1. Introduction

This research paper aims to study the impact of exchange traded funds (ETFs) on the volatility of its underlying constituent stocks in Korea and Hong Kong stock markets. Four exchange traded funds are studied in this research, i.e., KODEX200, KOSEF200, TRACKER FUND and HSI ETF.

One of the most successful financial innovations in the past twenty years is the advent of the Exchange Traded Fund (ETF). This kind of basket securities is structured to track the performance of the broad-base stock index. Unlike the traditional mutual fund, the ETFs can be traded like ordinary stocks in the stock exchange. Also, short selling is allowed for ETF trading. Accordingly, ETF provides investors very flexible way to access the diversification opportunities. Consequently, the introduction of ETF was accompanied by the spectacular growth in both trading volume and the number of ETFs listed in the stock markets.

As the financial markets have evolved and released new financial products over time, the study about the impact that the new financial product have on related market and securities are necessarily important for both academics and regulators. At the present, many academic papers are devoted to study about the impact of introduction of ETF. Those research papers try to answer the question: How the ETF affect the market liquidity of underlying securities? What impact the introduction of ETF has on the efficiency of derivatives markets? What is the lead financial instrument in the price discovery process after the advent of ETF. However, a few academic papers were conducted to investigate whether the advent of ETF affects the volatility of its underlying stocks.

The main purpose of this research paper is to determine whether the establishment of ETFs in Korea and Hong Kong stock markets contributed to significant changes in volatility of the underlying component stocks. Two main possible situations could rise after the advent of ETF. First, the arbitrage activities by the participating dealers (authorized participants), market makers
and also ETF investors through the in-kind redemption and creation process\(^1\) can occur. Also, the arbitrage activities by index derivative investors will be facilitated by ETF listing. Second, the investors in the ETF could be investors who migrate from the pre-existing index markets (underlying market). Therefore, the mixture between less-informed/index-based trading and informed trading in the underlying equity market might change. The interesting question is whether arbitrage activities and migration of less-informed traders can cause the change in volatility of underlying constituents.

To the best of my knowledge, at the present, my research paper is one of a few academic papers that study the impact ETF trading on the volatility of underlying stocks. My study contributes several interesting empirical evidences to regulators, issuers of ETFs, investors and academics. First, as the attempt of stock exchange regulator in many countries to continuously launch the innovative financial products and the issuers (sponsors) to sell their financial products in the stock market, it is very important to know the impact or feedback of listing those financial innovations in the stock market. The results of this study can show whether the advent of ETF stabilizes the underlying market. Second, the investors can use the result of this study to help them to make the investment decision because the listing of ETF might change the risk of holding components. Lastly, this study can give some idea to the academics that might want to create the new models or theory to explain the impact of ETF on volatility of underlying constituents.

After controlling for change in volatility of the non-index stock sample, the results show significant reduction in volatility after the creation of KODEX200, KOSEF200 for the case of Koreas, but the results are quite not robust. Moreover, the results indicate that Hang Seng Index ETF, the second ETF in Hong Kong, lead to the significant decrease in underlying constituents of Hang Seng index. It is further noted that no significant change in volatility of underlying

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\(^1\) In-kind creation is the process of creating new shares of ETF, authorized participants can create the new unit of ETF by delivering the underlying constituents (plus some cash) to issuer, and then the issuer will return the created new ETF shares to authorized participants. In-kind redemption is the process of redeeming the existing shares of ETF, the process is just the reverse of in-kind creation. The in-kind creation and redemption process can be done only between the authorized participants and ETF issuer.
components after the introduction of Tracker fund of Hong Kong (TraHK). In sum, the result in this study tends to support that arbitrage effect serve to stabilize the underlying constituents in the stock market.

The remainder of paper is organized as follows. Section 2 provides the literature review. Section 3 presents the market background and data description. Section 4 describes the methodology. Section 5 and 6 provide the empirical result and the conclusion, respectively.

2. Literature reviews

There are two main possible effects following the onset of ETF that might impact the volatility of underlying stock index. First, the establishment of ETF contributes to the higher intensity of the index arbitrage activities. This can induce the improvement in liquidity and eventually affect the volatility of underlying market. Second, the investors in the ETF could be investors who migrate from the pre-existing index markets (underlying market). Therefore, the mixture between uninformed and informed traders in the underlying stock market can structurally change. This will raise the issue about asymmetric information in underlying market. Finally this will lead to change in volatility in cash market. For better understanding, it is more appropriate to review the literatures about arbitrage effect and asymmetric information effect separately.

2.1 Impact of index arbitrage

As the ETF intensifies index arbitrage activities of underlying index, we should expect the increase in trading volume of derivative market and improvement in pricing efficiency between index futures and spot prices. *Hedge and McDermott (2004)* examine the market liquidity of DJIA and trading activities in DJIA index futures before and after the introduction of ETF by using 50-day event window. They significant increase in trading volume and open interest of DJIA and NasDaq100 index futures. According to the derivative pricing theory, the arbitrage
activities will constrain the price of the financial derivative so that the prices of these financial instruments will fluctuate tightly around their theoretical value, and then improve the pricing efficiency of financial derivatives. Furthermore, many academic researches, Park & Switzer (1995), Switzer, Varson and Zghidi (2000), Kurov & Lasser (2002), support that the advent of ETF appears to enhance inter-market efficiency between index futures market and underlying market.

From theoretical perspective, Fremault (1991) constructs the theoretical model to study about the impact of index arbitrage by assuming the partially integrated of financial markets, she find that the introduction of a basket instrument removes some of the barriers that once limited the arbitrageurs from making profitable portfolios. Arbitrage activity and competition among informed traders will increase, and then results in the higher liquidity in the underlying cash market. Importantly, she finds that index arbitrage reduces the informational asymmetry across markets and within the underlying market, and the arbitrageurs serve a stabilizing function in the underlying market. Consequently, due to the higher liquidity and the decrease in asymmetric information in the underlying constituent stocks, the ETF listing should contribute to the lower volatility in the underlying constituent stocks.

2.1 Impact of migration of less-informed traders

Generally, traders who know more about values and traders who know more about what other trader intend to do have a great advantage over those who do not. Well-informed traders profit at the expense of less-informed traders. Less-informed traders therefore try to avoid well-informed traders because trading with the informed traders has the cost called “the adverse selection cost”. If possible, the less-informed investor therefore will migrate from the market that has well-informed traders. Less-informed investors view the exchange traded fund as the lower cost, more diversification and lower adverse selection cost. The reasonable result is that some less-informed traders will want to move their money from the underlying market to the ETF.
Subrahmanyam (1991) presents an information-based model specific to “basket trading”. He demonstrates that the basket security market most probably serves as the lowest-cost market for the index. Adverse selection costs are relatively lower on the market for the basket in which the firm-specific information is diversified. Also, in Gorton and Pennacchi’s (1993) model, there are two types of investor, liquidity (uninformed) and informed traders. Their model indicates that liquidity trader prefer the basket instrument because it enables them to build the portfolios at a lower cost and the presence of insiders in underlying market reduce the expected utility of liquidity traders. This results in the migration of liquidity traders to the basket market. As the proportion of uninformed traders in the underlying market decrease, informed traders are less subject to the detection of uninformed traders. The informed traders therefore tend to use the larger size trade (less-camouflage). The larger size trade in underlying securities will have higher adverse selection risk. This will cause the price in underlying securities become more sensitive to the trade quantities, the adverse selection risk will increase, and then lead to higher price volatility.

Wang (1993) presents the model of asset pricing under asymmetric information. He find that informational asymmetry among investors in the stock market can lead to higher volatility. When information is asymmetric, better informed investors have the better information compared to the less-informed or uninformed investors. The less-formed investors, therefore, encounter with adverse selection risk. They require higher risk premium to compensate the higher risk when they trade against the better informed trader. Finally, this will lead to increase in the price volatility of the stocks.

2.3 Empirical studies on volatility impact of ETF

Given the conflict predictions of theoretical model, the volatility of underlying stock market can either increase or decrease depending on the net impact between index arbitrage effect and less-informed trader migration effect. Thus, the net effect the ETF listing on the volatility
underlying stock market should be settled by empirical issue. There are only a few papers that study the impact of ETF inception on the volatility of underlying securities. Richie and Madura (2007) examine the impact of QQQ\(^2\) creation on the risk of the underlying stocks. They estimated two-factor market model and use the return of CRSP value-weighted index as the proxy for the market return. In their model, the dummy variable used to capture the post ETF inception event shows the negative and statistically significant coefficient. It indicates that the systematic risk of the underlying stocks decrease when compare with the control sample. Ching-Lin and Chiang (2005) investigate the impact of Taiwan Top 50 Tracker Fund\(^3\) on the change in volatility of the component stocks of the Taiwan 50 Index. In their study, they find that the establishment of Taiwan Top 50 Tracker has increased the volatility of the component stock of Taiwan 50 Index. Furthermore, their result appears to show that the volatility effect of TTT may differ according to the market size and sector the size and sector of the underlying companies. Specifically, their empirical study demonstrates that the volatility effects of TTT do not affect the companies that have different market capitalization differently, and there was weak evidence that the volatility of the electronic and the financial sectors increase more than those of companies in the mixed sector. However, their study did not give any idea about why the volatility of constituents stocks change after the introduction of TTT and did not compare the result with any control sample.

3. Market background and data description

3.1 Market background

Korea Exchange

Korea Stock Exchange was established in 1956 with only 12 listed companies. Initially, the major trading volume was dominated by bond trading. Nevertheless, Korea stock market grew rapidly due to the government action aimed to develop the capital market. In the 2004, the Korea

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\(^2\) The ETF that tracks the performance of NASDAQ-100 Index

\(^3\) The ETF that tracks the performance of Taiwan Top 50
Stock Exchange merged with Korea Futures Exchange and KOSDAQ. Through the merger, the
Korea stock exchange became Korea Exchange (KRX). Korea Exchange now has 3 main
operations. These are stock market division, KOSDAQ division and derivative market division.
As of December 2008, the Korea Exchange had 763 listed companies with market capitalization
of $580 billion. The normal trading sessions start from 09:00am to 03:00pm on all days of the
week except Saturdays, Sundays and holidays declared by the Exchange in advance. The KRX is
an order-driven market where bid and offer orders compete for the best price. Throughout the
regular trading session, customer orders are continuously matched at a price satisfying both
parties, according to price priority and time priority. For trading activities, Korean market is
largely dominated by retail investors. Retail investors account for 60-70% of trading activity in
the stock market.

Hong Kong Stock Exchange

Initially, The Association of Brokers was founded in 1891. Later, the Association of
brokers was renamed to the Hong Kong Stock Exchange in 1914. In 2000, the merger among
Hong Kong stock exchange, Hong Kong Futures Exchange Limited and Hong Kong Securities
Clearing Company Limited was complete. Under the merger, Hong Kong Exchanges and Clearing
became the single holding company of Hong Kong Stock Exchange. By the end of 2008, 1,087
companies were listed on the Main Board with a combined market capitalization of HK$10.3
trillion. For the trading system, similar to the Korea Exchange, Hong Kong stock exchange is an
order-driven system where orders are continuously executed according to price and time
priority. The normal trading session is divided into two starts from 10:00 to 12:30 and from 14:30
to 16:00. For the market participants, Hong Kong stock market is mostly dominated institutional
investors. Institutional investors have increasingly played the important role as they contribute
65% of trading activity in 2007.
3.2 ETF background

KODEX200 & KOSEF200

The first two exchange traded funds in Korea – KODEX200 and KOSEF200\(^4\) – were simultaneously introduced on Oct 14, 2002. KODEX200 was launched by Samsung Investment Trust Management, while KOSEF200 was produced by Woori CS Asset Management Company. The objective of both ETFs is to track as closely as possible the performance of KOSPI200. Between the two, KODEX200 seems to be the more important in term of asset under management and volume. As of February 2009, the asset under management of KODEX200 was approximately US$ 668 million while KOSEF has only US$ 90.16 million in asset under management. One year after ETFs listing, KOSPI200 moved from 77.27 to 100.58 which gave approximately 30.16% in return. At the same time, KODEX200 increased 30.19% and KOSEF200 increase 30.65%. The trading volume of KODEX200 and KOSEF200 has increased from around 20 billion won (US$16.7 million) a day in 2002 to around 40 billion won (US$31.4 million) a day in 2008. As the support of Korea Exchange, the ETF market in Korea has been increasingly growing in term of type and number of funds. The total amount of NAV of ETFs in Korea stock market has increased from 344 billion won (US$287.7 million) in 2002 to 2.8 trillion won (US$ 2.2 billion) in 2008. As of Dec 31, 2008, 37 ETFs were listed on Korea Exchange. This number tends to continuously increase in the future.

Tracker fund of Hong Kong and Hang Seng Index ETF

In 1999, Hong Kong government as the holder of a large amount of Hong Kong shares wanted to dispose of its shareholding of HK$ 118 billion (US$ 15.2 billion) with minimum disruption to Hong Kong stock market. The Government therefore pooled these shares of stocks

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\(^{4}\) See product summary of KODEX200 and KOSEF200 in appendix (Table A1)
and then set up the Tracker fund of Hong Kong (TraHK\textsuperscript{5}) as the disposition channel for these shares. The Tracker fund of Hong Kong therefore was introduced on November 12, 1999 with the issue size of HK$33.3 billion (US$4.3 billion). It is managed by State Street Global Advisors Asia Ltd. Tracker fund is designed to track the movement of Hang Seng index. However, in the first year of listing, Tracker fund outperformed the movement of the Hang Seng index as Hang Seng rose approximately 6.6\% while Tracker fund rose approximately 7.6\%. This is because the IPO price of Tracker fund is set at discount. As of February 2009, the asset under management of Tracker fund of Hong Kong is approximately US$ 3.9 billion.

On September 21, 2004, the second ETF that track the performance of Hang Seng index – Hang Seng Index ETF\textsuperscript{6} – was introduced by Hang Seng Investment Management Ltd. Its objective is to provide the performance which closely corresponds to the movement of Hang Seng index. However, Hang Seng index ETF have lower trading volume and asset under management relative to the Tracker fund of Hong Kong. For the first year performance, Hang Seng index ETF price increased 15.07\% while Hang Seng index moved from 13304.48 to 15274.31 which gave approximately 14.8\% in return. As of February 2009, the asset under management of Hang Seng index ETF is around US$ 1.6 billion. It is Hong Kong's third largest ETF in terms of asset under management, behind the Tracker fund of Hong Kong and the iShare FTSE/Xinhua A50 China Tracker.

### 3.3 Data description

In this study, underlying stocks in Korea and Hong Kong stock markets are investigated, I employ daily closing prices, opening prices, intraday high and low prices, trading volume, market value and the number of shares outstanding of all stocks. All of data sets are obtained from

\textsuperscript{5} See product summary of TraHK in appendix (Table A1)

\textsuperscript{6} See product summary of Hang Seng Index ETF in appendix (Table A1)
Datastream. Initial sample cover all common stocks that are listed in the Korea Exchange and Hong Kong Stock Exchange. Table 1 provides the mean summary of variables used in this study.

[Table 1 is here]

For the event window, I employ 250 days and 500 days around the ETF listing date for two portfolios. I divide 250-day (500-day) period into 125-day (250-day) pre-listing and post-listing periods. Moreover, I eliminate the 20 trading days around the ETF listing date for both before ETF listing and after ETF listing to avoid contaminating the results with any direct impact of listing. For the KODEX200 and KOSEF200 case, 250\textsuperscript{7} day pre- and post-listing periods start from October 5, 2001 to October 20, 2003. For Tracker fund case, 250\textsuperscript{8} day pre- and post-listing periods start from November 10, 1998 to November 15, 2000. For Hang Seng Index ETF case, 250\textsuperscript{9} day pre- and post-listing periods start from September 19, 2003 to September 26, 2005.

In each market, all stocks are divided into two portfolios. The first portfolio is the portfolio of index stocks. This portfolio contains the stocks that are included in KOSPI200 for the Korea case and Hang Seng Index for the Hong Kong case. As the index providers always make the adjustment of components of underlying index, the stocks that are newly added or deleted during the period of study are therefore dropped from the samples. The second portfolio is the non-index stocks portfolio. For the second portfolio, I eliminate some stocks that are newly listed (delisted) in the post-listing (pre-listing) period during the period of study to avoid the problem of asymmetric in number of trading days between before and listing date of ETF. Moreover, I eliminate the stocks that have the number of no-trading-volume days greater than two third of total trading days in either pre-listing or post-listing periods or both to avoid the illiquidity

\textsuperscript{7} 125-day pre- and post-listing periods start from April 10, 2002 to April 14, 2003 for KODEX200 and KOSEF200 case.

\textsuperscript{8} 125-day pre- and post-listing periods start from May 14, 1999 to May 18, 2000 for Tracker fund case.

\textsuperscript{9} 125-day pre- and post-listing periods start from March 22, 2004 to March 24, 2005 for Hang Seng Index ETF case.
problem in non-index stocks. The comparison of two portfolios is made to control for the potential market wide phenomenon.

4. Methodology

The study begins with the univariate statistic analysis. Volatilities of underlying stocks in each country are calculated. The first measure of volatility is the traditional standard deviation of the stock returns which is:

\[
\sigma = \sqrt{\frac{1}{n-1} \sum_{t=1}^{n} (r_t - \bar{r})^2}
\]  

(1)

\( r_t \) = the daily return on day \( t \)
\( \bar{r} \) = the daily mean return in the event window
\( n \) = number of days in calculation

However, the standard deviation utilizes the closing price of daily trading which can be manipulated in the end of each trading day. Moreover, the standard deviation ignores the intraday price movement. I therefore employ the second measure of volatility. That is the Parkinson’s volatility which is:

\[
\sigma_i = \sqrt{\frac{(\ln H - \ln L)^2}{4\ln 2}}
\]  

(2)

\( \ln H \) = natural log of daily price high
\( \ln L \) = natural log of daily price low

The Parkinson volatility is the extreme value measure of volatility because it utilizes daily high and low market price in the calculation. Parkinson volatility is an attractive measure since it can captures the intraday price movement. Two measures of volatility for index stocks are
computed for both pre-listing and post listing periods. Nonetheless, the analysis of change in volatility without comparison with the control sample is quite unreliable. In practice, there are many factors that can affect the volatility of stock market. Such as, market condition (bull or bear market), change in macroeconomic variable, stock market crash, world economy situation and other uncontrollable situations. Accordingly, the volatilities of non-index stocks are also computed to control for the potential market wide phenomenon.

The $t$-statistic is used to test whether the change in volatility after ETF listing is statistically significant. Also, Wilcoxon signed-rank test is employed to test the same hypothesis. Wilcoxon signed-rank test is nonparametric test. It does not require the assumption about the normal distribution. Moreover, to compare the difference of the change in volatility between index and non-index stocks, I calculate the volatility ratio which is:

$$\text{volatility ratio} = \frac{\text{volatility after ETF listing}}{\text{volatility before ETF listing}}$$  \hspace{1cm} (3)

The mean of volatility ratios for index and non-index stocks are compared. The $t$-statistic (Wilcoxon rank sum test) is used to test whether the mean (median\(^{10}\)) volatility ratio between index and non-index stocks is statistically different. If the $t$-statistic (Wilcoxon rank sum test) shows the negative sign, it means that the mean (median) of volatility ratio of index is less than that of non-index stocks. Also, If the $t$-statistic (Wilcoxon rank sum test) shows the positive sign, it means that the mean (median) of volatility ratio of index is greater than that of non-index stocks.

\(^{10}\) To make the result in table 2 concise, the median is not shown in the table because it can be implied from the sign of Wilcoxon rank sum test. Only mean of volatility ratios are presented in table 2, column 6.
To gain further insight to the univariate statistics, the multiple regressions are also estimated. I pool the data for index and non-index stocks and use the pooled data set to estimate the following model:

\[
\ln V_{o,j} = \delta_0 + \delta_1 E_{TF} + \delta_2 E_{TF} \times \text{Index}_j + \delta_3 \ln M_{v,j} \\
+ \delta_4 \ln P_{RC} + \delta_5 \ln V_{ol,j} + \varepsilon_j
\] (4)

\(\ln V_{o,j}\) = Natural log of daily volatility of firm j at time t, where \(t=0,1\)

\(E_{TF}\) = Dummy variable which is equal to 1 after the listing of ETF and zero otherwise

\(E_{TF} \times \text{Index}_j\) = Interactive dummy which is equal to 1 for index stocks after the listing of ETF and zero otherwise

\(\ln M_{v,j}\) = Natural log of average of daily market value of firm j at time t, where \(t=0,1\)

\(\ln V_{ol,j}\) = Natural log of average of daily trading volume\(^{11}\) of firm j at time t, where \(t=0,1\)

\(\ln P_{RC}\) = Natural log of average of daily stock price of firm j at time t, where \(t=0,1\)

Each firm will have two observations in the data sets. Time \(t=0\) is the pre-listing period and \(t=1\) is the post-listing period. This model enable us to obviously see whether the introduction of ETF cause the change in volatility of index stocks relative to non-index stocks. The variable of interest is interaction dummy (\(\delta_2\)) coefficient. If the establishment of ETF is contribute to

\(^{11}\) The trading volume in this study is measured by using the daily number of shares traded divided number of share outstanding.
significant change in volatility of index stocks relative to that of non-index stocks, the coefficients of interaction dummy ($\delta_2$) should be statistically significant.

The model in equation (4), I employ the concept of Kumar et al. (1995)’s model. The price and trading volume of the stock are used as the control variables to study the impact of ETF listing on the underlying constituents. As documented in previous studies (e.g., Schwert (1989), Karpoff (1987), JKL (1994)), the volume and volatility has the positive relationship. Hence, the expected sign of $\delta_3$ should be positive. In Korea and Hong Kong, the tick size is the function of prices. It means that tick size will increase as the price of stock increase. Thus, the expected sign $\delta_4$ is positive. Moreover, market value of firm is also used as another control variable. As Harris (1989) state that “large size firms are usually better diversified and less subject to catastrophic events than are small firms”. The expected sign of $\delta_5$ is therefore negative. The model in equation (4) is estimated by using the panel data (fixed effect or random effect) regression.

5. Results and analysis

5.1 KODEX200 & KOSEF200

In table 2.1, panel A, the result show that the mean volatilities of index stocks decrease in both measures of volatility. P-values from Wilcoxon signed-rank test and t-statistics indicate that the decreases in volatility in the 250-day event window (+-125 days around the listing date) are highly statistically significant at 0.01 significant levels. In absolute term, this result suggests that the establishment of KODEX200 and KOSEF200 in 2002 is associated with the decrease in volatility of underlying index stocks. However, it is necessary to analyze in relative term by comparing index stocks with non-index stocks because the decrease in volatility of index stocks might coincide with the period of decrease in volatility of Korea stock market. The results from
The results in panel A reveal that the extent of declining in volatility of index stocks seems to be more intense than that of non-index stocks. As can be seen, in the panel A, mean volatility ratios for two measures of volatility of index stocks are lower than that of non-index stocks. Also, the percentage of stocks with increase in volatility for index stocks is lower when compared to the non-index stocks. However, the results are not robust as only t-test indicates that the mean volatility ratio of index is significantly lower than that of non-index stocks when standard deviation is used as the volatility measure. For panel B, the result and interpretation are similar to panel A. The interesting differences which should be noted is that the evidence of lower in volatility of index stocks relative to non-index stocks become more obvious when the percentage of stocks with increase in volatility for index stocks considerably decline for the 500-day event window (+/-250 days around the listing date). Besides, t-statistics of mean volatility ratio in panel B show the negative sign and indicates that the mean volatility ratio for both standard deviation and Parkinson volatility of index stocks is significantly less that of non-index stocks. Moreover, Wilcoxon rank sum test in column 6 also indicate that the median of volatility ratio of index stocks is significantly less than that of non-index stocks when Parkinson volatility is used as the volatility measure. In summary, the result show weak evidences that index stocks realize the larger decrease in volatility when compare to non-index stocks. Also, the results imply that the impact of KODEX200 and KOSEF200 listing is become clearer as the magnitude of decrease in volatility of index stocks is relatively greater when event window is extended.

As can be seen from univariate statistics, the result show some evidences that the introduction of KODEX200 and KOSEF200 cause the relatively decrease in volatility for index stocks. However, the decrease in volatility might due to other important factors that affect volatility. Hence, the analysis of change in volatility should control for impact of change in trading volume and other variables. The estimated multiple regressions of model in equation (4)
are summarized in panel A, table 4. In panel A, column 2,3,4 and 4, the results show that the estimated coefficients of trading volume ($\delta_1$) are positive and significant in all regressions. This is consistent with the positive relation between volume and volatility as suggested by Schwert (1989), Karpoff (1987), JKL (1994), etc. The coefficients of dummy listing ($\delta_2$) in panel A are all statistically significant and show the negative sign in every column. This indicates that the ETF listing is coincident with the period of decrease in volatility of Korea stock market. In relative term, in column 2 and 3, the coefficients of interaction dummy ($\delta_2$) show the significant negative sign when standard deviation is used as the dependent variable. However, the interaction dummy ($\delta_2$) is not statistically significant when Parkinson’s volatility is used as the dependent variables. Accordingly, the result for 250-day window (+-125 days) implies weak evidence that the ETF listing decrease the volatility of underlying components relative to that of non-underlying components. Nonetheless, when 500-day window (+-250 days) is employed, the interaction dummy ($\delta_2$) show the robust empirical result that the advent of KODEX200 and KOSEF200 caused the decrease in volatility of index stocks relative to non-index stocks as the $\delta_2$ in column 4 and 5 show the highly significant negative sign in both measures of volatility. Moreover, the increase in the magnitude of $\delta_2$ in column 4 and 5 is consistent with the preliminary analysis that the size of decrease in volatility becomes larger when event window is extended.

In sum, the result show the some evidence that the introduction of KODEX200 and KOSEF200 cause the decrease in volatility of underlying constituents relative to that of non-index stock sample. However, the result of decrease in volatility becomes more obvious when the event window is extended to 500-day window (+-250 days). The evidence from KODEX200 and KOSEF200 indicate that the arbitrage effect dominate the less-informed-trader migration effect.
5.2 Tracker fund of Hong Kong

In table 2.2, panel A, the result from univariate analysis of change in volatility indicate that the mean volatilities of index stocks significantly increase in both measures of volatility as confirmed by p-values from Wilcoxon signed-rank test and t-statistics. However, the results of non-index stocks in panel A also show that non-index stocks experience increase in volatility. Further analysis, from mean volatility ratio, suggests that the magnitude of increase in volatility of index stocks is less than that of non-index stocks. However, this result is quite ambiguous and not robust because the percentage of stocks with increase in volatility for index stocks is higher when compared to the non-index stocks and only t-statistic of mean volatility ratio for Parkinson volatility is statistically significant. For panel B, the result indicates the similar interpretation. Wilcoxon signed-rank test and t-statistic indicate that the volatility of non-index stocks experience significant increase in volatility after the establishment of Tracker fund. However, t-statistic indicates no significant change for index stocks. T-statistic of mean volatility ratio in panel B indicates that the magnitude of increase in volatility for both standard deviation and Parkinson volatility of index stocks is significantly less than that of non-index stocks. In contrast, Wilcoxon rank sum test indicate no significant difference in the volatility change between index and non-index stocks. To summarize, the result show some but not robust evidences that index stocks experience the smaller increase in volatility when compare to non-index stocks.

The multiple regression results for the case of Tracker fund of Hong Kong are summarized in table 4. In panel B, the estimated coefficients of trading volume ($\delta_1$) are positive in all regression. Again, this is consistent with the positive relation between volume and volatility. The coefficients of dummy listing ($\delta_2$) in panel B are all statistically significant at 0.01 level and show the positive sign in every column. This indicates that the ETF introduction is coincident
with the period of increase in volatility of Hong Kong stock market. In both 250-day window and 500-day window, the coefficients of interaction dummy ($\delta_2$) show the positive sign in for both measures of volatility. However, none of the coefficients are significant. The result indicate that the advent of Tracker fund of Hong Kong did not cause the significant change in volatility of index stocks relative to that of non-index stocks.

In sum, the result indicates that the increase in volatility of underlying constituents is mainly due to the market wide phenomenon. The empirical evidence of Tracker fund introduction implies that the impact of arbitrage effect tend to be equivalent to the impact of less-informed-trader migration effect. Consequently, the advent of Tracker fund did not cause the significant change in volatility of underlying constituents relative to that non-index stock sample.

### 5.3 Hang Seng index ETF

In table 2.3, both panel A and B, the result show the strong evidence that the mean volatilities of index stocks decrease in both measures of volatility. P-values from Wilcoxon signed-rank test and t-statistics indicate that the decreases in volatility in window are statistically significant at 0.01 significant levels. In absolute term, this result suggests that the establishment of Hang Seng ETF is associated with the decrease in volatility of underlying index stocks. In relative term, the results in panel A and B indicate that the size of declining in volatility of index stocks is greater than that of non-index stocks as mean volatility ratios for two measures of volatility of index stocks are obviously lower than that of non-index stocks in both panels. This is confirmed as the T-statistic and Wilcoxon rank sum test robustly indicate that the difference in the change in volatility between index and non-index stocks is statistically significant in both panels. Furthermore, the percentage of stocks with increase in volatility in column 7 for index stocks is lower when compared to the non-index stocks. It means that index stocks experience the significantly larger decrease in volatility when compare to non-index stocks. To summarize, the
result show the strong evidence that Hang Seng Index ETF contribute to the significant decrease in volatility of underlying constituents relative to non-index stocks.

[Table 4 is here]

The estimated coefficients of model in equation (4) are summarized in table 4, panel C. Column 2 and 3 present the result from 250-day window while column 4 and 5 present the result from 500-day window. Again, the results in column 2, 3, 4 and 5 show that the estimated coefficients of trading volume (\( \delta_1 \)) are positive and significant in all regressions. The coefficients of dummy listing (\( \delta_1 \)) in panel C are all statistically significant and show the negative sign in every column. This indicates that the ETF listing is coincident with the period of decrease in volatility of Hong Kong stock market. The coefficients of variable of interest, interaction dummy (\( \delta_2 \)), show the highly significant negative sign in column 2 through 5. Moreover, the increase in the magnitude of \( \delta_2 \) in column 4 and 5 is consistent with the preliminary analysis that the magnitude of decrease in volatility becomes larger when event window is extended. This means that the Hang Seng Index ETF listing contribute to the significant change in the volatility of underlying stocks and the magnitude of decrease is larger when event window is longer.

In conclusion, the result show the strong evidence that the introduction of Hang Seng Index ETF cause the significant decrease in volatility of underlying constituents. Moreover, the size of decrease is greater when the event window is extended to 500 day window (+/-250 days). The empirical result of Hang Seng Index ETF case indicates that arbitrage effect dominates the less-informed- trader migration effect.

6. Conclusion

To the extent that the advent of ETFs can affect the structure of underlying market, this study investigates the change in volatility of underlying constituents after the introduction of ETF
in four cases. The empirical evidence indicates that the creation of KODEX200 and KOSEF200, the first two ETFs in Korea that tracker the performance of KOSPI200 index, and Hang Seng Index ETF (HSI ETF), the second ETF that track the movement of Hang Seng index, caused the significant change in volatility of underlying constituents after control for the potential market wide phenomenon. However, the evidence from KODEX200 and KOSEF200 is not robust. This finding is consistent with Richie and Madura (2005). On the contrary, the result of introduction of Tracker fund of Hong Kong (TraHK) indicates no significant change in volatility of underlying constituents after controlling for non-index stocks. The increase in volatility after the establishment of Tracker fund is just the market wide phenomenon. In conclusion, the increasing arbitrage activities facilitated by the creation of ETF tend to dominate the impact of less-informed traders migration in this study. According to Fremault (1991), the arbitrage activities tend to improve the liquidity and reduce the informational asymmetry within underlying market and across markets. The arbitragers therefore serve to stabilize and reduce the volatility of underlying constituents.