0071
MON	-0.0028 (1.44)	-0.0038 (1.06)	-0.0028 (1.14)	0.0019 (0.77)
TUES	-0.0050 (2.62)	-0.0047 (1.32)	-0.0064 (2.60)	-0.0007 (0.29)
THURS	-0.0025 (1.29)	0.0004 (0.11)	-0.0063 (2.55)	-0.0015 (0.60)
FRI	-0.0003 (0.13)	0.0010 (0.28)	-0.0021 (0.83)	0.0016 (0.63)

Notes: ρ_i = autocorrelation for lag i. (standard errors in parentheses);

φ(5) = Box-Pierce-Ljung portmanteau test for first- to fifth- order autocorrelation (prob-value in parentheses);

RSEA (-i) = coefficient of RSEA lagged i periods in a regression of RSEA on five lagged values of itself and a constant (absolute value of the t-ratio in parentheses);

R^2 relates to the regression of RSEA on five lags of itself and a constant; and

MON, TUES, WED, THURS are DOW dummy variables in a regression including five lags of RSEA and a constant (absolute values of the t-ratio in parentheses).

The results for Shenzhen are quite clear. Both measures of predictability were highest during the period when the banks were excluded from the stock market and this effect is confirmed by the individual autocorrelation and regression coefficients. As was the case for the Shanghai exchange, the DoW effect seems to have completely disappeared after 1999.

The results for Shenzhen and, to a lesser extent, those for Shanghai suggest that the exclusion of the banks have not improved the efficiency of the stock market in the sense of making returns less predictable. This is consistent with the liquidity explanation, that the banks are important sources of liquidity (and perhaps expertise)and that excluding them from involvement in the stock market may make for a more competitive and diversified brokerage industry in the long run but in the short run reduces the amount of trading in the market and so slows the information diffusion.

5.3. The Semi-Strong EMH

The semi-strong EMH requires an absence of forecasting ability for returns using any publicly-available information. While the information set is potentially very large, we confine our attention to the lagged returns on the other board in the same exchange and we examine semi-strong efficiency by investigating the relationships between the indexes. We test forecastability using a regression of current returns on lagged returns as well as cointegration tests. The regression tests for the Shanghai Exchange are reported in Table 8.

Table 8: Relationship between A and B Boards: Shanghai

Regressor	Dependent Variable	
	RSAA	**RSAB**
RSAA(-1)	0.0433 (1.99)	0.0494 (3.49)
RSAA(-2)	0.0438 (2.00)	0.0110 (0.78)
RSAA(-3)	0.0258 (1.18)	0.0042 (0.29)
RSAA(-4)	0.0136 (0.62)	0.0116 (0.81)
RSAA(-5)	0.0294 (1.34)	-0.0351 (2.47)
RSAB(-1)	0.0214 (0.63)	0.1843 (8.41)
RSAB(-2)	0.0029 (0.08)	-0.0532 (2.39)
RSAB(-3)	0.0477 (1.39)	0.0581 (2.62)
RSAB(-4)	0.0066 (0.19)	-0.0084 (0.38)
RSAB(-5)	0.0109 (0.32)	0.0046 (0.21)
CONST	0.0007 (0.92)	-0.0001 (0.23)
SumRSAA	0.15590 (3.39)	0.0410 (1.37)
SumRSAB	0.0895 (1.37)	0.18546 (4.36)
R^2	0.0093	0.0502
Granger causality (F)	0.5539 (0.735)	3.9379 (0.001)

Notes: Figures in parentheses under estimated coefficients are absolute t-statistics. The "SumRSAA" and SumRSAB" figures are the sum of the estimated coefficients of all lagged values of RSAA and RSAB respectively; the figures in parentheses under them are t-statistics for the test that the sum of the coefficients is zero. The "Granger causality" figures are F-statistics for the test that all the lagged RSAB (RSAA) variables are insignificant in the RSAB (RSAA) equation; the figures in parentheses under them are prob values.

In both equations the addition of the lagged returns from the other board has little effect on the coefficients of the lagged returns. In the equation for RSAA none of the lagged values of RSAB is significant, the sum of the coefficients is small relative to that of the lagged RSAA variables, the sum is insignificant and the coefficients of lagged RSAB are all jointly insignificant as evidenced by the F-statitistic. Therefore RSAB does not Granger-cause RSAA. The irrelevance of the lagged RSAB variables in the RSAA equation is reflected in the very small increase in R^2 compared to the figure in Table 3 where RSAA is regressed only on its own lags. The results for the RSAB equation are contrasting: two of the lagged returns on the A board are individually significant and they are jointly significant as indicated by the prob value for the F-statistic although the sum of the lagged RSAAs is not significant. Hence we can conclude that RSAA Granger-causes RSAB but not *vice versa*. These findings are consistent with those found by other authors for earlier periods and using different techniques such as Chui and Kwok (1998), Sjoo and Zhang (2000) and Chen, Lee and Rui (2001). In summary, there is some evidence of the violation of the semi-strong EMH for the B board in that lagged RSAA can be used to predict RSAB. But this is not true of the A board. This is consistent with our earlier findings of stronger evidence of departures from efficiency for the B board.

The tests reported for the Shanghai exchange were repeated for the Shenzhen exchange and the results are reported in Table 9. As with the results reported for the Shanghai exchange, the addition of the lagged returns from the other board makes little difference to the original equations reported in Table 3 – the estimated coefficients, their t-ratios and the R^2 values are little changed. However, in contrast to the Shanghai results, there is no evidence of forecastability based on the lagged returns from the other board; this is true for both boards in Shenzhen. Both tests for Granger causation cannot reject the null of absence of causality. The addition of the lagged returns from the other board have effectively no impact on the returns so that there seems to be very little interaction between the returns on the two boards in Shenzhen, in contrast to the results for Shanghai where there seems to be strong causality from the A to the B board. this is also in contrast to the results of Sjoo and Zhang (2000) who find some evidence of causation from the B returns to the A returns for the Shenzhen exchange.

Table 9: Relationship A and B Boards: Shenzhen

Regressor	Dependent Variable	
	RSEA	RSEB
RSEA(-1)	0.0060 (0.26)	-0.0033 (0.17)
RSEA(-2)	0.0491 (2.14)	0.0107 (0.56)
RSEA(-3)	-0.0029 (0.13)	0.0340 (1.76)
RSEA(-4)	0.0372 (1.62)	0.0119 (0.61)
RSEA(-5)	0.0286 (1.25)	-0.0123 (0.63)
RSEB(-1)	0.0344 (1.26)	0.1817 (7.90)
RSEB(-2)	-0.0131 (0.47)	0.0076 (0.33)
RSEB(-3)	0.0378 (1.37)	0.0715 (3.01)
RSEB(-4)	0.0360 (1.30)	0.0449 (1.92)
RSEB(-5)	0.0056 (0.20)	0.0251 (1.09)
CONST	0.0003 (0.54)	-0.0003 (0.55)
SumRSEA	0.1181 (2.39)	0.0410 (0.98)
SumRSEB	0.1006 (2.04)	0.3309 (7.95)
R^2	0.0098	0.0525
Granger causality (F)	1.3196 (0.252)	0.8235 (0.533)

Notes: Figures in parentheses under estimated coefficients are absolute t-statistics. The "SumRSEA" and SumRSEB" figures are the sum of the estimated coefficients of all lagged values of RSEA and RSEB respectively; the figures in parentheses under them are t-statistics for the test that the sum of the coefficients is zero. The "Granger causality" figures are F-statistics for the test that all the lagged RSEB (RSEA) variables are insignificant in the RSEB (RSEA) equation; the figures in parentheses under them are prob values.

An alternative test of SSEMH is that of cointegration of the (log) price indexes. If they are cointegrated, the Granger Representation Theorem[8] states that a valid vector error-correction model (VECM) exists which in turn implies that at least one of the variables can be used to predict the other so that the semi-strong EMH is

[8] See Engle and Granger (1987).

violated. The results of testing for cointegration on the Shanghai exchange are reported in Table 10.

Table 10: Cointegration Tests: Engle-Granger: Shanghai

Regressand	Test	Trend?	Test Statistic	10% Critical Value
LPSAA	ADF	No	-2.4330	-3.04
		Yes	-3.6920	-3.50
	PP	No	-2.4823	-3.04
		Yes	-3.8996	-3.50
LPSAB	ADF	No	-2.5382	-3.04
		Yes	-2.0942	-3.50
	PP	No	-2.4395	-3.04
		Yes	-2.2926	-3.50

There is little evidence of cointegration of the two variables – the only cases are where LPSAA is the regressand in the equation relating LPSAA and LPSAB and where a trend is included in the equation used to test the stationarity of the residuals – this result holds whether the ADF or PP version of the stationarity test is used. Only one of these cases is significant at the 5% level. If we use the Johansen test which has better large-sample properties, the result is the same – the trace and maximum-eigenvalue statistics both tests lead to the conclusion that there is no cointegrating vector.

Cointegration results are reported for the returns on the Shenzhen A and B boards in Table 11.

Table 11: Cointegration Tests: Engle-Granger: Shenzhen

Regressand	Test	Trend?	Test Statistic	10% Critical Value
LPSEA	ADF	No	-1.1148	-3.04
		Yes	-1.5684	-3.50
	PP	No	-1.2965	-3.04
		Yes	-1.7577	-3.50
LPSEB	ADF	No	-1.5926	-3.04
		Yes	-0.9540	-3.50
	PP	No	-1.4479	-3.04
		Yes	-0.7876	-3.50

The null hypothesis of no cointegration cannot be rejected for either board, no matter which test we use and whether a trend is included in the test equation or not. There is thus no evidence of violation of the semi-strong EMH from the cointegration tests. The results of the cointegration tests for both of the markets seem to be in contrast to those reported by Huang, Yang and Hu (2000) who find evidence of cointegration although they concentrate on the relationship between the Shanghai and Shenzhen markets rather than the relationships between the two boards for the same market. they also use an earlier sample period.

6. Conclusions

This paper has explored both weak and semi-strong efficiency in the Shanghai and Shenzhen stock exchanges.

We found that there was evidence of departures from weak efficiency in the form of predictability or returns on the basis of their own past values. Over the period as a whole this was most marked for the B boards in both the exchanges and absent altogether in the index for the 30 leading stocks on the Shanghai market. These results suggest that much of the apparent predictability simply reflects thin trading so that there may be little if any unexploited profits in this predictability. We also found evidence that efficiency suffered when banks were excluded from the stock market in 1996 and efficiency improved when they were re-admitted in early 2000. We offered a tentative explanation in terms of liquidity given the traditionally dominant role played by the banks in the Chinese financial system – when the banks were excluded liquidity suffered and information transmission was less efficient and this process was reversed in 2000. Clearly this hypothesis needs more exploration with more disaggregated data. We also found widespread evidence of the day-of-the-week effect as others have before us, particularly that there are lower than average returns on Tuesdays. Interestingly, we found this effect to have completely disappeared in the 2000-2001 part of our sample period. We found little evidence of a holiday effect.

In the area of semi-strong market efficiency, we found predictability from the predictability from the A to the B board returns in Shanghai abut no evidence of cross-board causality in Shenzhen.

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