Chinese Closed-End Fund Market (1998-2003): An Empirical Investigation

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ABSTRACT

The objective of this study is to carry out an empirical analysis of the relationship between trading volumes, returns and volatility on closed-end funds (CEFs) market in China using data for 1998-2003. In addition, the transmission of market volatility between Chinese stock market and CEF market is also examined. Further, empirical investigations are conducted on the relationship between premia of CEFs and their future net asset value returns, investor sentiment hypothesis and cointegration of fund share prices and net asset values. The lack of empirical studies on Chinese CEF and also the fast growth of funds in the last few years justify this research. The results of this study show that GARCH(1,1) model can capture the dynamic characteristic of CEF market in China and there is an asymmetric relationship between price change and trading volume. This study also provides evidence that the transmission of volatility occurs between stock market and closed-end fund market. Finally, the results suggest that investor sentiment hypothesis can explain the disparity between fund share prices and net asset values. But the rejection of cointegration between fund prices and net asset values indicates that excess returns cannot be obtained by investing in Chinese CEFs with lower discounts. The important policy implication from this research is that since daily price limits have a significant impact on the fluctuations of closed-end fund prices and the movement of discounts or premia of closed-end funds, policy makers should review the price limits so as to improve market making activities.

Key Words: China, closed-end funds, GARCH model, error-correction model
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1.0 Introduction

Chinese equity markets are set to expand rapidly in the coming years as the state and individual entrepreneurs tap investors to help finance the economic restructuring of state-owned enterprises and fund the expansion of privatized firms. The Shanghai and Shenzhen Stock Exchanges are mainland China's two official stock markets and were established in December 1990 and July 1991 respectively.

With the fast growth of the Chinese stock markets, the first closed-end fund was launched in Shanghai market in 1994, and since then the closed-end fund market has recorded a rapid development. By the end of 2003, 25 funds were listed in Shanghai market and 29 in Shenzhen separately with an approximate total trade volume of 64.66 billion yuan (US$7.8 billion) (Shenzhen Stock Exchange 2003). However, most existing research on Chinese securities markets are focused on market segmentation i.e. A and B shares. There is very little research on rapidly expanding closed-end fund markets in China, which deserves an empirical investigation.

This paper investigates the performance of Chinese closed-end fund market from a number of angles. First of all, it explores the relationship between price change and trading volume. Second, it examines the dynamic characteristic of closed-end fund market and model the market volatility. Third, GARCH model is modified to test whether volatility transmission exists between Chinese stock market and closed-end fund market. Fourth, it tests whether investor sentiment hypothesis can explain closed-end fund puzzle in China. Fifth, it examines whether there is an equilibrium (cointegration) relationship between closed-end fund prices and their net asset values.

The paper is organized as follows: Section Two provides a review of literature. Section Three consists of a discussion on the data and methodology adopted in this study. Section Four presents the results generated using the methodology outlined in Section Three. The results are discussed and analyzed in relation to the hypotheses and findings of prior studies. Finally, Section Five provides an overview of this study, giving a discussion on the major findings and presenting a conclusion of this study.

2.0 Literature Review

2.1 Price-Volume Relationship

A number of empirical studies provide evidence on the relationship between trading volume, stock returns and volatility. After Harris (1989) reported that returns on the New York Stock Exchange (NYSE) tend to follow a U-shaped pattern during the trading day, Lockwood and Linn (1990) proved that intraday volatility also exhibits a U-shaped pattern. In addition, trading volume was found to follow the U-shaped pattern during the trading day by Jain and Joh (1988). Hence, considering the similar patterns observed for returns, variance and volume, a positive correlation between the returns, variance and trading volume may be inferred. Support is offered by Harris (1987) who found a positive correlation between changes in volume and changes in squared returns for individual NYSE stocks. Gallant, Rossi and Tauchen (1992) and Jones, Kaul and Lipson (1994) documented a strong positive correlation between absolute price changes in volume and changes in absolute price in various futures market contracts.

French and Roll (1986) showed that volatility is higher during trading hours when information production is at its greatest. On an equivalent hourly basis, French and Roll documented that volatility during trading hours on the NYSE is far greater than during weekend non-trading hours and concluded that the greater variance during trading time is due to the arrival of private information. Supportive evidence indicate that a high level of volume (measured by both number of stocks traded and number of transactions) immediately followed earnings announcements (Woodruff and Senchack Jr.1988). However, Jain (1988) reported that while S&P500 Index returns respond rapidly to macroeconomic news announcements such as money supply, consumer price index, industrial production and unemployment statistics, trading volume was unaffected by these announcements. Therefore, Jain's results imply that there is no direct association between trading volumes and returns.

Karpoff (1986) made an attempt to develop a model which links returns and volatility with trading volume. Karpoff's model ultimately leads to an asymmetric relationship between volume and price change. Karpoff concluded that trading volume is a result of the price revisions which occur when either a buyer or a seller or both revise their respective bid and ask prices. The resultant model showed that the consequent revisions in the bid-ask spread follow a stochastic process. When the revision in bid prices grows at a relatively faster rate than the revision in asking prices for given variances, the probability of a trade increases. In this model, short positions are not possible. However, short selling can be incorporated into the model which results in an asymmetric relationship between volume and price changes. Since the short position is more costly than long positions, investors in short positions will be less responsive to price changes than investors in long positions. This result leads to an expectation that the association between volume and non-negative price changes will be greater than the association between volume and negative price changes.

Another model which predicts an asymmetric relationship between trading volume and price changes is the one originally proposed by Epps (1975) and developed by Jennings, Starks and Fellingham (1981). In this model, investors are classified as either “optimists” or “pessimists”. Again, short positions are assumed to be less responsive to price changes. Jennings, Starks and Fellingham (1981) showed that when a trader is a pessimist, the trading volume is less than when the trader is an optimist. Since prices decrease with a pessimistic seller and increase with an optimistic buyer, it follows that volume is low when prices decrease and high when prices increase. As Karpoff (1987) noted, the model of Jennings, Starks and Fellingham relied upon a distinction between optimists and pessimists and the consequent behavioral distinction between the two groups.

In the absence of data on bid-ask schedules, order queues, information and investor preferences, the models of Karpoff or Jennings, Starks and Fellingham are not directly testable. However, Brailsford (1996) pointed out that the predictions of the models are able to be examined. The models predict a positive but asymmetric relationship between trading volume and the absolute value of returns. The slope of the line of best fit between trading volume and negative returns is expected to be flatter than the slope of the line of best fit between trading volume and non-negative returns (Brailsford 1996).

Clark (1973) and Epps and Epps (1976) introduced ‘mixture of distributions’ hypothesis. The hypothesis links information flow, volume and price variability. It is argued that prices and volume react to pieces of information which arrive throughout the trading day and the daily price change (and volume) is the sum of the intraday price changes (and volume) (Tauchen and Pitts 1983). To the extent that the number of traders with private information changes over time, volatility during trading hours is expected to change over time. Further, as Brailsford (1996) stated that the model was still need another two assumption. It is assumed that the amount (and rate of arrival) of information varies across days and that price changes and volume are jointly independently and identically distributed with finite variance. Then, this joint distribution will be bivariate normal following the Central Limit Theorem.

The daily returns and volume are drawn from a mixture of distribution as the amount (and rate of arrival) of information varies. The mixing variable is the information which arrives and trading volume is used as a proxy for the mixing variable. Hence, the MDH provides an indirect test for the link between price changes and information flow (Brailsford 1996).

Jain and Joh (1988) carried out an empirical study on the relationship between hourly price change and trading volume by using a multiple regression equation. Based on Jain and Joh's study, Brailsford (1996) proposed modified equations to test the relationship between trading volume and price variability in the Australian stock market. The equations used by Brailsford have some advantages, because they can measure the relationship between price change and volume irrespective of the direction of price change. Further, the analysis can be repeated and confirmed by testing the association between squared return volatility and volumes. However, there are also some disadvantages for the equations. For instant, since absolute values were used as regressors in the equation, the (x, y) co-ordinates were forced into the first and fourth quadrants and then the residuals exhibited a high degree of serial dependence. To remove the serial correlation, the regressions were estimated with a first-order autoregressive process and a lag of the dependent variable was added to the equations. Hence, it could be concluded that Brailsford's approach is reasonable and it is another way to illustrate price-volume change relationship.

In addition to the literature on price-volume change relationship, there are also substantial studies on association between return and market volatility. Financial economists show that the autoregressive conditional heteroskedasticity (ARCH) process provides a good fit for many financial return time series. As Lee, Chen and Rui (2001) state, the ARCH model allows the conditional variance to change over time as a function of past squared errors. Further, since an autoregressive structure is imposed on conditional variance, the model can appropriately parameterize 'volatility clustering' or 'volatility pooling' phenomenon, which is common to many series of financial asset returns.

2.2 Return Volatility

Bollerslev (1986) extended the ARCH process to GARCH (Generalized ARCH) model. Although both ARCH and GARCH model involve a maximum likelihood procedure in parameter estimation, the GARCH model allows for a more flexible lag structure for conditional variance (i.e. the conditional variance depends on previous own lags and lagged error). According to Lee, Chen and Rui (2001), the GARCH model is more concise and less likely to breach non-negativity constraints compared to the ARCH model.

In addition to pure GARCH model, another important model in GARCH family is the exponential GARCH model proposed by Nelson (1991). Based on the EGARCH equation, non-negative constraints can be removed because σ_t^2 is modeled and it is always positive. Moreover, asymmetries can be allowed for by using EGARCH equation.

Yu (1996) utilizes the ARCH/GARCH framework to study the volatility of the Chinese stock exchanges. Yu studied daily index return data for both the Shanghai and Shenzhen exchanges and found evidence in favor of an ARCH (2) model for the Shenzhen index returns and a GARCH (1,1) model for the Shanghai index returns.

Su and Fleisher (1998) also used the ARCH/GARCH framework to examine the volatility. However, they specified the mean equation for their model to include a normal of local and global information variables, such as lagged Chinese, Hong Kong, US and MSCI global stock index returns, lagged US interest rates and lagged exchange rates. A subset of the local and global information variables is found to be significant. In addition, they examined the distributional assumptions underlying the ARCH/GARCH model with a view to explaining more of the fat-tailed behavior of Chinese stock returns. They also found that volatility changes could be linked to changes in the degree of market regulation.

Song, Liu and Romilly (1998) also examined the volatility of the two Chinese stock markets by GRACH models. They applied descriptive statistics, individual autocorrelation coefficients test and Ljung-Box Q(12) cumulative autocorrelation statistic to justify the fitness of GARCH models. The tests show that the distribution of the two returns series are not normal and independence assumption for two series is rejected. Further, the results of GARCH models illustrate that the two series may be best explained by the GARCH-M(1,1) specification with the mean equations of

ARMA(6,6) for Shanghai and ARMA(10,10) for Shenzhen. The estimated GARCH-M models are consistent with a positive risk premium on stocks. In contrast, Lee, Chen and Rui (2001) report that there is no relation between expected returns and expected risk by using GARCH-M model. They suggest that variables other than volatility estimates should be used when formulating expected returns in China. Moreover, they rejected the random walk hypothesis and also showed that stock returns are not independent and identically distributed. In addition, the result of a long memory test in stock returns strongly suggests the possibilities for improving price forecasting performance by GARCH models.

Su and Fleisher (1999) examined why the volatility of “A” shares is much greater that that of “B” shares in China. They use daily return data on the 24 companies that have both ‘A’ and ‘B’ shares for the period 6 August 1993 through to 25 September 1997 (Su and Fleisher 1999). A modified mixture of distribution hypothesis in which trading volume approximates the flows of news into financial markets is used. They find that news flow more intensively into ‘A’ share markets; news is more highly correlated with trading for ‘A’ share market and new is more persistent for ‘A’ shares. Thus, their finding provided insight into why ‘A’ shares are more volatile than ‘B’ shares.

Lee, Chen and Rui (2001) examined empirical contemporaneous and causal relationships between trading volume, stock returns and return volatility in China’s four stock markets (Shanghai ‘A’ shares, Shanghai ‘B’ shares, Shenzhen ‘A’ shares and ‘B’ shares market) and across these markets. In their study, Dickey-Fuller and Phillips-Perron tests confirm that the trading volume and stock return series are both stationary. They also found the existence of a positive contemporaneous relationship between trading volume and returns in all ‘A’ and ‘B’ shares markets. However, it was found that trading volume does not Granger-cause stock market returns on each of the markets. Additionally, U.S. and Hong Kong financial market information contained in returns, volatility and volume has very weak predictive power for Chinese financial market variables.

Although there are a number of studies on price variability and trading volume relationship, most of them examined Chinese stock markets and focused on the comparison of ‘A’ share markets and ‘B’ share markets. Studies on closed-end fund markets in China are lacking. Recently Gu (2001) attempted to explain why the prices of closed-end funds differ from net asset value (NAV) of those funds. Gu did not examine the association between prices, volumes and return volatility in closed-end fund markets. Hence, the proposed study will fill up that gap by examining price-volume relationship and dynamic properties of Chinese closed-end fund markets.

2.3 Disparity of Closed-end Funds Prices and Net Asset Value

Expected investment performance hypothesis (EIPH) proposed by Boudreaux (1973) attempts to explain substantial discounts and premiums on closed-end funds within market efficiency framework. Boudreaux (1973) argued that given a number of evidence of efficiency in the securities markets, the market price of closed-end fund per share should equal to its net asset value when investors perceive there is no alteration in the fund's portfolio. If investors are optimistic about the results of future portfolio alteration, the fund will be sold at premium. Conversely, the fund will be sold at discounts due to the pessimistic concern about future portfolio performance.

Based on the assertion above, Boudreaux (1973) demonstrated that the market price-net asset value divergence could be explained by market expectation on future investment performance.

The study of Boudreaux (1973, p.518) utilized closed-end funds' turnover ratio to measure historical percentage portfolio alteration in the U.S. closed-end fund market during the period 1960 to 1970. It was assumed that the market expected the fund manager to maintain its historical turnover ratio, and turnover ratio was supposed to be positively correlated with the absolute value of change in closed-end funds' divergences between net asset value and market price. In addition to portfolio turnover ratio, other historical performance measures such as return-to-variability of net assets and annual growth rate of net asset value per share were used to serve as proxies for market expectations about future portfolio alteration. The empirical results of the study showed that turnover ratio and other historical measures, which are considered as proxies for market expectations about the size and quality of future portfolio revisions, were significantly correlated with the change in discount and premia of closed-end funds. Thus, the research of Boudreaux (1973) provided a reasonable explanation about the closed-end fund price puzzle consistent with market efficiency and refuted market irrationality.

However, there are still some close-end fund puzzles that could not be explained by the expected investment performance hypothesis (Lee, Shleifer and Thaler 1991). The observation that closed-end funds are issued at premia in initial public offerings while existing funds are traded at a discount is the first puzzle. Lee, Shleifer and Thaler (1991, p.76) also claimed that closed-end funds sell at an average discount of ten percent after 120 days of their initial public offerings as documented by Weiss (1989) could not be explained. In addition, the expected investment performance hypothesis fails to explain the mean-reverting pattern of closed-end fund discounts and why there is no significant correlation between premium and discount changes and interest rate changes (Lee, Shleifer and Thaler 1991).

Based on the research of Boudreaux (1973), Ferguson and Leistikow (2004) argued that the phenomena mentioned above could also be explained by the expected investment performance hypothesis. According to Ferguson and Leistikow (2004), the reason for closed-end fund premium in initial public offerings is attributed to market optimism about fund managers.
It was reported that those who have good recent performance record were elected to be new closed-end funds managers and some of the good performance was expected to be persistent. This explains why premia are the norm for closed-end funds on the IPO.

Ferguson and Leistikow (2004) also proposed explanations for other closed-end fund puzzles under the expected investment performance hypothesis framework. In addition to the explanation, they conducted three empirical tests of the investment performance hypothesis and the results of the tests strongly supported the hypothesis that closed-end fund discounts reflect expected investment performance.

Underlying portfolio value hypothesis is another explanation for the divergence between market price of closed-end funds and their net asset value. The hypothesis was proposed by Malkiel (1977) and Thompson (1978). The study of Malkiel (1977) showed that capital gains tax liability caused the possibility that the closed-end funds' underlying portfolio values may be overestimated. It is because the net asset value of the fund doesn't reflect accrued capital gains tax liabilities whereas the capital gains tax must be paid when appreciated assets in the fund are sold. In addition, since investors are also subjected to personal income taxes, the discounts (i.e. a higher expected return before tax) are regarded as compensation for investors (Thompson 1978).

Another explanation for the disparity between market price of closed-end funds and net asset value is restricted asset hypothesis. Malkiel (1977) suggested that the value of restricted or letter stock[1] held in portfolio might be overestimated. It was argued that due to high illiquidity, the market prices of theses stocks are not a fair indication of their value on liquidation. The study of Malkiel (1977, p.854) showed that restricted stock variable significantly explained over 50 percent of U.S. closed-end fund discounts at average in the years 1969 through 1974.

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[1] Restricted stock is the stock whose sale is restricted. Letter stock refers to those whose buyers are required to sign an "investment contract", pledging that the stock has been bought for investment purposes, and indicating that the stock will be held for a considerable period of time.

Roenfeldt and Tuttle (1973), Ingersoll (1976) and Thompson (1978) proposed agency costs hypothesis to explain CEFs discounts. They argued that agency costs could create CEF discounts if management expenses and fees are too high or if future portfolio management and performance is expected to be inadequate. However, Boudreaux (1973) argued that security transactions costs and management fees are too small to account for the magnitude and variability of discounts and premiums on closed-end funds.

Additionally, observable premiums can not be explained by this hypothesis and strongly supports the assertion that agency costs are not a major concern on the issue. For example, Malkeil (1977) reported regression results of agency cost hypothesis rejecting managerial fees and expenses explanation which involves agency cost hypothesis.

The first proposition of investor sentiment hypothesis can be found in Zweig (1973) who suggested that discounts on closed-end fund reflect expectations of individual investors. Based on the study of Zweig (1973), Delong, Shleifer, Summers and Waldmann (1990) (DSSW) developed the investor sentiment hypothesis. In their analytical model, investors were divided into two types: rational investors and noise investors (irrational investors). Rational investors have rational expectations about future returns whereas noise investors are affected by sentiment and consequently have irrational expectations. Their analytical model is based on two important assumptions. The first assumption is the investment horizon for rational investors is short. The second assumption is related to stochastic noise traders' sentiment, which is supposed to be difficult to forecast. Meanwhile, DSSW regarded the price puzzle in closed-end fund markets as an application of their analytical model. However, as Lee, Shleifer and Thaler (1991) noted, other additional assumptions are needed. Sentiment hypothesis requires that closed-end funds be held predominately by individual small and irrational investors and noise traders are more likely to make investment in closed-end funds than other assets. Therefore, the discounts are generated by irrational investors' pessimism and the excess return requested by rational traders for the extra noise trader risk. Additionally, since noise traders hold and trade a preponderance of closed-end fund shares, changing investor sentiment risks cannot be diversified and regarded as a systematic risk.

Based on DSSW model, Lee, Shleifer and Thaler (1991) proved that investor sentiment hypothesis is a better explanation of discounts on closed-end fund. Firstly, since holding closed-end funds is much riskier than directly holding underlying assets in portfolio, the discounts phenomena after closed-end funds' IPOs could be explained automatically. Secondly, over-optimism of irrational traders about closed-end funds' future performance and the lack of rational investors buying closed-end funds at the beginning can explain why closed-end funds start at premium. Thirdly, the fluctuation of the discounts during closed-end fund life period is a result of the stochastic changing investment sentiment. Finally, by the time of the announcement of open-ending or liquidation, the observable rising market price of closed-end funds is attributed to the elimination of noise trader risk (Lee, Shleifer and Thaler 1991).

In addition to justifying investment sentiment hypothesis for closed-end fund market puzzle, Lee, Shleifer and Thaler (1991) conducted tests for additional implications of investor sentiment explanation. One of the implications is whether the movement of discounts of closed-end fund is highly correlated between funds and whether the changes in discounts also move together across funds.

The result of their study shows that the discounts as well as the changes in discounts are highly correlated and suggests that noise trader risks affect the aggregated closed-end fund market and investor sentiment hypothesis is an alternative explanation against standard economic theories.

Noronha and Rubin (1995) also have provided additional evidence of investor sentiment hypothesis in explaining closed-end funds' discount puzzle. In contrast to a substantial proportion of studies discussed above focused on equity funds or a mixture of equity and bond funds, the study of Noronha and Rubin (1995) was conducted on closed-end bond fund market in the United States. Since junk bonds were extremely popular in the financial markets during the period from 1985 to 1987, it is supposed that the portfolios of closed-end bond funds constructed with a larger proportion of junk bonds will be sold at a premium or lower discounts if investor sentiment factor does exist. The model used by Noronha and Rubin (1995) successfully captured investor sentiment factor in generating discounts and the results showed that investor sentiment hypothesis was suitable to explain part of the discount puzzle in closed-end bond fund market.

Recently, the research of Gu (2001) found that the assumptions of investor sentiment hypothesis were nearly met in Shenzhen closed-end fund market. The study of Gu (2001) also suggested that the sentiment hypothesis could be used to explain the puzzle on Chinese close-end fund markets because the discounts and the changes in discounts were highly correlated. However, Gu (2001, p.19) only conducted the examination in Shenzhen market and utilized weekly data from January

2000 to October 2000. It is interesting to check empirically whether sentiment hypothesis is applicable to explain the puzzle in both Chinese closed-end fund markets for a longer period.

2.4 Relationship between Closed-end Fund Premium and Returns

Except for a number of literature on how to explain the disparity between closed-end fund market prices and net asset values (Boudreaux 1973, Zweig 1973, Lee, Shleifer and Tahler 1991), some researchers were interested in whether the discounts or premium contain information on future expected returns.

Thompson (1978) examined the relationship between closed-fund premiums and return and illustrated that fund premium was negatively correlated with fund share returns. Thompson (1978) demonstrated that the trading rules utilized to generate excess returns are based on the size and magnitude of closed-end funds' discount or premium.

The portfolio composing of only discounted funds outperformed other portfolio with all funds and three market portfolios. It was concluded that the discounts of closed-end funds contain information about future expected rates of return on closed-end investment company shares.

Pontiff (1995) provided additional evidence for Thompson's (1978) finding. The return-generating model proposed by Pontiff (1995) incorporated a number of variables including discounts or premium, four types excess return measures, sentiment risk, January effect, bid-ask spread, and income dividend yield. The test result showed that "funds with 20% discounts have expected twelve-month returns that are 6% greater than nondiscounted funds" (Pontiff 1995, pp.1). However, the relationship between discounts and returns is a result of the mean-reverting pattern of discounts.

As Pontiff (1995) pointed out that excess returns generated by closed-end funds with greater discounts was attributed to its discount mean-reversion, Gasbarro, Johnson and Zumwalt (2003) attempted to verify whether discounts or premium of closed-end funds follows a mean-reverting pattern. The study applied two time-series methodologies to model the mean-reversion tendencies of closed-end funds and the results suggested that changes both in market prices and net asset value forced the discounts to exhibit mean-reverting tendency. They point out that excess returns could be generated by those funds whose mean-reverting pattern of discounts is mainly caused by market price changes.

3.0 Data and Methodology

3.1 Data Description

The sample of closed-end funds used in this study includes all closed-end funds launched both on Shanghai Stock Exchange and Shenzhen Stock Exchange in China after the new regulatory framework on mutual fund management took effect in 1997.

In order to examine the association between trading volume and price changes on the aggregate fund markets in Shanghai and Shenzhen, daily fund index and daily trading volume will be used. However, due to some missing data for trading volume in 2000, the data from 5 February 2001 to 14 April 2004 (765 observations) will be used to test the price-volume relationship in Shenzhen market. For Shanghai market, the data set includes 954 observations from 17 August 2000 to 15 April 2004. Additionally, the same data will be applied to test fund market volatility on both markets as well.

Market returns will be calculated from the Shenzhen Composite Price Index and Shanghai Composite Price Index. Both of the two indexes are capitalization-weighted indexes using the prices of all listed companies in China. However, weekly data will be used in the tests for investor sentiment hypothesis and the pattern of premia of closed-end funds because weekly net asset values of closed-end funds are publicly released.

The required stock market indexes, fund market indexes and trading volumes can be obtained from DataStream International. The historical data of closed-end funds listed in Shenzhen Stock Exchange has been provided by Shenzhen Stock Exchange, including market prices, trading volume and capitalization. Nanfang Fund Management Company provided the required data of closed-end funds traded in Shanghai Stock Exchange. The reported net asset values of funds have been publicly released through “Security News” in China and the respective web sites of fund management companies on a weekly basis.

3.2 Methodology

3.2.1 Price-Volume Models

A time series regression model is used to test the relationship between trading volume and price changes. The methodology proposed by Brailsford (1996) is closely followed and the model is given as below:

$$V_t=\alpha_0 + \gamma_1|R_t| + \gamma_2 D_t|R_t| + \mu_t \qquad (1)$$

$$V_t=\alpha_1 + \gamma_3 R_t^2 + \gamma_4 D_t R_t^2 + \mu_t \qquad (2)$$

where V_t is the daily number of closed-end fund shares traded, D_t is a dummy variable, and equals to 1 if the return is less than zero. Otherwise, D_t equals zero when the return is positive. R_t is the daily return and calculated as the change in closing Index or prices of successive days divided by previous closing Index or price:

$$R_t = (P_t - P_{t-1})/(P_{t-1}) \qquad (3)$$

In both of Equations 1 and 2, the relationship between absolute price change and trading volume is measured by the estimate of γ_1. By using a dummy variable in the equation, the asymmetric relation can be examined. As Brailsford (1996, p.99) noted, "a statistically significant negative value of γ_2 would indicate that the response slope for negative returns is smaller than the response slope for non-negative returns."

Due to the use of absolute values as regressors, the residuals may have a non-normal distribution violating one of classical assumptions. According to Brailsford (1996), the problem could be fixed by involving a first-order autoregressive process in the residuals based on a maximum likelihood procedure. In addition, as far as autocorrelation in disturbance term is concerned, a lag of the dependent variable will be incorporated into both of the equations. It is argued that the additional regressor and the first-order autoregressive process in residuals will remove most of the serial correlation. Standard diagnostic tests will be carried out on all the models estimated in this paper.

Finally, the data set of independent variables and dependent variables will be standardized before they are used in regressions. Such a procedure was also applied by Brailford (1996) to minimize the difficulties in interpreting coefficient estimates. The different scales applied in the dependant variable and independent variables can cause the interpretational difficulty. The trading volume and return series are standardized by subtracting their respective means and dividing by their respective standard deviations.

3.2.2 GARCH Models

To test whether time-varying volatility is persistent and predictable in Chinese-closed end fund markets, GARCH family models will be employed in this paper. Before GARCH models are applied for volatility analysis in closed-end fund markets, the Ljung-Box Q-statistic (Ljung and Box 1978) test will be conducted on fund share return time series. The test is used to detect whether volatility is autocorrelated and whether the generalized autoregressive conditional heteroskedasticity (GARCH) provides a good fit for the data set.

If the returns in closed-end fund markets do not follow random walks and remains stationary through time, GARCH model is used in modeling market volatility and examine the dynamic characteristics of closed-end fund markets in China. The GARCH (p, q) model consists of Equations 4 and 5:

$$R_t = \eta + \sum_{i=1}^{m}\theta_i R_{t-i} + \varepsilon_t + \sum_{j=1}^{n}\lambda_j\varepsilon_{t-j} \qquad (4)$$

where R_t is an index of daily returns as defined by Equation 3 and the conditional variance of returns is specified as:

$$h_t = \alpha + \sum_{i=1}^{p}\beta_i \varepsilon^2_{t-i} + \sum_{j=1}^{q}\varphi_j h_{t-j} \qquad (5)$$

Since the GARCH process allows the current conditional variance to be a function of past conditional variance as well as the past squared error terms derived from the mean equation, it is a more concise model compared to ARCH process. However, the GARCH model still suffers from some restrictions and limitations.

The restrictions put on a GARCH model is non-negative estimated values. That means the parameters should satisfy $\alpha>0$, $\beta>0$ and $\varphi>0$ in Equations 4 and 5. It is argued that the more parameters used in the conditional variance equation, the more likely the non-negativity constraints would be violated.

To model the spill-over effect of volatility in stock markets on closed-end fund markets, a lagged squared error term from the mean equation of the GARCH model for stock markets will be incorporated into the GARCH model for closed-end fund markets as an explanatory variable in the conditional variance equation. The spill-over effects from stock markets to closed-end fund markets may be captured by the following specification:

$$h_t = \alpha + \sum_{i=1}^{p}\beta_i\varepsilon^2_{t-i} + \sum_{j=1}^{q}\varphi_j h_{t-j} + \sum_{\gamma=1}^{\omega} \xi_\gamma\varepsilon^2_{st-\gamma} \qquad (6)$$

where h_t is conditional variance term and the $\boldsymbol{\varepsilon_{st-\gamma}}$ are previous shocks to stock markets and the coefficients ξ measures the impact of past shocks of stock markets on the returns of closed-end fund markets on the conditional volatility of stock markets. A significant estimate of ξ would suggest spill-over effects.

3.2.3 Pearson Product Moment Correlation

One important implication of the investor sentiment hypothesis in financial markets is that the risk from the unpredictability of future investor sentiment is systematic, i.e. the sentiment risk affects all securities at the same time.

Based on this implication, it is supposed that levels of and changes in premia should be highly correlated across funds. Lee, Shleifer and Thaler (1991) provided evidence for this implication using Pearson Product Moment Correlation.

This paper is also going to test if levels of and changes in premia are highly correlated across funds using Pearson Product Moment Correlation.

Pearson's correlation reflects the degree of linear relationship between two variables. This correlation ranges from +1 to -1. A correlation of +1 means that there is a perfect positive linear relationship between variables. A correlation of -1 means that there is a perfect negative linear relationship between variables. A correlation of 0 means there is no linear relationship between the two variables. The formula for Pearson's correlation takes on many forms.
A commonly used formula is shown as below:

$$r = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{N}}{\sqrt{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{N}\right)\left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}\right)}} \tag{7}$$

A simpler looking formula can be used if the numbers are converted into z score, where z_x is the variable X converted into z scores and z_y is the variable Y converted into z scores.

$$r = \frac{\Sigma z_x z_y}{N} \tag{8}$$

In addition to the pair-wise Pearson product-moment correlation test, p-value for a two-tailed test of the null hypothesis of zero correlation will be conducted as well. If the co-movements in premia of different funds are significantly correlated, it could be an evidence of the existence of noise trader risk in Chinese closed-end fund markets. Thus, as long as the assumptions of investor sentiment hypothesis are met and noise trader risk is systematic in the market, the investor sentiment hypothesis could be an explanation for the closed-end funds puzzle in China.

3.4.4 Unrestricted Error Correction Model (UECM)

To test the existence of an equilibrium relationship between closed-end fund price and its net asset value in Chinese close-end fund markets, an unrestricted error correction model (UECM) will be applied in the study. The UECM approach allows for the testing of cointegration of the variables in the model. This approach based on an autoregressive distributed lag (ARDL) model has the advantage of avoiding the classification of variables into *I*(1) or *I*(0) and unlike standard cointegration tests, there is no need for unit root pre-testing. In addition, as it involves estimating regressions which include both the levels of the variables and their first differences, the long-run relationship can be estimated without ignoring the short-run dynamics (Hendry, 1979). Moreover, as critics argue that the residuals of the first stage of the Engle-Granger two stage procedure are not well behaved and the standard t-statistic can not be used. Furthermore, according to Hall (1986), Phillips and Loretan (1991), and Boswijk and Fransers (1992), the coefficient values of the lagged level dependent variable of an ECM can provide a robust check of the existence of a long-run cointegrating relationship. Therefore, the use of UECM approach is justified.

The UECM model is formulated as below:

$$\Delta \ln P_t = \sum_{i=1}^{n1} b_0 \Delta \ln P_{t-i} + \sum_{i=0}^{n2} b_1 \Delta \ln NAV_{t-i} + \gamma_1 \ln P_{t-1} + \gamma_2 \ln NAV_{t-1} + \delta + \varepsilon_t \quad (9)$$

where P_t = closed-end fund's price per share

NAV_t = closed-end fund's net asset value per share

δ and ε_t are the constant and the random error term respectively.

OLS method can be used to estimate the UECM model. The usual 'general-to-specific" procedure for narrowing down independent variables can be used once modeling commences. This process has been advocated by Davidson, Hendry, Srba and Yeo (1978). Based on the coefficients of the lagged level variables, the long-run elasticity of the variables can be derived. Banerjee, Dolado and Mestre (1998) provide critical values for identifying the existence of cointegration in the estimated equation by examining the t-statistics of the error-correction term ($\gamma_1 \ln P_{t-1}$) in Equation 9. If the t-statistics (in absolute terms) of the error-correction term in the estimated equation exceeds the critical values specified by Banerjee, Dolado and Mestre (1998) series, then there is adequate evidence to reject the null hypothesis of no cointegration. In other words, there is a long-run equilibrium relationship between fund price and net asset value. In addition, a long-run elasticity coefficients of the two variable is calculated by dividing the coefficient of the net asset value (at the level lagged) by the coefficient of the error-correction term (at the level lagged) and reverse the sign.

4.0 RESULTS AND DISCUSSION

4.1 Price-Volume Relationship

Table 1 shows the relationship between standardized trading volume and absolute standardized return both in Shanghai closed-end fund market and Shenzhen market. The estimates of γ_1 in Equation 1, which measure the relationship between absolute price changes and trading volume, are significantly positive across Shanghai market and Shenzhen market. Moreover, the negative value of γ_2 indicates that there is an asymmetric relationship between price change and volume, i.e. the slope for negative returns is smaller than slope for positive returns. The estimates of γ_2 are significantly negative in both markets. The diagnostics tests are reported in Table 7. The value of adjusted R squared indicates that the model is well fitted and p-value of Breusch-Godfrey serial correlation LM(2) test indicates that there is no autocorrelation in the residuals. Thus, the results shown in Table 1 suggest that there is a positive relationship between absolute price changes and trading volume and there is an asymmetric relationship between price changes and trading volume on aggregate closed-end fund markets.

Table 2 shows the relationship between price change and trading volume using squared return instead of absolute return. The results are similar to those presented in Table 1. Both estimates of γ_3 and γ_4 are significant across Shanghai and Shenzhen market, indicating that there is a positive relationship between price changes and trading volume and an asymmetric relationship between the two variables exists. The results shown in Table 2 provide additional support for price-volume relationship in this study.

It is observed that the empirical results using data of Chinese closed-end fund markets are similar to those conducted by Brailsford (1996) using data of the Australian stock market. At the aggregate market level, a positive relationship between absolute return and trading volume is supported. Similar to Brailsford's (1996) results, this study also reveals an asymmetric relationship between the two variables.

Table 1 Relationships between Absolute Returns and Trading Volume on Shanghai and Shenzhen Closed-end Fund Markets:

Sample: From August 2000 to August 2004 (Shanghai Market) - Daily

Sample: From February 2001 to April 2004 (Shenzhen Market) - Daily

Equation 1

	Shanghai Closed-end Fund Market	Shenzhen Closed-end Fund Market
Dependant Variable:Volume		
α_0	-0.206075	-0.266
(t-Statistic)	(-8.581218)***	(-10.66267)***
γ_1	0.5701	0.725949
(t-Statistic)	(19.26408)***	(24.54395)***
γ_2	-0.480934	-0.602785
(t-Statistic)	(-11.20618)***	(-14.62769)***
DIAGNOSTICS		
Adjusted R^2	0.55	0.67
Breusch-Godfrey Serial Correlation LM(2) Test	1.327402	1.096776
[P-value]	[0.265617]	[0.3344]

*** Significant t-statistics at 1% level.

Table 2 Relationships between Trading Volume and Squared Returns on Shanghai and Shenzhen Closed-end Fund Markets:

Sample: From August 2000 to August 2004 (Shanghai Market) - Daily

Sample: From February 2001 to April 2004 (Shenzhen Market) - Daily

Equation 2

	Shanghai Closed-end Fund Market	Shenzhen Closed-end Fund Market
Dependent Variable: Volume		
α_1	-0.032860	-0.061272
(t-Statistic)	(-1.793702)*	(-2.718363)***
γ_3	0.075096	0.101726
(t-Statistic)	(16.56011)***	(19.81334)***
γ_4	-0.107840	-0.100225
(t-Statistic)	(-6.394154)***	(-6.699383)***
DIAGNOSTICS		
Adjusted R^2	0.514899	0.609714
Breusch-Godfrey Serial Correlation LM(2) Test	1.771120	1.215933
P-value	[0.17066]	[0.2969]

* Significant t-statistics at 10% level; *** Significant t-statistics at 1% level.

As discussed in the literature review chapter, Kapoff (1987) attributes this asymmetry to the greater cost of short position. In addition, Brailsford (1996) argues that it is difficult to find an asymmetric trading volume-relationship for stocks in which short selling is prohibited.

However, an asymmetric relationship between return and trading volume exists in Chinese closed-end fund markets although there is a prohibition on short selling. Moreover, the market Brailsford (1996) dealt with is a developed market (Australia), while the market examined in this study is closed-end fund market in a developing country (China). The existence of an asymmetric relationship could be attributed to two rather unique factors. First, the great majority of participants are short-term individual investors (Gu 2001) whose behavior can be characterized by overreaction to positive shocks. Second, the price limits imposed by China Securities Regulatory Commission hinder the information transmission mechanisms and the price will go up once the ceiling is reached. When prices go down, investors are observed to be more likely hold on to their fund shares and exhibit lower response for negative returns.

4.2 Market Volatility

First to twelfth order autocorrelation coefficients of the return, absolute return and squared return series for the two Chinese closed-end fund markets and the Ljung-Box statistic for testing the hypothesis that all autocorrelations up to lag 12 are jointly equal to zero are shown in Table 3. The testing results strongly suggest that the hypothesis of independence in daily returns should be rejected. Furthermore, the autocorrelation coefficients and Ljung-Box Q-statistic for the absolute and squared return series also indicate very strong autocorrelation. Overall, these results clearly reject the independence assumption for the two Chinese time series of daily closed-end fund returns and justify the use of the GARCH specification in modeling the variance of the Chinese closed-end fund markets.

To estimate GARCH models, a general specification of the mean equation described in the previous Section 3.4.2 has been firstly estimated. The orders of the AR and MA process in the mean equation are determined by the partial autocorrelation function (PACF) and the autocorrelation function (ACF) of the return series of Shanghai and Shenzhen respectively. Along these lines, the best specification for both Shanghai and Shenzhen market is the GARCH(1,1) with the mean equations of ARMA(4,4) for Shanghai and ARMA(3,3) for Shenzhen. Other models were also tried, but there were no significant improvements in goodness of fit based on likelihood-ratio tests.

Table 3 Ljung-Box Q-Statistic for the Closed-end Fund Returns in Shanghai and Shenzhen Markets

Sample: From August 2000 to August 2004 (Shanghai Market) - Daily

Sample: From February 2001 to April 2004 (Shenzhen Market) - Daily

Statistics	R_1	R_2	$\|R_1\|$	$\|R_2\|$	R_1^2	R_2^2
ρ_1	−0.483	−0.495	−0.487	−0.464	−0.467	−0.448
ρ_2	−0.053	−0.048	0.033	0.007	−0.001	0.001
ρ_3	0.01	0.035	−0.086	−0.065	−0.049	−0.071
ρ_4	0.066	0.043	0.111	0.094	0.034	0.045
ρ_5	−0.04	−0.028	−0.053	−0.044	−0.01	−0.019
ρ_6	−0.01	−0.018	−0.021	−0.025	−0.007	−0.01
ρ_7	0.01	0.022	−0.029	−0.051	−0.017	−0.02
ρ_8	0.038	0.01	0.072	0.106	0.04	0.046
ρ_9	−0.062	−0.025	−0.017	−0.049	−0.022	−0.021
ρ_{10}	0.039	0.018	−0.062	−0.022	−0.029	−0.026
ρ_{11}	−0.061	−0.067	0.064	0.033	0.044	0.039
ρ_{12}	0.082	0.113	−0.054	−0.051	−0.014	−0.018
Q(12)	271.15	225.84	290.87	209.87	237.29	178.75
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Note: R_1 and R_2 are the returns of the Shanghai and Shenzhen markets respectively

Table 4 contains parameter estimates of GARCH(1,1) model. At first glance, the results are consistent with those of other empirical works on time-varying volatility. First, the likelihood ratio statistics are large, which implies the GARCH model is an attractive representation of daily return behavior, successfully capturing the temporal dependence of volatility. Second, the GARCH parameterization is statistically significant and the value of the estimated parameters α, β_1 and φ_1 satisfy $\alpha>0$, β_1, $\varphi_1>0$. Third, the estimated φ coefficients in the conditional variance equation are considerably larger than the β coefficients. This implies that large market surprises induce relatively small revisions in future volatility (Lee, Chen and Rui 2001). Finally, the persistence of the conditional variance process, measured by $\varphi + \beta$ is high and often close to the integrated GARCH model of Engle and Bollerslev (1986). This implies current information is also relevant in predicting future volatility at a long horizon.

In summary, the individual autocorrelation coefficients from order 1 to order 12 and the Ljung-Box Q(12) cumulative autocorrelation statistic for the absolute and squared returns series suggest that there is considerable volatility in the two markets. Moreover, the price limits do contribute to the persistence of return volatility (Huang and Yang 2001). However, it is found that both the Shanghai and Shenzhen returns series could be best explained by the GARCH(1,1) model with the mean equations of ARMA(4,4) for Shanghai and ARMA(3,3) for Shenzhen.

Table 4 Estimates of GARCH (1,1) Models for Shanghai and Shenzhen Markets

Sample: From August 2000 to August 2004 (Shanghai Market) - Daily

Sample: From February 2001 to April 2004 (Shenzhen Market) - Daily

Equations 4 and 5

	Shanghai	**Shenzhen**
Parameter		
ARMA		
η	-0.000266	-0.0002
z-statistic	(-1.126)	(-0.681)
θ_3	-	0.48529
z-statistic	-	(-2.537)**
θ_4	-0.714182	-
z-statistic	(2.942)***	-
λ_3	-	-0.461146
	-	(-2.308)**
λ_4	0.725904	-
z-statistic	(2.942)***	-
GARCH		
α	8.83E-06	1.17E-05
z-statistic	(8.026)***	(10.001)***
β_1	0.226424	0.29904
z-statistic	(14.8421)***	(10.495)***
φ_1	0.686001	0.618381
z-statistic	(31.796)***	(24.861)***
Log-likelihood	3510.479	2752.294

□□

*Significant t-statistics at 10%level; ** Significant t-statistics at 5% level; *** Significant t-statistics at1% level

4.3 Volatility Transmission

The estimates of Equations 3.4 and 3.6 show that the coefficient of the lagged error term ξ_1 is significant. This means that shocks to the stock returns in Chinese stock markets are transmitted to the closed-end fund markets, i.e. spill-over effects exist between the two different markets in China. In addition, the results of likelihood-ratio test indicate the goodness of fit of Equations 3.4 and 3.6 for the data set.

The finding here is an extension to the result of Song, Liu and Romilly (1998) who found that volatility transmission existed between Shanghai stock market and Shenzhen stock market. In addition, they identified a causal relationship between the two stock markets in China. The finding of this study confirms the existence of spill-over effects.

Table 5 The Estimates of Equations 4 and 6 for Shanghai and Shenzhen Markets

Sample: From August 2000 to August 2004 (Shanghai Market) – Daily

Sample: From February 2001 to April 2004 (Shenzhen Market) - Daily

	Shanghai	Shenzhen
Parameter		
Equation 4		
η	-0.000141	-0.000255
z-statistic	(-0.5643)	(-0.830062)
θ_3	-	0.483233
z-statistic	-	(2.728)***
θ_4	-0.725127	-
z-statistic	(-2.464)**	-
λ_3	-	-0.4522
	-	(-2.432)**
λ_4	0.734016	-
z-statistic	(2.537)**	-
Equation 6		
α	9.31E-06	9.31E-06
z-statistic	(8.645)***	(7.407)***
β_1	0.234349	0.225139
z-statistic	(8.112)***	(8.319)***
φ_1	0.646591	0.639045
z-statistic	(31.798)***	(26.725)***
ξ_1	0.019727	0.044918
z-statistic	(1.762)*	(3.669)***
Log-likelihood	3217.817	2754.83

Note: ξ in equation 6 measures the spill-over effect between Shanghai stock market and Shanghai closed-end fund market, and Shenzhen stock market and Shenzhen closed-end fund market respectively.

* Significant t-statistics at 10%level; ** Significant t-statistics at 5% level;

*** Significant t-statistics at 1% level

4.4 Investor Sentiment Hypothesis

As discussed in the previous section, investor sentiment hypothesis cannot be applied until several assumptions are met. Within these assumptions, the most important one is also related to the market microstructure affecting market participants in a closed-end fund market. It is required that individual investors who are regarded as noise traders are the major market participants. However, based on the similar study conducted by Gu (2001), the assumption are believed to be nearly met in Chinese closed-end fund markets.

In addition, according to Lee, Shleifer and Thaler (1991), the risk from the unpredictability of future investor sentiment is systematic, and it cannot be diversified. Therefore, two tests on whether the movement of premia of closed-end fund is highly correlated between funds and the changes in premia also move together across funds have been conducted. The correlations are examined by Pearson Product Moment Correlation discussed in the previous Section 3.4.3.

Since there are totally 25 funds listed in Shanghai market, the correlation outputs could be not entirely shown in one page, only the level of the premia of fund Jintai with other twenty-four funds has been showed. The fund Jintai is randomly selected present and other parts of the correlation outputs could be provided if requested. Meanwhile, considering these twenty-five funds were listed at different times and the latest fund was listed on September 2002 in Shanghai market, the period included in this study is weekly data from September 2002 to December 2003. Tables 6 and 7 present the level of the premia of fund Jintai with other funds and the change in the premia of fund Jintai with other funds in Shanghai market.

As presented in Tables 6 and 7, both the levels of premia and the changes in premia show a high level of correlation. The p-values expressed in brackets indicate that most of the correlations are significant at 1% (2-tailed). The average pair-wise correlation of week-end premia for Shanghai closed-end fund market is 0.9246 (Table 6), while the average pair-wise correlation of weekly changes in premia is around 0.516 (Table 7).

Similar results for Shenzhen market are also obtained. Tables 8 and 9 contain the correlation outputs on the level of the premia of fund Kaiyuan with other funds listed in Shenzhen market, and the changes in the premia of fund Kaiyuan with other funds. Again, fund Kaiyuan is randomly selected and the weekly period examined is also from September 2002 to December 2004, because the last fund was launched in Shenzhe market on September 2002.

The results in Shenzhen market are consistent with those in Shanghai market. The average pairwise correlation of week-end premia for Shenzhen closed-end fund market is 0.9235 (Table 8), and the average pairwise correlation of weekly changes in premia is around 0.572 (Table 9).

The findings here are also consistent with prior studies such as Gu (2001) and Lee, Sheiler and Thaler (1991). Although Gu (2001) used different a time period to examine the correlations of levels of and changes in premia across all funds, the findings of Gu (2001) lend support to the fact that premia on different funds are driven by the same investor sentiment.

Since the assumptions of investor sentiment hypothesis are met, and the risk from investor sentiment has been found to exist systematically, investor sentiment hypothesis could explain the disparity of fund prices and net asset value on Chinese closed-end fund market.

Figures 1 and 2 present the whole premia profiles of closed-end funds listed in Shanghai and Shenzhen market separately. The sample period for Shanghai market is from September 1998 to December 2003, while the period of Shenzhen market is from November 1998 to December 2003. The two market level premia are calculated based on fund sized weight. It could be observed that the funds were sold at premia after their IPOs both in Shanghai and Shenzhen market. According to investor sentiment hypothesis, this phenomenon is explained by the overreaction and the over-optimism of individual investors about new financial products in China. However, the premia started dropping down from the beginning of 2000 (the trough in the middle of diagram) when insurance companies in China were permitted to invest in closed-end fund markets (Gu 2001). The investor sentiment hypothesis could also explain this phenomenon. Since insurance companies are institutional investors and regarded as rational investors compared to individual investors, the fall in fund prices were caused by the risk compensations requested from rational investors. In other words, rational investors (i.e. insurance companies) asked for a higher return for the exposure to noise trader sentiment risk.

Although insurance companies started to make investments in closed-end fund markets, the majority of market participants are still individual investors, the value of premia (discounts) fluctuated overtime, reflecting the investor sentiment variation overtime.

Table 6 Correlation of Weekly Premia of Fund Jintai and Other Funds in Shanghai Market

Sample: September 2002 to December 2003

Jintai	Taihe	Anxin	Hangsheng	Yuyang	Jingyang	Xinhua	Anshun	Jinyuan	Jinxing	Anrui	Hanxing	Yuyuan
-	0.978	0.979	0.984	0.946	0.827	0.895	0.958	0.987	0.980	0.987	0.987	0.923
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Jintai	Jingye	Xinghe	Purun	Jingding	Hangding	Xingye	Kexun	Hanbo	Tongqian	Tongde	Kerui	Yinfeng
-	0.979	0.863	0.979	0.989	0.961	0.978	0.949	0.981	0.985	0.971	0.953	0.966
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Table 7 Correlation of Changes in the Weekly Premia of Fund Jintai and Other Funds in Shanghai Market

Sample: September 2002 to December 2003

Jintai	Taihe	Anxin	Hangsheng	Yuyang	Jingyang	Xinhua	Anshun	Jinyuan	Jinxing	Anrui	Hanxing	Yuyuan
-	0.639	0.589	0.718	0.672	0.330	0.544	0.643	0.678	0.645	0.789	0.721	0.469
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.007]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Jintai	Jingye	Xinghe	Purun	Jingding	Hangding	Xingye	Kexun	Hanbo	Tongqian	Tongde	Kerui	Yinfeng
-	0.624	0.572	0.036	0.689	0.519	0.581	0.652	0.580	0.689	0.527	0.618	0.574
p-value	[0.000]	[0.000]	[0.774]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Table 8 Correlation of Weekly Premia of Fund Kaiyuan and Other Funds in Shenzhen Market

Sample: September 2002 to December 2003

Kaiyuan	Puhui	Tongyi	Jinghong	Yulong	Pufeng	Jingbo	Yuhua	Tianyuan	Tongsheng	Hongfei	Jingfu	Tongzhi	Jinsheng	Yuzhe
-	0.986	0.984	0.962	0.964	0.986	0.984	0.966	0.976	0.976	0.919	0.988	0.979	0.977	0.969
p-value	[0.000]	[0.000]]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Kaiyuan	Tianhua	Xingke	Anjiu	Longyuan	Puhua	Kehui	Kexiang	Xingan	Rongxing	Jiufu	Fenghe	Jiujia	Hongyang	Tongbao
-	0.973	0.969	0.963	0.982	0.977	0.969	0.958	0.949	0.941	0.983	0.982	0.976	0.982	0.970
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[.000]	[0.000]	[0.000]	[0.000]

Table 9 Correlation of Changes in the Weekly Premia of Fund Kaiyuan and Other Funds in Shenzhen Market

Sample: September 2002 to December 2003

Kaiyuan	Puhui	Tongyi	Jinghong	Yulong	Pufeng	Jingbo	Yuhua	Tianyuan	Tongsheng	Hongfei	Jingfu	Tongzhi	Jinsheng	Yuzhe
-	0.805	0.803	0.646	0.760	0.844	0.813	0.760	0.813	0.789	0.587	0.788	0.664	0.666	0.760
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

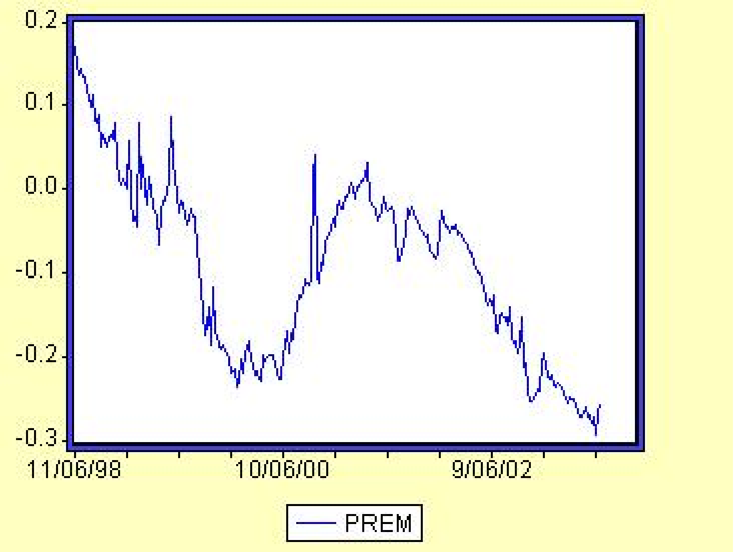
Kaiyuan	Tianhua	Xingke	Anjiu	Longyuan	Puhua	Kehui	Kexiang	Xingan	Rongxing	Jiufu	Fenghe	Jiujia	Hongyang	Tongbao
-	0.786	0.710	-0.584	0.750	0.662	0.761	0.811	0.760	0.687	0.658	0.708	0.802	0.762	0.705
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Figure 1: Premia (Discount) of Closed-end Funds in Shanghai Market

Sample: September 1998 to December 2003 - Weekly

Figure 2: Premia (Discount) of Closed-end Funds in Shenzhen Market

Sample: November 1998 to December 2003 - Weekly



4.5 Price-Net Asset Value Relationship

The last part of this study examines whether premia of closed-end funds exhibit a mean-reverting patter on Chinese closed-end fund markets. Whether the two variables are cointegrated will be examined on individual fund level by using an unrestricted error correction model (UECM).

Table 10 presents the means and standard deviations of the share price returns, net asset value returns and discounts or premia of closed-end funds listed in Shanghai markets. The similar information on those funds listed in Shenzhen market is provided in Table 11. The information is reported at individual fund level, and the time period of each fund is from its listed day to December 2003 using weekly data. As shown in the tables, funds traded in Shanghai market have slightly higher net asset value returns than those in Shenzhen market, while the share price returns (i.e. market return) in Shanghai is relatively lower than in Shenzhen market. For both closed-end fund markets, the standard deviation of net asset value returns is lower than that of the fund share returns. The mean discounts in Shanghai market is smaller than in Shenzhen and the standard deviation is less in Shanghai market as well.

Tables 12 and 13 present the estimates of the UECM model of closed-end funds listed in Shenzhen and Shanghai market separately. Sample periods are different across each UECM regression and the time period of each fund is from its listed day to December 2003 using weekly data. For Shenzhen market, the coefficient estimates of the error-correction term are statistically significant for only five funds, Tongyi, Tongzhi, Kehui, Xingan and Jiufu, indicating most of the premia of other closed-end fund traded in Shenzhen market do not exhibit a mean-reverting tendency. However, since the t-statistics of the error-correction term in the estimated equation of these five funds exceeds the critical value specified by Banerjee, Dolado and Mestre (1998) series, the two variables, i.e. the fund prices and their net asset values of these five funds seem to be cointegrated.

For Shanghai market, the empirical results are different from those in Shenzhen market. As shown in Table 13, the premia of twelve funds have a mean-reverting tendency, because the estimates of error-correction term are significant and passed the cointegration tests further.

Table 10 Summary Statistics for Closed-end Funds Listed in Shanghai Market

	Market Return		NAV Return		Premium/ Discount	
Funds	Mean	S.D.	Mean	S.D.	Mean	S.D.
Jintai	−0.00214	0.034184	−0.00001	0.030125	−0.101371	0.126806
Taihe	−0.000925	0.033168	0.000574	0.03923	−0.117302	0.107835
Anxin	−0.00058	0.0447	0.000265	0.0344	−0.065099	0.116186
Hansheng	−0.001051	0.0331	0.000113	0.0287	−0.14463	0.094551
Yuyang	−0.000585	0.0468	0.000334	0.0363	−0.08441	0.108313
Jingyang	−0.001681	0.0354	0.000296	0.025589	−0.081306	0.129612
Xinghua	0.000359	0.04121	0.000991	0.0335	−0.073902	0.090967
Anshun	−0.00734	0.031	0.00346	0.026	−0.123204	0.111158
Jinyuan	−0.001611	0.0539	−0.000303	0.0206	0.032851	0.153713
Jinxing	−0.001085	0.025264	0.000266	0.0233	−0.154832	0.093167
Anrui	−0.02482	0.0635	−0.00065	0.02385	−0.048876	0.144056
Hanxing	−0.001814	0.0228	−0.000457	0.0228	−0.134598	0.083641
Yuyuan	−0.000203	0.166	0.001786	0.0281	−0.106473	0.157927
Jingye	−0.003681	0.037295	−0.001382	0.0419	0.009311	0.1735
Xinghe	−0.00044	0.0285	0.000578	0.02456	−0.118099	0.095186
Purun	−0.009561	0.0448	−0.000478	0.015	−0.052189	0.156109
Jinding	−0.001547	0.0485	−0.00155	0.0233	0.016638	0.149978
Handing	−0.002179	0.0641	−0.000883	0.0178	0.1781833	0.24832
Xingye	−0.002435	0.0532	−0.000814	0.0225	0.006406	0.17109
Kexun	−0.07562	0.1613	−0.002348	0.048	−0.052136	0.156975
Hanbo	−0.001988	0.042673	−0.000513	0.0188	0.005638	0.145703
tongqian	−0.001979	0.02389	0.000355	0.0166	−0.130621	0.104275
Tongde	−0.001731	0.0672	0.000151	0.0154	−0.029802	0.183423
Kerui	−0.001281	0.021957	0.001462	0.016	−0.164822	0.085322
Yinfeng	−0.001379	0.01997	0.001785	0.0147	−0.162889	0.048467
ALL FUNDS MEAN	-0.0058919	0.14184	0.00012112	0.0741	−0.0679013	0.020541

Table 11 Summary Statistics for Closed-end Funds Listed in Shenzhen Market

	Market Return		NAV Return		Premium/ Discount	
Funds	Mean	S.D.	Mean	S.D.	Mean	S.D.
Kaiyuan	0.001433	0.0378	−0.00018	0.034925	−0.107245	0.112603
Puhui	0.00216	0.0373	0.001425	0.030997	−0.160613	0.096873
Tongyi	0.000667	0.035731	−0.00043	0.031313	−0.139529	0.101938
Jinghong	0.001741	0.037079	0.000629	0.036555	−0.12081	0.097835
Yulong	0.001545	0.035028	0.000431	0.033761	−0.140203	0.100718
Pufeng	0.002038	0.0273	0.000131	0.025014	−0.14204	0.110909
Jingbo	0.006535	0.065208	0.001106	0.024898	−0.08835	0.1514
Yuhua	−0.012978	0.045321	0.001487	0.028	−0.02045	0.08411
Tianyuan	0.000849	0.028038	−0.000671	0.024822	−0.15261	0.101141
tongsheng	0.001241	0.025338	−0.000103	0.022123	−0.15217	0.18581
Hongfei	0.006102	0.038278	−0.000578	0.019129	−0.0678031	0.08112
Jingfu	0.001599	0.02556	-7E+14	0.023632	−0.15217	0.12511
Tongzhi	0.002099	0.045706	-5E+95	0.017512	0.045981	0.11197
Jinsheng	0.003005	0.033778	0.00024	0.020577	−0.00634	0.07912
Yuzhe	0.002311	0.03289	0.000539	0.020908	−0.018999	0.08962
Tianhua	0.004206	0.023507	3.47E−0.5	0.017423	−0.12637	0.1471
Xingke	0.002862	0.03148.	0.000469	0.018581	−0.00156	0.17055
Anjiu	−0.000671	0.071559	−0.003659	0.027757	0.094531	0.18107
Longyuan	0.004132	0.030815	0.000386	0.038112	0.013373	0.082018
Puhua	0.006922	0.035997	0.001406	0.017833	−0.0532	0.17423
Kehui	0.003811	0.029722	−0.001456	0.017719	−0.07192	0.03812
Kexiang	0.003559	0.030583	−0.001498	0.017912	−0.06777	0.083567
Xingan	0.003631	0.027178	−0.000557	0.018357	−0.01764	0.09634
Rongxing	-2.10E-19	0.024218	−0.003327	0.018963	−0.12377	0.01788
Jiufu	−0.006662	0.032579	−0.000321	0.023903	−0.08727	0.18107
Fenghe	−0.002406	0.023213	0.000521	0.017055	−0.17746	0.078954
Jiujia	0.002029	0.023043	−0.001428	0.01788	−0.19719	0.125841
Hongyang	0.003084	0.302394	0.000274	0.018107	−0.15167	0.158974
Tongbao	0.005816	0.036895	0.000372	0.018208	−0.06663	0.14481
ALL FUNDS MEAN	0.0017469	0.037415	-1.724E+94	0.019741	−0.0847551	0.03514

Table 12 Estimates of the Unrestricted Error-Correction Models (Shenzhen Closed-end Fund Market)

$$\text{Equation 9: } \Delta \ln P_t = \sum_{i=1}^{n1} b_0 \Delta \ln P_{t-i} + \sum_{i=0}^{n2} b_1 \Delta \ln NAV_{t-i} + \gamma_1 \ln P_{t-1} + \gamma_2 \ln NAV_{t-1} + \delta + \varepsilon_t$$

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Kaiyuan	0.004262	-0.335403	-0.020166	-0.000456	0.163989	7.949552	1.748893	0.697221
	[0.2011]	[0.0001]***	[0.3696]	[0.9825]				
Puhui	0.000353	-0.278047	-0.026886	0.011016	0.077075	5.175596	4.200945	0.745248
	[0.9459]	[0.0014]***	[0.3612]	[0.695]				
Tongyi	-0.001173	-0.003822	-0.039969	0.023667	0.220269	17.17278	1.319505	2.548976
	[0.7616]	[0.212]	[0.0722]*Φ	[0.276]				
Jinghong	-0.001589	-0.249209	-0.033881	0.022026	0.146061	10.62120	3.382258	1.906646
	[0.6753]	[0.0005]***	[0.1789]	[0.3768]				
Yulong	0.001901	-0.266904	-0.014091	-0.003319	0.183527	13.36288	4.179814	1.120856
	[0.6004]	[0.0002]***	[0.5262]	[0.8787]				
Pufeng	0.003629	-0.189273	-0.001320	-0.018127	0.132316	9.158362	2.134120	0.641322
	[0.2189]	[0.0097]**	[0.9380]	[0.3105]				
Jingbo	0.004967	0.370935	-0.000437	0.000384	0.102730	6.810446	7.855050	7.338827
	[0.4040]	[0.0018]***	[0.9887]	[0.9935]				
Yuhua	-0.998567	2.41E-05	-0.011932	-0.262315	0.550578	55.82245	12.86263	12.85743
	[0.0000]***	[0.9997]	[0.6323]	[0.0000]***				
Tianyuan	-0.003105	0.003045	0.002357	0.018558	-0.005280	0.728181	1.829848	0.469501
	[0.4035]	[0.9685]	[0.9192]	[0.3698]				
tongsheng	-0.000677	0.024451	-0.024374	0.006313	0.217198	14.52625	9.917088	1.891007
	[0.8496]	[0.7062]	[0.2266]	[0.7797]				
Hongfei	0.009282	0.018488	0.036185	-0.034285	0.077488	3.141928	0.053667	2.943751
	[0.0711]*	[0.8598]	[0.2754]	[0.6879]				

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Table 12 Continued

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Jingfu	0.000499	-0.068761	-0.011789	-0.001219	0.270528	18.80101	2.935147	3.569855
	[0.8941]	[0.2973]	[0.5786]	[0.9609]				
Tongzhi	0.000835	-0.195758	-0.049640	0.172841	0.177421	10.54422	4.517694	7.980069
	[0.8118]	[0.0107]**	[0.0126]**Φ	[0.0137]**				
Jinsheng	0.003796	-0.124693	-0.014538	0.033713	0.168545	9.665903	2.507346	5.919413
	[0.1212]	[0.1052]	[0.4295]	[0.3767]				
Yuzhe	0.002194	0.131897	0.008668	-0.051585	0.005577	1.248179	1.633382	1.396857
	[0.3842]	[0.1855]	[0.7008]	[0.2337]				
Tianhua	0.002563	0.000157	0.025969	-0.077925	0.353276	16.97795	6.504014	2.949648
	[0.5138]	[0.9984]	[0.1981]	[0.1921]				
Xingke	0.003752	-0.072202	0.004588	-0.007252	0.364860	25.12713	2.035861	4.461944
	[0.0639]*	[0.2540]	[0.7721]	[0.8639]				
Anjiu	-0.008879	0.251964	-0.066047	-0.000152	0.050741	2.523419	0.692210	6.335418
	[0.6530]	[0.0888]*	[0.1007]	[0.9981]				
Longyuan	0.002972	0.012583	0.004736	-0.012954	0.051615	3.122530	5.236171	1.790783
	[0.4957]	[0.8748]	[0.8070]	[0.7485]				
Puhua	0.008758	-0.020529	0.008018	0.018013	0.306550	13.59885	0.630096	1.918629
	[0.2395]	[0.8176]	[0.8197]	[0.8640]				
Kehui	0.008575	0.062071	0.045879	-0.040051	0.402138	21.85143	6.151593	4.687153
	[0.0009]***	[0.4294]	[0.0185]**Φ	[0.3540]				
Kexiang	0.007729	0.095621	0.039582	-0.140766	0.079088	3.662268	4.677323	3.698487
	[0.0190	[0.4459]	[0.1282]	[0.0039]***				
Xingan	0.003535	-0.020500	0.029248	-0.062999	0.387016	26.09673	1.313706	2.447254
	[0.0800	[0.7524]	[0.0625]*Φ	[0.0944]*				

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Table 12 continued

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Rongxing	-0.006523	-0.114071	-0.162798	0.044174	0.452025	14.19842	2.833232	2.283922
	[0.4586]	[0.3020]	[0.1342]	[0.4574]				
Jiufu	-0.007711	0.046409	-0.041967	0.060580	0.476162	20.08869	0.484351	1.574621
	[0.0286]**	[0.5351]	[0.0455]**Φ	[0.2985]				
Fenghe	-0.007398	-0.034991	-0.033389	0.099228	0.541952	26.43833	5.165601	3.817122
	[0.0604]*	[0.6496]	[0.1056]	[0.0903]*				
Jiujia	0.004722	-0.141715	0.007472	-0.045838	0.452996	14.45727	2.379078	2.816578
	[0.6103]	[0.1583]	[0.8619]	[0.3486]				
Hongyang	0.001199	-0.088331	-0.009881	0.000681	0.450223	21.26821	2.772977	4.068482
	[0.7312]	[0.2491]	[0.7059]	[0.9911]				
Tongbao	0.005445	0.022733	0.009220	-0.017578	0.282756	12.13686	1.296097	18.58711
	[0.2706]	[0.8124]	[0.7463]	[0.8339]				

Φ Passes the cointegration test; p-values are in brackets; * significant t-statistics at 10% level, ** significant t-statistic at 5% level, ***significant t-statistics at 1% level.

Table 13 Estimates of the Unrestricted Error-Correction Models (Shanghai Closed-end Fund Market)

$$\text{Equation 9: } \Delta \ln P_t = \sum_{i=1}^{n1} b_0 \Delta \ln P_{t-i} + \sum_{i=0}^{n2} b_1 \Delta \ln NAV_{t-i} + \gamma_1 \ln P_{t-1} + \gamma_2 \ln NAV_{t-1} + \delta + \varepsilon_t$$

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Jintai	-0.002855	-0.023806	0.013332	0.001892	0.091678	7.409146	0.283533	1.911033
	[0.3135]	[0.6933]	[0.4385]	[0.914]				
Taihe	-0.000495	-0.104146	0.020797	0.011016	0.343284	30.92622	26.29183	13.34916
	[0.8546]	[0.0564]**	[0.2375]	[0.8151]				
Anxin	-0.003801	-0.394350	0.031743	-0.014565	0.292025	27.39868	9.977047	2.040451
	[0.2603]	[0.0000]***	[0.1647]	[0.4786]				
Hansheng	-0.000776	-0.317575	0.015895	-0.002506	0.236356	18.48731	3.571589	1.518850
	[0.8292]	[0.0000]***	[0.445]	[0.9070]				
Yuyang	-0.001171	-0.331132	0.039733	-0.023063	0.162362	13.40534	7.196304	1.096272
	[0.7627]	[0.0000]***	[0.1257]	[0.3762]				
Jingyang	-0.004367	-0.113102	0.038563	0.010936	0.016383	1.757824	0.199022	0.169605
	[0.1677]	[0.1315]	[0.0537]*Φ	[0.5850]				
Xinghua	-0.002409	-0.271896	0.048920	-0.021630	0.301264	28.59390	9.521144	4.308850
	[0.5068]	[0.0000]***	[0.0752]*Φ	[0.3818]				
Anshun	-0.001413	-0.210851	0.030911	-0.006757	0.210998	15.77520	4.482015	3.116395
	[0.6448]	[0.0033]	[0.0963]*Φ	[0.7049]				
Jinyuan	-0.006432	-0.343024	0.058762	-0.079019	0.390773	22.80841	0.841598	12.72465
	[0.2245]	[0.0021]	[0.0312]**Φ	[0.1763]				
Jinxing	-0.000527	-0.057471	0.017562	0.000786	0.239701	16.68479	3.582896	1.567329
	[0.8663]	[0.3600]	[0.3220]	[0.9658]				
Anrui	0.007263	-0.018416	0.140746	-0.357986	0.686253	63.88440	0.779456	30.39405
	[0.1122]	[0.8229]	[0.0053]***Φ	[0.0068]***				

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Table 13 continued

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Hanxing	-0.001073	-0.148233	0.006043	0.005703	0.243350	16.51792	0.877035	2.118839
	[0.7029]	[0.0255]**	[0.7333]	[0.7557]				
Yuyuan	-0.001171	-0.331132	0.039733	-0.023063	0.162362	13.40534	7.196304	1.096272
	[0.7627]	[0.0000]***	[0.1257]	[0.3762]				
Jingye	0.036318	0.024902	0.037916	0.121274	0.009876	1.249372	3.322502	7.133456
	[0.0640]*	[0.8174]	[0.1542]	[0.0709]*				
Xinghe	-0.000149	-0.037600	0.031097	-0.005965	0.498467	54.42137	1.979031	1.894605
	[0.9484]	[0.4762]	[0.0677]*Φ	[0.7015]				
Purun	-0.015846	-0.074428	-0.033459	-0.031658	-0.004047	0.904267	1.115327	1.904724
	[0.1040]	[0.4790]	[0.3392]	[0.7893]				
Jinding	-0.003701	0.066823	0.065215	-0.089959	0.567616	55.80774	2.045364	6.772712
	[0.2620]	[0.3618]	[0.0032]***Φ	[0.0561]*				
Handing	-0.025405	0.088556	0.076205	-0.165733	0.208137	11.84235	3.644272	4.928511
	[0.0873]*	[0.2648]	[0.0153]** Φ	[0.0902]*				
Xingye	0.013323	0.214759	0.063112	0.024403	0.111877	4.779122	7.450013	22.15968
	[0.5207]	[0.0229]**	[0.0288]** Φ	[0.8500]				
Kexun	0.004487	0.194566	0.072189	-0.006672	0.220486	9.839095	13.76330	26.28698
	[0.3745]	[0.1407]	[0.0114]** Φ	[0.9448]				
Hangbo	-0.011354	0.063903	0.098211	-0.206167	0.240949	13.45930	0.266396	8.501262
	[0.0630]	[0.5295]	[0.0034]***Φ	[0.0185]**				
Tongqian	-0.000259	-0.039427	0.007077	0.042603	0.551491	35.42902	2.750050	3.514839
	[0.9175]	[0.5564]	[0.6466]	[0.3014]				
Tongde	0.001500	0.016224	0.070164	-0.041724	0.082480	3.674365	0.826464	8.285818
	[0.8653]	[0.8839]	[0.0488]** Φ	[0.8323]				

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Table 13 continued

Funds	δ	ΔP_{t-1}	P_{t-1}	NAV_{t-1}	Adjusted R^2	F-statistiic	First Order Serial correlation (Godfrey)	Heteroscedasticity (White)
Kerui	-0.002613	-0.085208	0.002869	0.065094	0.593435	33.47682	2.215256	5.935595
	[0.4465]	[0.2389]	[0.8773]	[0.0919]*				
Yinfeng	-0.009477	-0.134380	-0.030255	0.093892	0.419672	12.57063	3.429932	4.475522
	[0.2678]	[0.2272]	[0.5920]	[0.0922]*				

Φ Passes the cointegration test; p-values are in brackets; * significant t-statistics at 10% level, ** significant t-statistic at 5% level,

*** significant t-statistics at 1% level.

Considering there are totally 54 closed-end funds traded in Chinese closed-end fund markets, and only 17 closed-end funds showing an equilibrium relationship between fund prices and net asset value (five funds in Shenzhen and twelve in Shanghai separately), we cannot conclude that there is an equilibrium relationship between fund prices and net asset value in Chinese closed-end fund market.

The findings here differ in comparison to prior studies. However, two reasons could be taken into account for the difference between this study and prior studies. First, the prior studies have been conducted on developed markets especially in American closed-end fund markets, while this study examines the long-run relationship between fund prices and net asset values in an emerging market, i.e. Chinese closed-end fund markets. Therefore, the daily 10 percent fund price limits may also disturb the relationship. Second, the data employed in this study still suffers from its insufficiency. The longest time period examined in this study is only around 60 months and all of these closed-end funds listed both in Shanghai markets and Shenzhen market still have at least 10 years life period before they are liquidated. Therefore, the equilibrium relationship between fund prices and net asset values discovered in other developed closed-end fund market could not be identified in Chinese closed-end fund markets.

5.0 Conclusion

Firstly, tests indicated that there is a positive relationship between absolute price change and trading volume and an asymmetric relationship between price change and trading volume exists both at aggregated closed-end fund markets and individual level. These findings are consistent with the results of Brailsford (1996) in Australia, although the reason for the asymmetric relationship was found to be different.

Secondly, the results found that market volatility could be captured by GARCH (1,1) model with the mean equations of ARMA(4,4) for Shanghai and ARMA(3,3) for Shenzhen.

Thirdly, since the existence of spill-over effects of volatility between stock market and closed-end fund market in China has been captured by a modified GARCH (1,1) model, the empirical findings support the third hypothesis involving volatility transmission.

Fourthly, since the assumptions of investor sentiment hypothesis has been proved to be nearly met in Chinese closed-end fund market and the level of and changes in premia across all closed-end funds have been observed to be highly correlated, investor sentiment hypothesis could be used to explain the closed-end fund puzzle in China.

Finally, the estimates of the UECM model showed that there is no equilibrium relationship between fund price and net asset value. However, since the funds both traded in Shanghai and Shenzhen market still have a long life period before they are liquidated, the findings should be interpreted with caution.

As far as policy implications of this paper are concerned, it has examined the dynamic properties of Chinese closed-end fund markets to throw light on the investment decisions of investors by modeling the price-volume relationship and market volatility. Furthermore, the investigation of closed-end fund puzzle in Chinese closed-end fund markets helps investors, fund managers and stock exchange to understand the market microstructure of closed-end fund market and the impacts of daily price limits on closed-end fund shares. Daily price limits imposed by regulators seem to have some distorting impacts on market prices. Hence, its complete removal or increase to a higher percentage (such as 20 percent) may benefit investors, fund managers and stock market. This seems to be the most important policy implication of this study.

References

Banerjee, A., Dolado, J. J. and Mestre, R. (1998), "Error-Correction Mechanism Tests for Cointegration in a Single-Equation Framework", *Journal of Time Series Analysis,* Vol.19**,** pp.267-283.

Bollerslev, T. (1986), "Generalised Autoregressive Conditional Heteroskedasticity", *Journal of Econometrics,* Vol.31**,** pp.307-327.

Boswijk, P. and Francers, P. H. (1992), "Dynamic Specification and Cointegration", *Oxford Bulletin of Economics and Statistics,* Vol.54**,** pp.369-381.

Boudreaux, K. J. (1973), "Discounts and Premiums on Closed-end Mutual Funds: A Study in Valuation", *Journal of Finance,* Vol.28**,** pp.515.

Brailsford, T. J. (1996), "The empirical relationship between trading volume, returns and volatility." *Accounting and Finance,* Vol.523-543**,** pp.89-106.

Clark, P. K. (1973), "A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices", *Econometrica,* Vol.41**,** pp.135-155.

Davidson, J., Hendry, D. F., Srba, F. and Yeo, S. (1978), "Econometric Modeling of the Aggregate Time-series Relationships between Consumers' Expenditure and Income in the United Kingdom", *Economic Journal,* Vol.88**,** pp.661-692.

Delong, J. B., Shleifer, A., Summers, L. H. and Waldmann, R. J. (1990), "Noise Trader Risk in Financial Markets", *Journal of Political Economy,* Vol.98**,** pp.703-738.

Epps, T. W. (1975), "Security Price Changes and Transaction Volumes: Theory and Evidence", *American Economic Review,* Vol.65**,** pp.586-597.

Epps, T. W. and Epps, M. L. (1976), "The Stochastic Dependence of Security price Changes and Transction Volumes: Implications for the Mixture of Distributions Hypothesis", *Econometrica,* Vol.44**,** pp.305-321.

Ferguson, R. and Leistikow, D. (2004), "Closed-End Fund Discounts and Expected Investment Performance." *Financial Review,* Vol.39**,** pp.179-202.

French, K. R. and Roll, R. (1986), "Stock Return Variances: The Arrival of Information and the Reaction of Traders", *Journal of Financial Studies,* Vol.3**,** pp.593-624.

Gallant, A. R., Rossi, P. E. and Tauchen, G. E. (1992), "Stock Prices and Volume", *Review of Financial Studies,* Vol.5**,** pp.199-242.

Gasbarro, D., Johnson, R. D. and Zumwalt, J. K. (2003), "Evidence on the Mean-Reverting Tendencies of Closed-End Fund Discounts", *Financial Review,* Vol.38**,** pp.273-91.

Gu, J. (2001), *An Empirical Study on Chinese Closed-end Fund Markets,* <http://yjwk.cninfo.com.cn/yjwk/cgpx2.html> (Accessed <04/04/2004 >)

Hall, S. G. (1986), "An Application of Granger and Engle Two-Step Procedure to United Kingdom Aggregate Wage Rate", *Oxford Bulletin of Economics and Statistics,* Vol.48**,** pp.229-239.

Harris, L. (1987), "Transaction Data Tests of the Mixture of Distrubutions Hypothesis", *Journal of Financial and Quantittive Analysis,* Vol.22**,** pp.127-141.

Harris, L. (1989), "A Day-End Transaction Price Anomaly", *Journal of Financial and Quantittive Analysis,* Vol.24**,** pp.29-45.

Hendry, D. H. (1979) In *Economic Modelling: Current Issues and Problems in the U.K. and the U.S.*(Ed, Ormerod, P.) Heineman, London, pp. 217-242.

Huang, B.-N. and Yang, C.-W. (2001), "An Empirical Investigation of Trading Volume and Return Volatility of the Taiwan Stock Market", *Global Finance Journal,* Vol.12**,** pp.55-77.

Ingersoll, J. E. (1976), "A Theoretical and Empirical Investigation of Dual Purpose Funds", *Journal of Financial Economies,* Vol.3**,** pp.83-123.

Jain, P. (1988), "Response of Hourly Stock Prices and Trading Volume to Economic News", *Journal of Business,* Vol.61**,** pp.219-231.

Jain, P. and Joh, G. (1988), "The Dependence between Hourly Prices and Trading Volume", *Journal of Financial and Quantittive Analysis,* Vol.23**,** pp.269-284.

Jennings, R. H., Starks, L. T. and Fellingham, J. C. (1981), "An Equilibrium Model of Asset Trading with Sequential Information Arrival", *Journal of Finance,* Vol.36.

Jones, C. M., Kaul, G. and Lipson, M. L. (1994), "Transactions, Volume and Volatility", *Review of Financial Studies,* Vol.7**,** pp.631-651.

Karpoff, J. M. (1986), " A Theory of Trading Volume", *Journal of Finance,* Vol.41**,** pp.1069-1088.

Karpoff, J. M. (1987), "The Relationship Between Price Changes and Trading Volume: A Survey", *Journal of Financial and Quantitative Analysis,* Vol.22**,** pp.109-126.

Lee, C. F., Chen, G.-m. and Rui, O. M. (2001), "Stock Returns and Volatility on China's Stock Markets", *Journal of Financial Research,* Vol.24**,** pp.523-43.

Lee, C. M., Shleifer, A. and Thaler, R. H. (1991), "Investor Sentiment and the Closed-end Fund Puzzle", *Journal of Finance,* Vol.46**,** pp.75-109.

Ljung, G. M. and Box, G. E. P. (1978), "On a Measure of Lack of Fit in Time Series Models", *Biometrika,* Vol.65**,** pp.297-303.

Lockwood, L. J. and Linn, S. C. (1990), "An Examination of Stock Market Return Volatility during Overnight and Intraday Periods:1964-1989", *Journal of Finance,* Vol.45**,** pp.591-601.

Malkiel, B. G. (1977), "The Valuation of Closed-end Investment-Company Shares." *Journal of Finance,* Vol.32, pp.847.

Nelson, D. B. (1991), "Conditional Heteroskedasticity in Asset Returns: A New Approach", *Econometrica,* Vol.59, pp.347-370.

Noronha, G. M. and Rubin, B. L. (1995) *Journal of Economics and Finance*, Vol. 19, pp. 29-44.

Phillips, P. C. B. and Loretan, M. (1991), "Estimating Long-Run Economic Equilibria", *Review of Economic Studies,* Vol.53, pp.407-436.

Pontiff, J. (1995), "Closed-end Fund Premia and Returns Implications for Financial Market Equilibrium", *Journal of Financial Economics,* Vol.37, pp.341-370.

Roenfeldt, R. L. and Tuttle, D. L. (1973), "An Examination of the Discounts adn Premiums of Closed-end Investment Companies", *Journal of Business Research,* Vol.2, pp.129-140.

Shenzhen Stock Exchange (2003), - Fact Book 2003, <http://www.szse.cn/UpFiles/Attach/10/2003/11/13/ssefactbook2003.pdf> 13/11/2003 (Accessed <01/04/2004 >)

Song, H., Liu, X. and Romilly, P. (1998), "Stock Returns and Volatility: An Empirical Study of Chinese Stock Markets", *International Review of Applied Economics,* Vol.12, pp.129-39.

Su, D. and Fleisher, B. M. (1998), "Risk, Return and Regulation in Chinese Stock Markets", *Journal of Economics and Business,* Vol.50, pp.239-56.

Su, D. and Fleisher, B. M. (1999), "Why Does Return Volatility Differ in Chinese Stock Markets?" *Pacific-Basin Finance Journal,* Vol.7, pp.557-86.

Tauchen, G. E. and Pitts, M. (1983), "The Price Variability-Volume Relationship on Speculative Markets", *Econometrica,* Vol.51, pp.485-505.

Thompson, R. (1978), "The Information content of Discounts and Premiums on Closed-end Fund Shares", *Review of Financial Economics,* Vol.6, pp.151-186.

Weiss, K. (1989), "The Post-offering Price Performance of Closed-end Funds", *financial Management,* Vol.18, pp.57-67.

Woodruff, C. S. and Senchack Jr., A. J. (1988), "Intrdaily Price-Volume Adjustments of NYSE Stocks to Unexpected Earings", *Journal of Finance,* Vol.43, pp.467-491.

Yu, Q. (1996), "A Conditional Variance Model for Daily Stock Returns in China's Emerging Stock Markets: Empirical Evidence on the Shanghai and Shenzhen Exchanges", *Journal of International Financial Markets, Institutions and Money,* Vol.6, pp.1-19.

Zweig, M. E. (1973), "An Investor Expectations Stock Price Predictive Model Using Closed-end Fund Premiums", *Journal of Finance,* Vol.28, pp.67.