Index futures, spot volatility, and liquidity: Evidence from FTSE Xinhua A50 index futures

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Abstract

This paper examines the impact of the introduction of the FTSE Xinhua A50 index futures contract on the volatility and liquidity of its underlying. The results indicate a significant increase in spot volatility and liquidity in the post-futures period. The conditional volatility estimations suggest that the change in volatility is attributed to an increase in the rate of flow of information to the spot market, rather than speculative trading. After controlling for factors that affect liquidity, we find confirmatory evidence on the hypothesis that introduction of futures trading induces migration of uninformed traders from spot market to futures market. Overall, the results have implications for financial regulators and policy-makers regarding the interaction between futures and spot markets, and integration of financial markets.

JEL Codes: G15, G19

Keywords : futures introduction, spot volatility, spot liquidity, volatility persistence, information asymmetry

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1. Introduction

Since the introduction of the S&P 500 index futures contracts, there has been a vast amount of literature examining the impact of stock index futures on its underlying spot market, and it has been one of the most fruitful areas of empirical financial research. The majority of the effort is devoted to explain the relationship between futures trading and spot volatility.[1] On the other side, there is the literature that examines the effect of stock index futures on spot liquidity, and information asymmetry.[2]

The aim of this study is to present recent evidence on the literature regarding the relationship between index futures trading, spot volatility, and liquidity, and the focus of interest will be on the newly introduced FTSE Xinhua A50 index futures. The contributions are expected to be threefold. First of all, although there have been studies on the impact of the introduction of index futures contracts on spot volatility and liquidity separately, this study reconciles these two strands of literature in one single setting. Second, as far as the author knows, this is the second study after Lee and Ohk (1992) that examines the effect of futures introduction in a foreign exchange on the domestic spot market, and third, it uses a unique sample that has not been studied before.

The case of the introduction of index futures covering Chinese stocks is worth investigating, because the Chinese financial markets distinguishes from other developed or emerging markets due to its unique experience with futures trading. The first striking

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[1] See Stoll and Whaley (1987), Edwards (1988a, b), Grossman (1988), Harris (1989), Bechetti and Roberts (1990), Bessembinder and Seguin (1992), Antoniou and Holmes (1995), Pericli and Koutmos (1997), Chang, Cheng and Pinegar (1999), Gulen and Mayhew (2000), and Yang, Balyeat, and Leatham (2005) for the impact of index futures on volatility.

[2] See Gammill and Perold (1989), Gorton and Pennacchi (1991), and Subrahmanyam (1991) for the impact of index futures on information asymmetry, and Jegadeesh and Subrahmanyam (1993) for the impact on liquidity.

difference is the brief experience that China had with futures contracts between 1993 and 1995. But the futures trading had to be halted due to illiquid and speculative trading. It would be worthwhile investigating the determinants and consequences of this brief exposure and compare it with the results obtained here, but unfortunately there is no data available for that period. The second difference comes from the origin of the stock exchange of introduction. It was an international stock exchange, Singapore Stock Exchange, which launched the FTSE Xinhua A50 index futures, covering the 50 major publicly companies traded in mainland China. Thus, examining the impact of an index futures contract that has its underlying in a different country is expected to yield interesting results. The results are expected to shed some light on the interdependence and integration of financial markets. Further, the results of the study are expected to give some preliminary information for Chinese regulators, who are prepared to launch their second stock index futures soon, and other emerging market regulators who plan to launch index futures contracts internationally due to fears of destabilization in domestic markets.

Overall, the results can be summarized as follows. First, using a family of GARCH models and after controlling for the common characteristics that drive the market, we find that there is a significant increase in post-futures spot volatility, which is attributed to the increased speed and quality of information flowing to spot markets. Second, the markets are more efficient in the sense of capturing different effects of recent information and incorporating them in the prices. Furthermore, after controlling for factors that affect liquidity, we find that even if the futures introduction has had a positive impact on spreads, there has been a significant decrease in the average bid-ask spreads in the post-futures period due to an increase in volume, price and volatility. Overall, the results imply an increased trading volume, and more volatile, but more efficient markets. The results have implications for policy-makers regarding the integration of international financial markets, the interaction between futures and spot markets.

The remainder of this article is organized as follows. Section 2 presents the related literature regarding the impact of introduction of index futures on spot volatility and liquidity. Section 3 presents the data and methodology used in the analyses, and Section 4 documents empirical findings. The final section offers concluding remarks.

2. Related Literature

The general approach in the literature up to now has been to examine the effect of futures trading on the volatility and liquidity of its underlying separately. This section follows this general approach, and presents important findings in those two branches of literature.

2.1. Literature on volatility

Although there have been many studies done for the last two decades, today, the literature on the effect of the introduction of index futures on spot volatility is less than conclusive. The evidence, thus far, on the effect of index futures on spot volatility can be summarized as follows: i) the futures index destabilizes the spot markets, and ii) the futures index stabilizes the spot markets.

The destabilization theory argues that the introduction of futures trading increases spot volatility. For example, Harris (1989) documents marginal increases in the variances of S&P 500 stocks after trading in S&P 500 index futures began. Lockwood and Linn (1990) report similar variance increases when index futures began trading in 1982. Brorsen (1991) finds that futures trading tends to reduce autocorrelations and increase the volatility of index stock returns. Lee and Ohk (1992) document that the volatility of stock returns in Australia, Hong Kong, Japan, the U.K., and the U.S. rose significantly, following the introduction of index futures. On the other hand, Antoniou and Holmes (1995), and Antoniou, Holmes, and Priestly (1997) also document increases in spot volatilities after the introduction of index futures, however this increase is attributed to an increase in the rate of flow of information to spot markets.

On the other side Edwards (1988a, b), Grossman (1988), and Bechetti and Roberts (1990) find that S&P 500 index futures have an insignicant impact on cash market volatility. Schwert (1990) maintains that the growth in stock index futures and options trading has not caused increases in volatility. Similar conclusions are reached by Becketti and Roberts (1990), Kamara, Miller and Siegel (1992), Pericli and Koutmos (1997), Galloway and Miller (1997), and Darat, Rahman and Zhong (2002), who document that introduction of stock index futures has either decreased or not significantly increased the volatility in spot markets, confirming the stabilization theory.

2.2 Literature on Liquidity

The literature on the relationship between index futures trading and the liquidity of the underlying also has different conclusions regarding the impact of futures introduction on spot liquidity. For example, Silber (1985) argues that as traders, market makers use index futures in order to hedge their inventory securities, they will be able to decrease the risk and the cost on these securities, and thus propose lower spreads, increasing the liquidity of the underlying stocks. On the other hand, Gammill and Perold (1989), Harris (1990), Gorton and Pennacchi (1993), and Subrahmanyam (1991) suggest that futures markets will attract uninformed traders because the impact of firm-specific information asymmetry is lower in futures markets. As a consequence of this, few uninformed traders will trade in stock markets, thus fixed component cost of market-makers will increase, and therefore market-makers will increase the spreads. Moreover market-makers will have an increased probability of making a transaction with informed traders on the stock markets. This will induce them to increase the spread between bid and ask prices, in order to compensate for the higher risk of trading with informed traders. Furthermore, if the migration of uninformed traders dominates, trading volume in the underlying stocks should decrease, and conversely, if the effect of additional informed trading dominates, it should cause an increase in stocks' trading volume.

Jegadeesh and Subrahmanyam (1993) empirically study the impact of the introduction of the S&P 500 futures contracts on the liquidity of the stocks in the spot index. After controlling for factors constituting the bid-ask spread, they examine the change in the proportional bid-ask spread of the stocks before and after the stock index futures introduction, and document that the average spread of the stocks increases after futures introduction. The authors conclude that index futures trading decreases the liquidity by drawing away uninformed traders from spot markets to futures markets.

The next section presents the data and the methodology for the tests conducted to measure the impact of the introduction of FTSE Xinhua A50 futures on spot volatility and liquidity.

3. Methodology and Data

This article follows methodologies outlined by Antoniou and Holmes (1995) for tests on volatility, and Jegadeesh and Subrahmanyam (1993) for tests on liquidity. The general approach is to examine the spot price volatility and liquidity before the onset of futures trading, and then to compare this with spot price volatility and liquidity post-futures. The next two subsections describe these approaches in detail.

3.1. Methodology on tests of volatility

In analyzing the effect of futures introduction on volatility, the first important task is to control for exterior effects that are not due to futures trading. In other words, one should isolate the influences that are due to other factors (market-wide factors), so that the impact of futures trading can be assessed more directly and precisely. This is extremely important for the Chinese index futures studied here, because the FTSE Xinhua A50 index has quadrupled since the introduction of index futures, and much of this increase is attributed to factors that are unrelated to futures introduction, such as increased interest by foreign and domestic investors. To isolate the effect of these market wide movements on spot volatility, we follow the methodology outlined by Antoniou and Holmes (1995), and include a proxy variable that captures market-wide movements and that is not related with futures contracts.

The next task is to identify the appropriate model to measure volatility. Today, there is a wide literature that documents the existence of serial correlation and heteroskedasticity in stock returns. Furthermore, the literature now agrees that volatility is time varying.[3] In addition, one has to distinguish the relationship between information and volatility. This relation is important, because as asserted by Ross (1989) any change in the rate of information flow will have a direct affect on the volatility of the underlying asset. Thus, a good model should take into account these two aspects, i.e time-variation in volatility and the direct relationship between information and volatility. The natural candidate turns out to be the GARCH family developed by Engle (1982), and extended by Bollerslev (1986), and Engle and Bollerslev (1986).

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model differs from other statistical models by modeling the conditional variance. In GARCH models, the conditional variance depends not only on the squared residuals of the mean equation but also on its own past values. A further advantage of GARCH family models is that they allow for volatility clustering and persistence, which is observed in financial data. Therefore, by using an appropriate GARCH model, while controlling for time-

[3] For a detailed review on the time-series properties of volatility and ARCH models, see Bollerslev, Chou, and Kroner (1992).

varying property of volatility, one can estimate the changes in the information flow, i.e. the impact of recent and old news, on volatility.

The family of GARCH models that forms the basis of our tests for the whole period is represented by:

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t) \tag{1}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} + \gamma DF \tag{2}$$

for the GARCH(p,q) model;

$$R_t^s = a_0 + a_1 R_t^p + a_2 h_t + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t) \tag{3}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} + \gamma DF \tag{4}$$

for the GARCH-M(p,q) specification;

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t) \tag{5}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} + \lambda \varepsilon_{t-1}^2 d_{t-1} + \gamma DF \tag{6}$$

for the TARCH(p,q) specification, and finally;

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t) \tag{7}$$

$$\log(h_t) = \alpha_0 + \sum_{i=1}^{p} \left(\alpha_i |z_{t-i}| + \lambda z_{t-i} \right) + \sum_{j=1}^{q} \beta_j \log(h_{t-j}) + \gamma DF \tag{8}$$

for the EGARCH(p,q) specification.

Equations (1), (3), (5), and (7) represent the conditional mean equations, and (2), (4), (6), and (8) represent the conditional variance equations for each model. R_t^s is the daily change in log prices of the FTSE Xinhua A50 index, and R_t^p is the daily change in log prices of the market proxy variable. h_t is the conditional variance of the error term, ε_t, d_t is a dummy variable where $d_t = \begin{cases} 1 & if\ \varepsilon_t < 0 \\ 0 & o.w. \end{cases}$, and $z_t = \frac{\varepsilon_t}{\sqrt{h_t}}$ is the standardized residual. DF is the dummy variable which takes on values 0 pre-futures, and 1 post-futures. DF is naturally omitted when estimating volatility models in pre-futures and post-futures periods. Modeling conditional volatility in one of the four forms presented above will help us evaluate the following questions:

1. Does the introduction of futures trading have an effect on volatility?

2. If yes, what is the relationship between information and volatility pre- and post-futures?

The answer to the first question lies in the significance of the dummy coefficient, γ. After controlling for market-wide factors captured by R_t^p, if γ turns out to be significant then one can assert that the introduction of futures trading has had an impact on spot market volatility. The answer to the second question will be given by dividing the sample into two sub-samples: pre-futures, and post-futures. By comparing α_1 and β_1, pre-futures and post-futures, it is straigthforward to evaluate the impact of the rate of information flow on volatility.

3.2. Methodology on tests of liquidity

The literature on liquidity identified three factors that constitute the bid-ask spread. These are the information asymmetry, fixed costs, and inventory costs. Benston and Hagerman (1974), and Stoll (1978) have empirically investigated the determinants of the bid-ask spread, and found that a large portion of the variation in bid-ask spread can be explained by differences in price level, return variance, and volume of transactions. The intuition behind why these variables are related to bid-ask spreads is as follows: For a given number of shares traded, a high price for a stock will imply higher dollar volumes, thus decreasing fixed costs, implying lower spreads. Second, a high stock volatility implies higher inventory risk for risk-averse market-makers, and greater potential profits for informed traders, inducing an increase in spreads. Finally, higher trading volume enables the market-maker to offset his inventory balances more flexibly, implying lower spreads.

Therefore, it is necessary to control for changes in these factors before analyzing the impact of futures trading on spot bid-ask spreads. It is also important to note that this part of the analysis deals with individual stocks that constitutes the index, rather the index itself. This is due to the fact that there is no bid-ask data for an index. Taking into account the above pre-identified factors, we apply a log-linear regression model with pooled cross-sectional and time-series data suggested by Jegadeesh and Subrahmanyam (1993), i.e.

$$\begin{aligned} LNSPRD_{it} &= a_0 + a_1 LNPRC_{it} + a_2 LNVOL_{it} + a_3 LNVAR_{it} \\ &\quad + bDF_t + \varepsilon_{it}, \quad i = 1, \ldots, N \text{ and } t = 1, 2. \end{aligned} \tag{3}$$

In the above specification, $LNSPRD_{it}$ is the natural logarithm of the average quoted percentage spread (the quoted spread as the percentage of the price level), and $LNPRC_{it}$, $LNVOL_{it}$, and $LNVAR_{it}$ are the natural logarithms of the average month-end prices, average monthly trading volume, and the monthly return variance, respectively. The number of stocks included in the regression is denoted as N , and $t = 1$ or 2 denotes the pre- and post-futures periods. The dummy variable DF_{it} takes on the value 0 pre-futures, and 1 post-futures. The focus of interest will be on the dummy coefficient, *b*, which indicates how the bid-ask spread has changed after the onset of futures trading, and after accounting for changes in other spread determinants.

3.3. Data

Chinese stock index futures commenced their trading on September 5th 2006. Traded on the Singapore stock exchange, the FTSE Xinhua A50 futures is an index-based contract comprising of fifty major A-share Chinese stocks in terms of market capitalization. The data covers the period 09/01/2005 to 09/03/2007 for a total of 484 trading days, which roughly corresponds to 12 months before and after the introduction.

For tests on volatility, we use the daily log returns $ln(P_t /P_{t-1})$, where $P_{t,}$, and P_{t-1} are the closing levels of the index, at t and $t-1$, respectively . As stated in the previous section, it is important to control for the market-wide factors by incorporating a proxy variable in the mean equation given by (1). This proxy should be able to capture the general trend in the Chinese market, not highly correlated with the FTSE Xinhua A50 index, and not associated with the futures contract. The first proxy that comes to mind is the SSE300 index which includes the 300 biggest companies in terms of market capitalizations in the Shanghai and Shenzen Exchanges, but unfortunately, this index inhibits many of the stocks that are included in the FTSE Xinhua A50 index, therefore not satisfying the third criteria. The case with the FTSE Xinhua 600 index is similar. On the other hand, the FTSE Xinhua Small Cap Index is composed of companies listed on the Shanghai and Shenzhen stock exchanges, which have a too small market capitalization to be listed on the FTSE Xinhua 600 Index. It satisfies the above three criteria, and is therefore chosen as the proxy to control for market-wide factors.[4] All data is downloaded from Datastream, and after excluding non-trading days, we end up with 484 daily return observations (242 pre-futures, and 242 post-futures), which form the basis for tests on volatility.

Regarding the tests on liquidity, the sample consists of stocks that have been included in the FTSE Xinhua A50 index throughout the whole sample period. Applying this criteria results in $N = 28$ stocks that form the basis for the pooled regression equation given by (3). For each stock in the sample, the following data were obtained from Datastream:

- end-of-month closing quotes for bid and ask prices
- daily and monthly closing prices
- daily number of shares traded

The pre-futures (post-futures) spread for a company is then simply the average of the monthly pre-futures (post-futures) bid-ask spreads. Similarly, the pre-futures (post-futures) price level of a stock is given by the average of the monthly pre-futures (post-futures) price levels. The monthly trading volume is the cumulative number of shares traded for that company for that month, and the associated pre-futures (post-futures) trading volume is calculated by the average of the monthly pre-futures (post-futures)

[4] The correlation of the FTSE Xinhua Small Cap returns with FTSE Xinhua A50 returns is 0.71, and it does not contain any stocks included in FTSE Xinhua A50 index.

trading volumes. Finally, the monthly return variance is estimated by using daily log returns and the pre-futures (post-futures) return variance is calculated by the average of the monthly pre-futures (post-futures) return variances.

4. Empirical Findings

4.1 Impact on volatility

Before presenting the results on the impact of futures trading volatility, we first analyze the behavior of daily log returns of FTSE Xinhua A50 index. Second, we focus on the date of the introduction of futures trading, and examine whether there has been a structural change in the returns of FTSE Xinhua A50 index. Finally, we analyze in detail the effect of futures introduction on volatility.

4.1.1 Descriptive statistics

As can be seen from Table 1, the standard deviation of daily returns of the FTSE Xinhua A50 index is higher after the introduction of futures trading. This is a preliminary indication that futures introduction might have led to a higher volatility, but we have to analyze this finding more in detail in order to come up with a statistically meaningful explanation. Furthermore, there has been a significant increase in the mean daily returns, and the sample exhibits negative skewness and leptokurtic behavior. The highly significant Jarque-Bera statistics for all periods studied reject the hypothesis that the returns of daily returns of the FTSE Xinhua A50 index are normally distributed.

<<Insert Table 1 here>>

To further analyze whether the introduction of futures trading created a structural change in the behavior of daily returns of the FTSE Xinhua index, we conduct a cumulative sum plots (CUSUM) test suggested by Taylor (2000). The CUSUM test detects the possible points of change in time series data. The CUSUM plots, S_i , are given by the following equation,

$$S_i = S_{i-1} + \left(X_i - \overline{X}\right) \quad for \quad i = 1,2,\ldots,n$$

where n is the number of observations, $X_1, X_2, \ldots, X_n$ represent daily log returns of the FTSE Xinhua A50 index, $\overline{X}$ is the mean return, and $S_0 = 0$.

The CUSUM plots give us an idea on how the FTSE Xinhua A50 return series behave around its mean. If the CUSUM chart resemble an upward slope during a period this indicates that the returns in that period tend to be above the overall average, and similarly a segment with a downward slope indicates a period of time where the returns tend to be below the overall average. Thus a sudden change in direction of the CUSUM indicates a shift in the value of the time series which tends to be above the average instead of below or below instead of above. Thus, it shows a change of trend's value compared to the overall average.

<< Insert Figure 1 here>>

Figure 1 plots the CUSUM chart with the FTSE Xinhua A50 returns from August 2005 to October 2007. As can be observed from the CUSUM plots, the structure of FTSE Xinhua A50 returns have changed between 14/08/06 and 30/10/06. During this period the FTSE Xinhua A50 stock index futures contracts have been launched on the Singapore Stock Exchange, the 5th September 2006. Thus, the CUSUM plots suggest preliminary evidence that a structural change in return behaviour might have occurred due to the introduction of index futures. In order to be able to confirm whether this change is attributed due to a change in spot volatility induced by the introduction of futures contract, conditional volatility estimations for the whole period and for the pre-futures and post-futures period are conducted.

4.1.2. GARCH estimations

To formally test the effects of the introduction of futures trading on volatility, we first estimate a variety of GARCH(p,q), GARCH-M(p,q), TARCH(p,q), and EGARCH(p,q) specifications equations (with $p = 1, 2, 3, 4, 5$, and $q = 1, 2, 3, 4, 5$) where the conditional mean equations are given by (1), (3), (5), and (7), and conditional variance equations are given by (2), (4), (6), and (8), respectively.

The unreported log-likelihood ratios and F-statistics indicate that GARCH(1,1) model represents the best specification for modeling conditional volatility throughout the sample period. Table 2 reports the estimation results of the GARCH(1,1) model for the whole period, and for pre-futures, and post-futures respectively. To test the effect of futures introduction on volatility for the whole period, the dummy variable DF is introduced into the GARCH(1,1) process. The associated t-statistics and the p-values give us the significance of the estimated coefficients.

<<Insert Table 2 here>>

The first observation is that the dummy variable (γ) for the whole period is positive and significant. The dummy coefficient suggests that the spot volatility has increased due to the introduction of the futures contracts. However, the analysis of the dummy variable does not let us know the exact source of this increase. The literature has identified the increase in the amount of information disseminated, and the speed of information being impounded in prices as two factors that might result in increased volatility after futures introduction.

To find out whether more information is being transmitted to the market due to futures introduction, we compute the unconditional variances between two periods, given by the formula $UV = \alpha_0 / (1 - \alpha_1 - \beta_1)$. The reasoning behind comparing unconditional variances in pre-futures and post-futures periods is as follows. Ross (1989) theoretically develops a no-arbitrage condition that shows the relationship between the rate of information disseminated and the volatility in the market. The condition for no arbitrage implies that the variance of price change will be equal to the rate (or variance) of information flow. The implication of this is that the volatility of the asset price will increase as the rate of information flow increases. If this is not the case, arbitrage opportunities will be available. It follows, therefore, that if futures increase the flow of information, then in the absence of arbitrage opportunities the volatility of the spot price must change. By computing the unconditional variance pre-futures and post-futures, we find UV_{pre} = 0.0000948, and UV_{post} = 0.000492. The five-fold increase in the unconditional variance is consistent with more information being transmitted into the market in the post-futures period.

Next, we examine the source of the increase in the content of information. In other words, we examine whether this increase in the rate of information being transmitted is due to recent news, or old news. The coefficient of the squared error term, α_1, relates to the changes in the spot price only on the previous day, which is attributable to market specific factors. Thus, α_1 gives us information about the speed of incorporation of recent news into prices. On the other hand, the coefficient of the lagged volatility, β_1, relates to the volatility on the previous day, which in turn incorporates information about the older days. Thus, β_1 gives us information about the speed of incorporation of old news into prices.

By comparing the coefficients in Table 2, we observe that $\alpha_{1,post} > \alpha_{1,pre}$, and $\beta_{1,post} < \beta_{1,pre}$. Thus, we conclude that the launch of futures trading increased the speed of recent news, and decreased the speed of old news being incorporated into the prices. The results make sense, because the increase in the flow of information is expected to lead to a decrease in the uncertainty regarding previous news. In addition, a significantly lower β_1 (also called the persistence parameter) indicates that volatility is much less persistent in the post-futures period. The sum of α_1 and β_1 pre-futures is close to unity (0.96), whereas it decreases significantly to 0.57 post-futures, indicating a significant decrease in persistence post-futures.[5]

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[5] Since the sum is close to unity pre-futures, we also performed tests of stationarity to see whether there exists a unit root in the return series especially before futures introduction. The unreported results reject the existence of a unit root both at the pre-futures and post-futures periods.

Furthermore, the statistically insignificant β_1 might indicate that GARCH(1,1) specification might not be the best representation of conditional volatility in the post-futures period. Therefore, we estimate different specifications conditional volatility that might capture the difference in increased volatility and information in the post-futures period. Table 3 presents the comparisons of different conditional volatility models in the post-futures period.

<<Insert Table 3 here>>

Looking at the coefficients, log-likelihood ratios and Akaike and Schwarz information criteria, we conclude that an EGARCH(1,1) is the most parsimonious model that explains post-futures volatility among the four models considered. α_1, and β_1 are statistically significant, the model selection criteria are the lowest. Furthermore, what is striking is that, γ, the coefficient for the standardized residual is also statistically significant and negative. This indicates the existence of the leverage effect in FTSE Xinhua A50 returns during the post futures period. In other words, in the post-futures period we observe not only the effect of increased dissemination of recent news being impounded into prices, but also the asymmetric effect of news in the conditional volatility. The EGARCH(1,1) model captures not only the effect of increased rate of news dissemination on the FTSE Xinhua A50 returns volatility, but also differentiates the asymmetric effect between good news and bad news. A statistically significant and negative coefficient indicates that bad news (associated with negative standardized residuals) have a much higher impact on volatility than good news.[6]

Overall, our findings on the effect of futures introduction on FTSE Xinhua A50 return volatility can be summarized as follows. The positive and significant dummy coefficient indicates that FTSE Xinhua return volatility significantly increased after the introduction of futures trading. GARCH(1,1) is found to be the best specification to model conditional volatility for the whole sample period. Furthermore, a detailed comparison of α_1, and β_1 pre-futures, and post-futures suggests that introduction of futures trading on the Chinese markets improved the quality and speed of the information being impounded in the prices. The results also indicate less persistent volatility post-futures. Finally, we find that EGARCH(1,1) is the best specification to model post-futures volatility, which captures the asymmetric relationship between news and volatility. The results imply that although the introduction of futures has an increasing effect on volatility, futures trading can be used as a tool to develop the efficiency of Chinese financial markets by increasing the quality and the flow of the information into the spot market, and by better differentiating the effect of different news (good and bad) on the market.

Finally, to check the robustness of the above results, we also performed several analyses considering the impact of the introduction of FTSE Xinhua A50 index futures on the more general Shanghai and Shenzhen 300 (SSE300) index, and further by using

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[6] This is in line with the phenomenon that increased market volatility coincides with downward market moves, reported by French, Schwert, and Stambaugh (1987), and Glosten, Jagannathan, and Runkle (1993). Engle and Ng (1993) also show that volatility is more associated with downward market moves due to the leverage effect.

the EGARCH methodology. The results are similar to the ones drawn here.[7] Overall, the findings suggest that the underlying Chinese spot market is more volatile, but less persistent in the post-futures period. This increase in volatility is viewed as a result of increase in the flow of information to the spot market, rejecting the destabilization theory.

4.2. Impact on liquidity

This section presents the results for the tests regarding the impact of the introduction of FTSE Xinhua A50 index futures on liquidity. The measure of liquidity is the average percentage bid-ask spread of the stocks, which were included in the index throughout the whole sample period. We follow the methodology outlined in the previous section.

4.2.1 Tests on liquidity

As discussed previously, the literature has identified three determinants of the bid-ask spread: information asymmetry, fixed costs, and inventory costs. Furthermore, empirical studies show that that a large portion of the variation in bid-ask spread can be explained by differences in price level, return variance, and volume of transactions. Thus, it is important to see changes in these parameters before examining the effect of introduction of futures trading on liquidity formally. Table 4 presents the changes in the

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[7] The results are available upon request.

average quoted spreads, average end-of-month price, average trading volume, and average estimated variance, between pre-futures and the post-futures periods.

<<Insert Table 4 here>>

As can be seen from the table, the results indicate a forty three percent decrease in the average quoted percentage spreads from 1.08% to 0.62%, after the introduction of futures contracts. Furthermore, there have been significant increases in the average end-of-month prices, average trading volumes, and average estimated variances. According to theory, the increase in volume should lead to a decrease in fixed costs and the inventory-holding costs for the market-makers, implying to a decrease in the spreads. The increase in prices is also expected to decrease the fixed cost component for the market makers. However the significant increase in return variance implies more risk for the market-makers holding the inventory securities, and thus they are expected to increase the spreads due to a rise in volatility.

Although the decrease in average spreads is large and significant, it is premature to draw conclusions on the effect of the introduction of futures contracts on the spread. The decrease in the bid-ask spread might be due to changes in the three factors outlined in the literature, or the introduction of futures trading, or both. Thus, to explore the effect of futures trading on bid-ask spreads we control for the above-mentioned variables and perform a log-linear regression model with pooled cross sectional time series data as shown in the methodology part. The results are presented in Table 5.

<<Insert Table 5 here>>

As can be seen from Table 5, all the coefficients are statistically significant. The three variables outlined in the literature have a negative impact on the logarithm of the average quoted percentage spread of the price level. The volume and the price are in line with the literature, which suggests a negative relation between spreads and prices or volume. The negative coefficient of the volatility factor does not follow the results of Stoll (1978), and Jegadeesh and Subrahmanyam (1993). Their theory predicts that a higher volatility will imply more inventory risk for market-makers inducing increase in spreads. However, on the other hand, Admati and Pfleiderer (1988) suggest a negative relationship between liquidity and volatility. They argue that disguise of information traders among liquidity traders lead to a negative relationship between liquidity and volatility variables. Our results are in line with theirs, and might indicate that there exist informed traders who trade at times of high liquidity in order to disguise the information content of their trades. This might in turn be a factor that draws away uninformed traders from the market.

Regarding the effect of futures trading, the positive dummy coefficient indicates that the introduction of the FTSE Xinhua A50 futures contract has had a negative effect on the liquidity of the 28 stocks in the sample. This might at first sight seem contradictory to the significant decrease at the spreads. However, the significant decrease in spreads is probably due to the fact that there have been five-fold increases in prices, and two-fold increases in volatility and trading volume post-futures. Therefore although the introduction of futures contracts had a reducing effect on the liquidity of the constituents of the index, the effects of these factors are more pronounced and dominate the negative effect of futures introduction on liquidity.

The difference in average spreads in the pre- and post-futures period is economically significant as well. The estimate from the pooled regression indicate that the proportional spread has increased by more than 80% due to the introduction of futures markets. So, keeping all the other factors fixed, the cost of purchasing 1,000 shares of stock for $10 that had a proportional spread of 1% in the pre-futures period would increase by $81.56, which is a significant amount given the dollar size of the trade.

In short, theories predict a widening or a narrowing of the spread due to futures' introduction. The positive dummy coefficient we find means that the spread has increased due to futures trading confirming the move-away of uninformed traders from the spot market. This follow the conclusions of Gammill and Perold (1989), Harris (1990), Gorton and Pennacchi (1993), and Subrahmanyam(1991) who suggest that market markers will have an increased probability of making a transaction with informed traders on the stock markets. This will induce an increasing effect on the bid and ask spread, in order to compensate this higher risk. The results do not confirm the theory of Silber (1995) who predicts a decrease in spread due to the possibility for the market makers to hedge their inventory portfolio with the introduction of futures which give them low-cost market opportunity.

5. Conclusion

There have been many studies done in the literature investigating the effect of futures introduction on spot volatility and liquidity, however the results are less than conclusive. This article adds to the literature in two dimensions: i) by examining a previously unstudied futures contract, the FTSE Xinhua A50 index futures, and ii) by examining the effect of an internationally traded futures contract on the volatility and liquidity of its domestic underlying.

The results indicate that volatility of the FTSE Xinhua A50 index has increased significantly after the introduction of stock index futures by the Singapore Stock Exchange. Further analyses imply that this increase is due to the fact that more information is impounded to prices after the introduction of futures trading. Moreover, the speed and the nature of information also differ between pre-futures and post-futures periods. More specifically, recent news is impounded more rapidly into prices post-futures, and post-futures market is more efficient in the sense that it can differentiate good news from bad news, a phenomenon not observed pre-futures. Furthermore, the incorporation of old news has significantly reduced in the post-futures period, indicating that the market is less persistent to changes in volatility.

Regarding liquidity, although the average quoted percentage spreads have decreased post-futures, after controlling for the effects of price, volume and volatility, we find evidence that futures introduction has a negative effect on the liquidity of its underlying. The results support the theory that introduction of futures trading draw away uninformed traders from stock markets.

Overall, the introduction of FTSE A50 futures contracts implies a more volatile, but less persistent, more efficient, and less liquid spot markets. The findings presented in this article might be interesting for regulators and policy-makers who plan to launch the trading of stock index futures domestically or internationally.

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Table 1

Summary statistics for the FTSE Xinhua A50 index

Period	n	Mean	Std. Dev.	Skewness	Kurtosis	JB
Whole period	484	0.15	0.76	-0.77	7.09	384.89^{***}
Pre-futures	242	0.04	0.51	-0.15	4.41	20.97^{***}
Post-futures	242	0.25	0.94	-1.03	6.14	142.25^{***}

Note: This tables reports the mean, standard deviation, skewness, and kurtosis of the daily log returns of the FTSE Xinhua A50 index. Mean and standard deviation of returns are reported in percentages. JB is the Jarque-Bera test statistic for normality, and *** denotes the 1% significance level for rejection of normality. The whole period is from 09/01/2005 to 09/03/2007, pre-futures period is from 09/01/2005 to 09/04/2006, and post futures from 09/05/2006 to 09/03/2007. After excluding bank holidays and non-trading days, we end up with 484 days of data for the whole period, 242 for the pre-futures, and 242 days of data for the post-futures period.

Table 2

GARCH(1,1) estimations

Period	n	a_0	a_1	α_0	α_1	β_1	γ
Whole	484	0.34	0.56	0.50	0.12	0.81	3.43
		(2.28*)	(18.87***)	(1.73*)	(3.27***)	(13.88***)	(1.98**)
Pre-futures	242	0.14	0.57	0.41	0.14	0.82	-
		(0.94)	(23.48***)	(0.95)	(2.53**)	(9.18***)	
Post-futures	242	1.60	0.55	2.12	0.29	0.28	-
		(3.62***)	(8.41***)	(2.29**)	(2.15**)	(1.24)	

Note: The GARCH(1,1) specifications are given by

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma DF$$

for the whole period, and

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$$

for the sub-periods. R_t^s is the daily change in log prices of the FTSE Xinhua A50, R_t^p is the daily change in log prices of the FTSE Xinhua SmallCap index, and DF is a dummy variable that takes on values 0 pre-futures, and 1 post-futures. The coefficient a_0 is multiplied by 10^3, and the coefficients α_0, and γ are multiplied by 10^6 for expository purposes. The numbers in the parantheses are the t-statistics, and ***, **, * denote the 1%, 5%, and 10% significance levels, respectively. All the estimations are adjusted for Bollerslev-Woolridge robust standard errors and covariance.

Table 3

Comparison of conditional volatility models in the post-futures period

Model	a_0	a_1	a_2	α_0	α_1	β_1	γ	$-2LL$	AIC	SC
GARCH(1,1)	1.60	0.55		2.12	0.29	0.28		870.55	-7.15	-7.08
	(3.62***)	(8.41***)		(2.29**)	(2.15**)	(1.24)				
GARCH-M(1 ,1)	2.10	0.56	-0.08	2.27	0.29	0.25		870.09	-7.14	-7.05
	(0.92)	(8.55***)	(-0.21)	(2.04**)	(2.16**)	(0.94)				
TARCH(1,1)	1.41	0.54		2.48	0.06	0.18	0.49	874.65	-7.18	-7.09
	(3.35***)	(10.17***)		(3.22***)	(0.92)	(1.05)	(2.05**)			
EGARCH(1 ,1)	1.34	0.54		-5.52	0.46	0.49	-0.22	874.78	-7.18	-7.10
	(3.16***)	(10.16***)		(-3.38***)	(3.00***)	(3.00***)	(-2.18**)			

Note: The GARCH(1,1) specification is given by

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1},$$

the GARCH-M(1,1) specification is given by

$$R_t^s = a_0 + a_1 R_t^p + a_2 h_t + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1},$$

the TARCH(1,1) specification is given by

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma \varepsilon_{t-1}^2 d_{t-1},$$

and the EGARCH(1,1) specification is given by

$$R_t^s = a_0 + a_1 R_t^p + \varepsilon_t, \qquad \varepsilon_t | \psi_{t-1} \sim N(0, h_t)$$

$$\log(h_t) = \alpha_0 + \alpha_1 |z_{t-1}| + \beta_1 \log(h_{t-1}) + \gamma z_{t-1}.$$

R_t^s is the daily change in log prices of the FTSE Xinhua A50, and R_t^p is the daily change in log prices of the FTSE Xinhua SmallCap index. h_t is the conditional volatility, d_t is a dummy variable where $d_t = \begin{cases} 1 & if\ \varepsilon_t < 0 \\ 0 & o.w. \end{cases}$, and $z_t = \frac{\varepsilon_t}{\sqrt{h_t}}$ is the standardized residual. The coefficient a_0 is multiplied by 10^3 for expository purposes. Log-likelihood (LL) denotes the logarithm of the likelihood (probability) that the observed values of the dependent may be predicted from the observed values of the independents, and calculated by using maximum likelihood estimation (MLE), and AIC, and SC denote Akaike information criterion and Schwarz criterion, respectively. The numbers in parantheses are the t-statistics, and ***, **, * denote the 1%, 5%, and 10% significance levels, respectively. All the estimations are adjusted for Bollerslev-Woolridge robust standard errors and covariance.

Table 4

Average percentage spreads, average month-end price, average monthly variance, and average monthly trading volume (millions of shares) in pre-futures and the post-futures periods.

	FTSE Xinhua A50 (*N=28*)
Mean Percentage Spreads	
- Before futures	1.08
- After futures	0.62
- t-Statistic	-2,31**
Average month end closing price	
- Before futures	290.77
- After futures	960.49
- t-statistic	8,22***
Average monthly variance	
- Before futures	0.06
- After futures	0.12
- t-statistic	2,64**
Average monthly volume	
- Before futures	510.93
- After futures	1138.77
- t-statistic	2,34**

Note: This table reports the average percentage spreads, average month-end price, average monthly variance, and average monthly trading volume (millions of shares traded) in the pre-futures and the post-futures periods. The sample consists of *N=28* stocks that have been included in the index throughout the sample period studied. The t-statistic tests for the equality of means pre- and post-futures, and ***, **, * denote the 1%, 5%, and 10% significance levels, respectively.

Table 5. Estimates of the pooled cross-sectional time-series regression

Variable	Coefficient	t-statistic
Intercept	-3.96	-2.63**
LNPRC	-0.89	-10.99***
LNVOL	-0.32	-4.12***
LNVAR	-0.40	-2.01**
DUMMY	0.82	3.56***

Note: The model estimated is represented as:

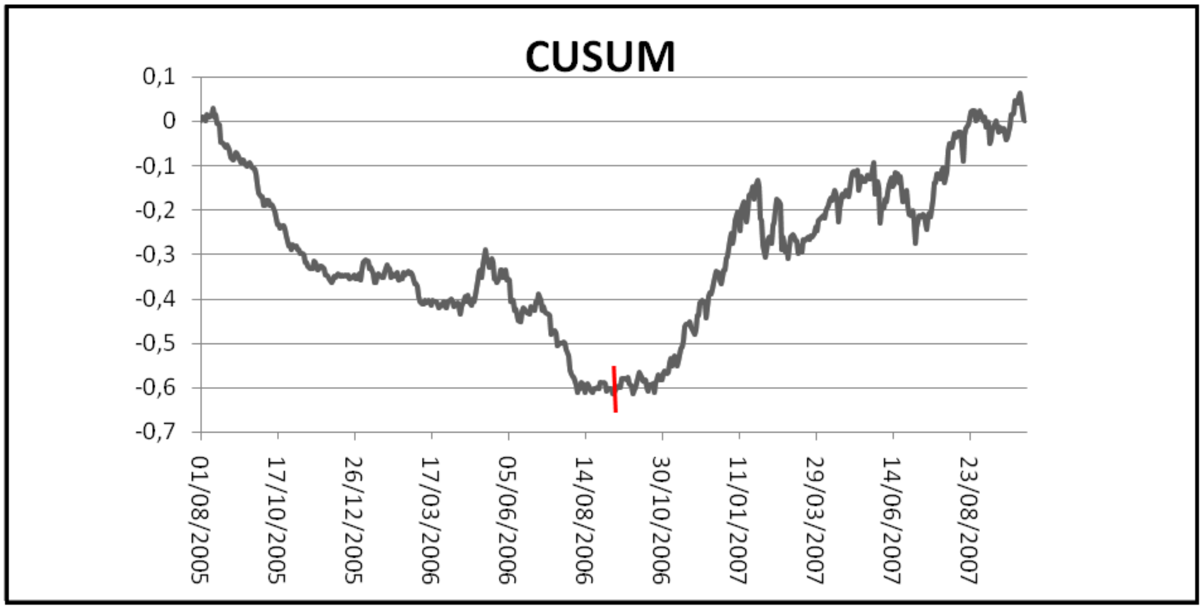
$$LNSPRD_{it} = a_0 + a_1 LNPRC_{it} + a_2 LNVOL_{it} + a_3 LNVAR_{it} + bDF_t + \varepsilon_{it},$$

$$i = 1, \ldots, N \ and \ t = 1, 2.$$

where $LNSPRD_{it}$ is the natural logarithm of the average quoted percentage spread (the quoted spread as the percentage of the price level), and $LNPRC_{it}$, $LNVOL_{it}$, and $LNVAR_{it}$ are the natural logarithms of the average month-end prices, average monthly trading volume, and the monthly return variance, respectively. The number of stocks included in the regression is denoted by N, and *t = 1* or *2* denotes the pre- and post-futures periods. The dummy variable DF_{it} takes on the value 0 pre-futures, and 1 post-futures. ***, **, * denote the 1%, 5%, and 10% significance levels, respectively. All t-values are corrected for autocorrelation (with lag = 3) and heteroskedasticity as suggested by Newey and West (1987).

Figure 1

The CUSUM plot for the log returns of the FTSE Xinhua A50 index



Note: This chart plots the cumulative sums for the log returns of the FTSE Xinhua A50 index for the period 08/01/2005 to 10/19/2007, given by the equation $S_i = S_{i-1} + \left(X_i - \overline{X}\right), \quad i = 1,2,\ldots,n$ where, X_1, X_2,, …represent consecutive observations of the returns, $\overline{X}$ is the mean return, $S_0 = 0$, and $n = 538$. The red line indicates the introduction date of the FTSE Xinhua A50 index futures.