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Which is Dominant? ETFs or Highly Capitalized Stocks: Evidence from an Emerging Market

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The launch of exchange-traded funds (ETFs) provides an alternative for informed traders to execute long or short strategies in response to new information in spot market other than trading futures or options in derivative market. This paper uniquely exploits market prices and net asset values (NAVs) of Taiwan 50 ETF to explore the relative rates of price discovery between ETFs and highly capitalized stocks markets. The results indicate that there exists a cointegrated system between two price series and the vector error correction model could be applied to describe their dynamics. For the first half of the 7-year data period, the NAVs lead the market prices in an absolute manner showing that since the limited volume of Taiwan 50 ETF, informed traders still prefer to react to information by trading highly capitalized stocks, and for the second half data period while the trading volume of the ETF has doubled this outcome changes. Such evidence supports"market liquidity hypothesis".

JEL Codes: G12 and G14

1. Introduction

According to Fama's (1970) description: in a market with pricing efficiency, the prices traded in that market will fully reflect all available information, which suggests that financial products with same underlying assets but traded in different markets, in the premise of markets are efficient, should adjust to the new equilibrium simultaneously, otherwise arbitrage opportunities arise, and will carry those prices into identity. However, due to the existence of differences between various structures, information transmits in different markets at different rates, creating a lead-lag relationship in the price discovery process. Because informed traders tend to trade through "securities with advantages" or "markets with superior structures", prices of such securities or markets response to information faster and tend to lead others in the process of price discovery. Such markets, therefore, possess the efficiency of price discovery.

For the studies on the efficiency as well as the dynamic relationship between the spot and derivative index markets, generally the spot, futures, options, exchange traded funds (hereafter ETFs), etc. are included to examine their relative information transmission speed, price discovery function and lead-lag relationship. Viewing from the favorable structure conditions such as higher leverage, lower transaction costs, fewer trading restrictions, higher sensitivity to market-wide information, etc., it seems that those with higher leverage, futures or options, digest the impact of new information and then discover prices better than ETFs and the spot, and the ability of ETFs to be better than that of the spot. Through sound empirical researches in the

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mature markets, the results expected above could be obtained (see Kawaller et al. 1987, Stoll and Whaley 1990, Chan 1992, Kawaller et al. 1993, Ghosh 1993, Booth et al. 1999, Chu et al. 1999, Tse 1999, 2001, etc.); but for researches in emerging markets, affected by market maturity and different trading mechanisms, such results found in the mature markets are not necessarily drawn (see Huang and Shyu 1997, Hsieh, 2002.)

A variety of information-based microstructure models hold that new information will be reflected in the prices of financial products through trading by informed traders. If informed traders prefer to choose one particular market to respond to their private information, the prices of this market tend to lead prices of other markets. Five hypotheses based on different market structures and product designs have been proposed to explain how informed traders form their preferences. These hypotheses are the leverage hypothesis, the trading-cost hypothesis, the uptick rule hypothesis, the liquidity hypothesis, and the market-wide information hypothesis (Kawaller et al. 1987, Stoll and Whaley 1990, Fleming et al. 1996, Chung 1991, Chan 1992, Stephan and Whaley 1990, Chu et al. 1999, Chou and Chung 2006.) Consolidated standpoints of all the five hypotheses, securities with higher degree of leverage, lower trading costs, fewer trading restrictions, higher liquidity, and higher sensitivity to react to market-wide information tend to play better price discovery function.

ETFs are one kind of index funds yet have the uniqueness that they can be traded in exchanges like stocks. They, therefore, have two prices at the same time. One is the market price which is ETF’s trading price, and the other is the net asset value (hereafter NAV) decided jointly by the constituent stocks’ trading prices. The former is formalized in the ETF market and the latter indicates the price movements of the spot market. Since these two prices are underlain by exactly the same assets, if markets are efficient and fully integrated, both prices shall react to the new information synchronously and adjust to the new equilibrium with no delay. However, since there exist differences on market structure or product feature between the two markets, the study is interested to know whether their abilities to disseminate and act on information so as to discover prices might be different. This paper uniquely exploits market prices and NAVs of Taiwan 50 ETF to explore the relative rates of price discovery between ETFs and highly capitalized stocks markets (NAVs represent the proxy of highly capitalized stock prices, and market prices stand for the Taiwan 50 ETF prices.) Comparing Taiwan 50 ETF and highly capitalized stocks, both apply the same upmost degree of leverage and short sale restriction, but Taiwan 50 ETF has lower trading costs and higher sensitivity to market-wide information yet lower trading volume. Thus, the outcome that the market price leads the NAV supports both the trading-cost hypothesis and the market-wide information hypothesis, otherwise supports the market liquidity hypothesis to be valid.

This study provides valuable contributions to the existing literature. First, through using data gathered in an emerging market, the three hypotheses for explaining the preference of informed traders according to different market structures and security designs are examined again, a supplementary substance to the existing literature since past researches focus mostly on mature markets. Second, based on the results of this study, it can learned more clearly about informed traders’ preference that which index instrument they tend to exploit for their information advantage.

The rest of this article is organized as follows. Section 2 outlines the status of Taiwan ETF market. Section 3 provides an overall literature reviewing. Section 4 describes the data used. Section 5 discusses the methodology and results. And Section 6 provides a summary and conclusion of this study.

2. An Overview of Taiwan ETF Market

In June 2003, Polaris Securities Investment Trust Corporation (Polaris SITC) launched the first ETF in Taiwan whose constituents cover the top 50 listed stocks in terms of market cap, and these constituents are so-called "highly capitalized stocks". This ETF, named as "Taiwan Top 50 Tracker Fund" (hereafter Taiwan 50 ETF), tracks Taiwan 50 Index compiled by the cooperation of Taiwan Stock Exchange Corporation (TSEC) and FTSE Group, and until now is still the most active product in Taiwan ETF market. However, unlike ETF trading volumes in mature markets are always among the tops, the volume rankings of Taiwan top 50 ETF fall behind (ranked 295 in December 2006, and further raised to 77 in June 2010.) Also, compared to the average volumes of its component stocks or other active stocks, those of Taiwan top 50 ETF seem too less to transmit information and to discover price. Table 1 shows the comparison of trading volumes of the top 10 average of the whole listed market, the component average of Taiwan 50 ETF, and Taiwan 50 ETF itself. No matter in the last month of the first half or the last month of the second half of the 7-year data period in this study, the average daily volumes of Taiwan 50 ETF are significantly less than the top 10 average or its component stocks' average volumes, though the average daily volume of the latter half has more than doubled that of the first half period (from 6,117 thousand shares to 12,548 thousand shares, see Figure 1 as a reference.) From the viewpoints of leverage hypothesis and trading restriction hypothesis, the information transmission and price discovery abilities of Taiwan 50 ETF and its component stock markets are comparable (see Table 2). As for the viewpoints of trading-cost hypothesis and market-wide information hypothesis, Taiwan 50 ETF should perform better price-leading ability. But if market liquidity hypothesis is considered, the inference is on the contrary; namely, highly capitalized stocks would lead ETFs in the price discovery process. Such incompatible possibilities lead to an interesting issue worthy of study: the lead-lag relations between the Taiwan 50 ETF and its component stocks which are highly capitalized stocks. Since the liquidity, trading volume or ranking, market share or depth of Taiwan 50 ETF are far inferior to those of other mature markets, it might lead to a result that, in response to the Taiwan stock market information, a great deal may still be accustomed to trade highly capitalized spot stocks with larger trading volumes and deeper market depth as a priority. Especially while the constituents of Taiwan 50 ETF are the top 50 listed stocks in terms of market cap, it is of high probability that traders prefer to react to information obtained through trading constituent stocks which would cause that the NAVs of Taiwan 50 ETF, compared to market price, could transmit information more quickly and perform price discovery function better. This study thus aims to know if such condition does exist in Taiwan 50 ETF's market or which hypothesis is supported in an emerging market like Taiwan. In actual implementation, I uniquely adopt NAVs as the proxy for the prices of these component stocks and also a representative of the spot price, to match with the market prices of Taiwan 50 ETF. I also divide the whole 7-year data period into two sub-periods to investigate if the ascending of Taiwan 50 ETF's trading volume affect its price-discovery function or status; that is, to know the relative rates of price discovery between market prices and NAVs have ever changed as the Taiwan 50 ETF liquidity doubled. This study design can once again verify the validities of the three hypotheses mentioned above, show which factor appears to be the primary characteristic in determining the price discovery roles of the Taiwan 50 index prices, and bring better comprehending of the impact of liquidity on price discovery function.

Table 1: A Comparison of Trading Volume

Item	December 2006† Total Volume (thousand shares)	Average Daily Volume (thousand shares)
Top Ten Average	1,078,787	51,371
The Average of Taiwan 50 ETF Component Stocks	306,584	14,599
Taiwan 50 ETF (ranked 295)	81,422	3,877
Item	**June 2010† Total Volume (thousand shares)**	**Average Daily Volume (thousand shares)**
Top Ten Average	811,251	38,631
The Average of Taiwan 50 ETF Component Stocks	302,135	14,387
Taiwan 50 ETF (ranked 77)	156,663	7,460

†：December 2006 and June 2010 are the last months of the first and second halves, respectively, of the 7-year data period in this study. Both of them have 21 business days.

Source：Taiwan Stock Exchange

Figure 1: Daily Trading Volume of Taiwan 50 ETF, 2003/6/30~2010/6/30

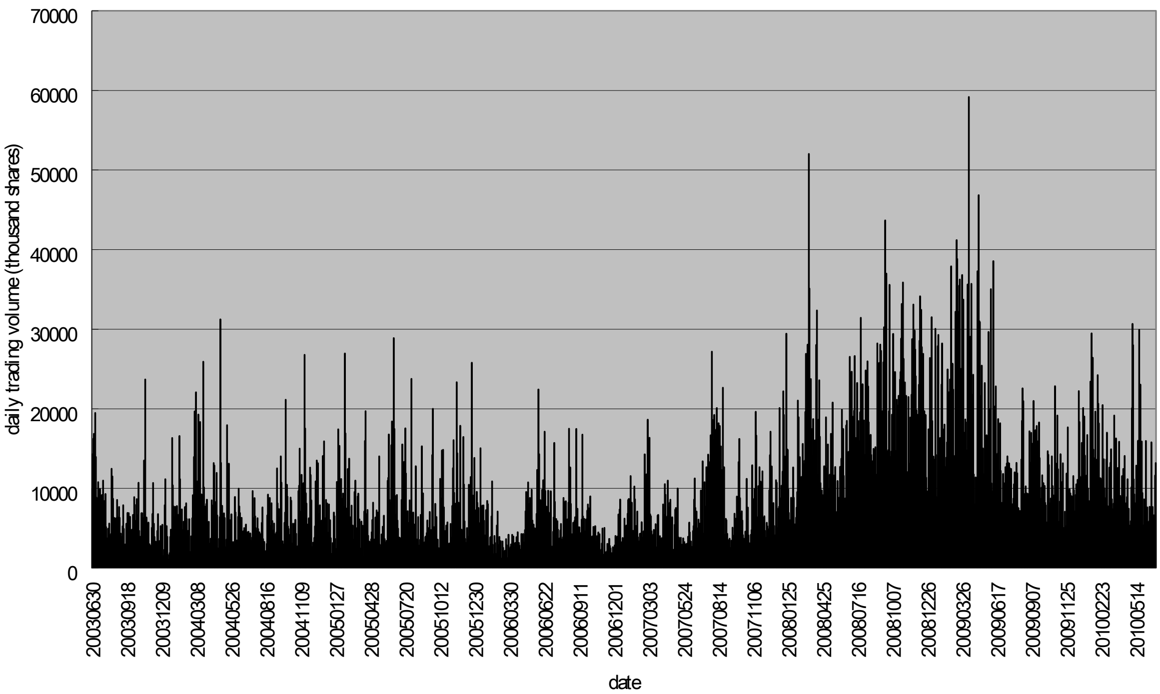

Table 2: A comparison of market structures and product designs of Taiwan spot and derivative markets

item	stocks	ETFs	futures	options
leverage	Up to 1.67 times through margin trading (margin percentage 40%)	Up to 1.67 times through margin trading (margin percentage 40%)	15~20 times	Generally higher than futures'
trading costs	fee rate: at most 1.425‰ trading tax: 3‰only for selling occasion	fee rate: at most 1.425‰ trading tax: 1‰only for selling occasion	fee rate: 0.5‰~ 0.83‰of contract value trading tax: 0.04‰ of contract value for both buying and selling occasions	fee rate: 0.2‰~ 0.3‰ trading tax: 1‰of premium for both buying and selling occasions
trading restrictions	Only 150 stocks exempted from short sale restrictions, the remaining can not be short sold at prices below the closing of the previous session	No short sale restrictions	No short sale restrictions	No short sale restrictions
market-wide information sensitivity	low	high	high	high

Source: Taiwan Stock Exchange, Taiwan Futures Exchange, and this study.

3. Literature Review

Past studies on the dynamic relationships between spot indices and their derivative markets focus mostly on the connection between cash and futures prices; including Kawaller et al. 1987, 1993, Stoll and Whaley 1990, Chan 1992, Ghosh 1993, Tse 1999, 2001 are all studies for the dynamics of price discovery between spot indices and their futures derivatives in the U.S. market. All their results point to futures prices lead spot prices to change, two prices co-integrate in a stable relationship, in the short-term interaction the futures prices show strong influence on the spot prices, or there exist a significant bi-directional interaction as well as information flow between them, etc. Wahab and Lashgari (1993) use daily closing data of U.S. S&P 500 Index and the UK FTSE 100 index to test the dynamic relationship between spot index and index futures markets, and find that there exists a stable long-term equilibrium relationship between the spot index and the nearby index futures no matter for S&P

500 index or for FTSE 100 index. However, in the process of price discovery, it is more significant that the spot leads the futures. Min and Najand (1999), studying the relationship of South Korea KOSPI 200 index and index futures, also find an integrated system in these two price series, and futures prices leads cash prices in the price discovery process. As for the Taiwan stock index market, Huang and Shyu (1997) study the dynamic relationship and the price discovery role between Morgan Stanley Capital International (MSCI) Taiwan Index and its futures derivative traded on the Singapore Exchange (SGX-DT). Since the data used are gathered from the early stage of the futures trading, they find that due to the market immaturity and the impact of trading mechanisms, futures did not show its leading function anticipated; that is, results of vector error correction model indicate that adjustment towards the long-term equilibrium is mainly completed by the futures market, manifesting that the spot market’s stronger leading status. On the other hand, Hsieh (2002) uses the data of TAIEX Futures traded on the Taiwan Futures Exchange (TAIFEX) to re-examine the dynamic relationship between cash and futures prices. Their main findings are different from Huang and Shyu (1997): futures prices dominate cash prices, more and stronger information are found to flow from futures market to spot market (that is, futures market show a stronger price discovery function), there is two-way feedback of information transmission between the futures and spot markets, and comparing results of sub-periods, with the enlarged trading volume, the dominant position of the futures market is enhanced significantly, which is due to the getting mature of the futures market causing the better price discovery ability.

In addition to studying the lead-lag relationship between the spot index and index futures prices, there are literatures including options products into their research of the dynamic relationship between various index prices. For example, Booth et al. (1999) apply co-integration and error correction model to analyze the information flow among the Germany's DAX index and its futures and options contracts in the price discovery process. The results show that index derivatives perform better price discovery ability than the spot index, and futures are better than options. Hsieh et al. (2007) also include three index prices, cash, futures and options prices, to observe their dynamic relationship and find that there exists a common stochastic trend in the cointegrated system of these three prices. Three prices all display a tendency to converge to their long-run equilibrium price level, but it is the spot index that have the most obvious adjustment, which means that the two derivative markets lead the spot market in the price discovery process. As for the short term interaction, there is information feedback phenomenon among these markets. Further applying information share model of Hasbrouck (1995) to analyze lead-lag ranks, they find that, in the process of price discovery, futures is in the most dominant place, followed by options, spot index price changes are mainly affected by the two other markets.

Recent advent of ETF products makes researchers start to take ETF prices into account to study the association of various index markets. For example, Chu et al. (1999) examine the price discovery functions of S&P 500 index and its futures and ETFs (i.e. SPDRs). Their results show that these three prices also form an integrated system with a long-run stochastic trend; the main price adjustments are from the spot and the SPDRs markets, indicating that futures are in a dominant position in the price discovery process; moreover, decomposing the common stochastic trend it is found that futures prices are the most dominant one, followed by SPDRs, the spot is in the last place. The authors believe that leverage and short sales restrictions hypotheses could explain these results better. Tse et al. (2006) explore the dynamics of price discovery between the Dow Jones Industrial Average (DJIA) index and its three derivatives including the DIAMOND ETF, the floor-traded regular futures, and the electronically traded mini futures (E-mini futures). Though the American Stock Exchange is the primary listing exchange for the DJIA ETF, the paper finds that the electronically traded ETF on the Archipelago (ArcaEx) electronic communications network dominates the price discovery process for DIAMOND shares. The E-mini futures contribute the most to price discovery, followed by ArcaEx DIAMOND, and the spot index, and regular futures the least; such results indicate that the informed traders favor electronic trading that the trading cost hypothesis gets more support. In addition, Hsu and Wu (2003) study MSCI Index and its correspondent ETFs (i.e. iShare EWT listed on American Exchange) and find that two prices cointegrate with a long-term common stochastic trend, but the spot index tends to lead ETFs.

4. Data

This study investigates the dynamics between the NAVs and market prices of Taiwan 50 ETF in order that we can catch the picture of lead-lag connection between ETFs and highly capitalized stocks to react to new information. Therefore I gather daily closing market prices and NAVs data of Taiwan 50 ETF, 7-year data period from July 1, 2003 to June 30, 2010 which amounts to totally 1,742 trading days (see Figure 2); data source is the "Taiwan Economic Journal database". Following the past practice, the two price series are taken the natural logarithm and their movements are plotted in Figure 3. Their descriptive statistics are summarized in Table 3; moreover, as I would divide the whole data period to two sub-periods (each covers 3.5 years) to observe the changes of the dynamic relationship between the two prices, market prices and NAVs, of Taiwan 50 ETF, I also list the descriptive statistics of each sub-period of the two price series in Table 3. The results in Table 3 show that no matter in the whole data period or in the two sub-periods the two prices are very close to each other, but averagely speaking it display discount occasion (market prices are less than the NAVs), and the average price level of the latter 3.5 years are higher than that of the former 3.5 years.

Figure 2: Taiwan 50 ETF market price and NAV, 2003/7/1 to 2010/6/30

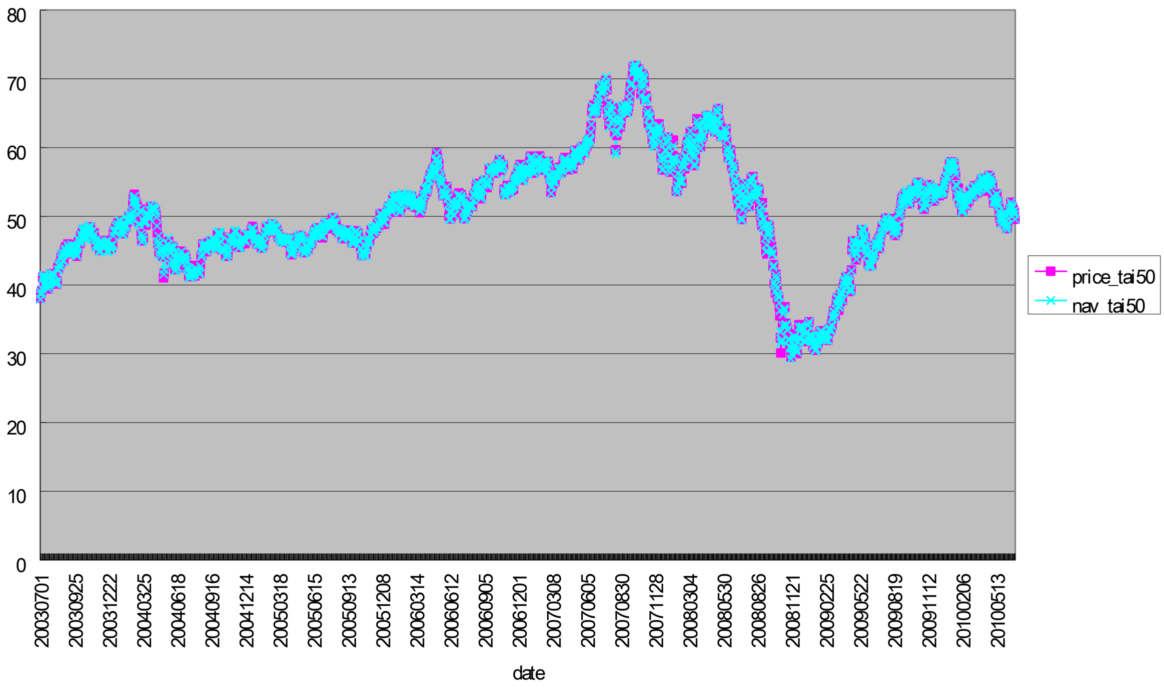

Figure 3: Logarithm of Taiwan 50 ETF market price and NAV, 2003/7/1 to 2010/6/30

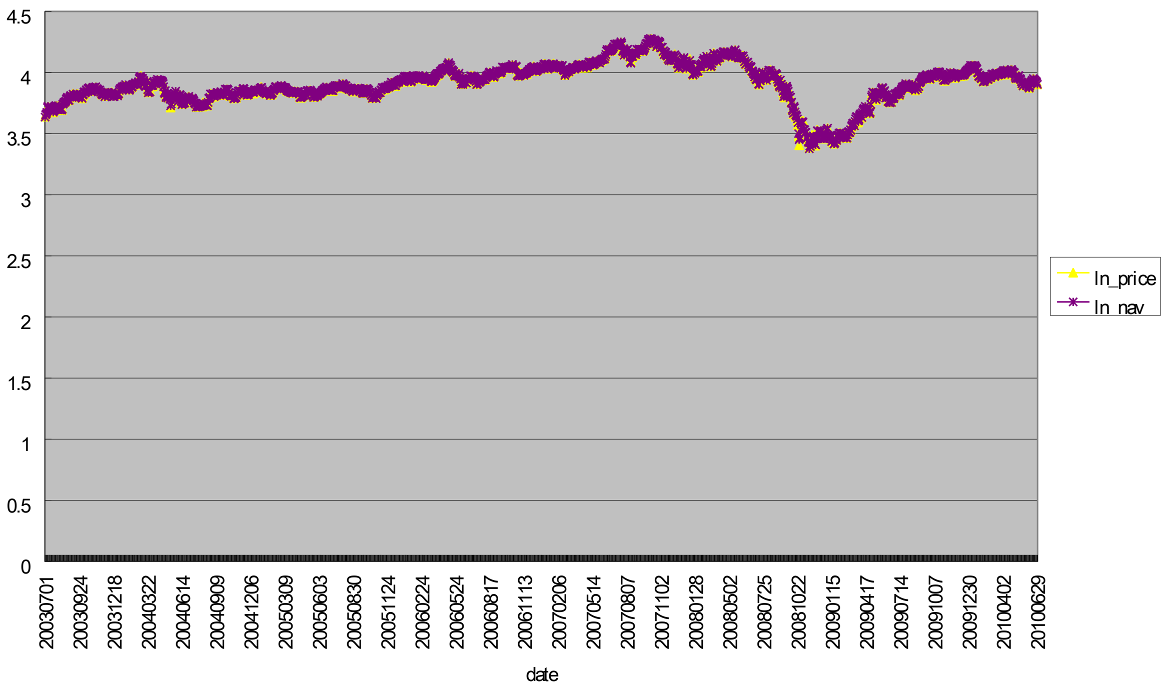

Table 3: Statistic Summary of Taiwan 50 ETF market prices and NAVs

Data Period	Full 2003/7/1~2010/6/30		First half 2003/7/1~2006/12/29		Latter half 2007/1/2~2010/6/30	
Series	Price	NAV	Price	NAV	Price	NAV
Sample Size	1742	1742	875	875	867	867
Mean	3.9124	3.9127	3.8778	3.8782	3.9473	3.9474
Medium	3.9210	3.9207	3.8633	3.8647	3.9908	3.9908
Maximum	4.2753	4.2782	4.0809	4.0811	4.2753	4.2782
Minimum	3.3844	3.3755	3.6389	3.6352	3.3844	3.3755
Standard Deviation	0.1642	0.1642	0.0852	0.0855	0.2109	0.2108
Skewness	-0.6395	-0.6450	0.1583	0.1501	-1.0345	-1.0367
Kurtosis	3.9163	3.9283	2.6570	2.6291	3.3274	3.3375
NormalityTest:						
Jarque-Bera	179.68***	183.34***	7.9413**	8.2990**	158.51***	159.43***
Probability	0.0000	0.0000	0.0189	0.0158	0.0000	0.0000

***、** and *: indicate significance at 1%, 5% and 10% confidence level respectively.

5. Methodology and Results

This article is mainly to understand the lead-lag relation between Taiwan 50 ETF market prices and NAVs so that the relative price discovery functions of ETFs and highly capitalized stocks could be confirmed. As previously mentioned, the outcome that the market price leads the NAV supports both the trading-cost hypothesis and the market-wide information hypothesis, otherwise supports the market liquidity hypothesis to be valid. In this section, I describe the research methods adopted sequentially, and after each method their correspondent results are listed along.

5.1 Unit Root Test

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used to test the existence of unit roots and to indentify the order of integration of the two closing price series, market prices and NAVs of Taiwan 50 ETF. Table 4 presents the results of the two tests applied on the log-levels and log-first difference of daily ETF market price and NAV series. The null hypothesis of a unit root in the log-level daily closing prices could not be rejected at all the 1%, 5% and 10% significance level, suggesting that the logarithm of the closing prices of ETF market prices and NAVs are non-stationary. But the first difference of logarithm of both closing prices yields larger statistics that reject the null hypothesis even at the 1% significance level, indicating that there is unit root in both logarithmic market prices and NAVs but that both of them become stationary after their first difference. Therefore, both series have the same integrated order which is the first order; that is, both series are I (1) series.

Table 4: Unit Root Tests

The Whole Data Period	Market Prices (Levels)	NAVs (Levels)	Market Prices (First Difference)	NAVs (First Difference)
ADF (probability†)	-2.3498 (0.1565)	-2.3121 (0.1682)	-42.0704*** (0.0001)	-40.0281*** (0.0000)
PP (probability†)	-2.2901 (0.1753)	-2.2952 (0.1737)	-42.1256*** (0.0001)	-40.0023*** (0.0000)

†：MacKinnon (1996) one-sided probability value.
***、** and *: indicate significance at 1%、5%, and 10% confidence levels, respectively.

5.2 Cointegration Test

Using Johansen's cointegration test, I preliminary find the existence of cointegration relation between the two price series, and according to Akaike Information Criteria and Schwarz Criteria by rank (rows) and model (columns), I decide to adopt "no intercept and no trend term" model to test this cointegration relation further. The results of Johansen cointegration test based on the trace test and the max-eigenvalue test are reported in Table 5, and both of their results allow me to reject the null hypothesis of no cointegrating vector at 1% significance level and to be unable to reject the null hypothesis of at most one cointegrating vector at all the 1%, 5% and 10% significance level. Therefore the overall results indicate the existence of one cointegrating vector between market prices and NAVs of Taiwan 50 ETF. Table 5 also reports the cointegration test results of the two sub-periods.

Table 5 Johansen Cointegration Test

Entire Period: 2003/7/1~2010/6/30		trace test (λ_{trace})		max-eigenvalue test ($\lambda_{\max}$)	
H_0	Eigenvalue	Statistic	5% Critical Value	Statistic	5% Critical Value
None	0.104533 (Prob.†)	191.8306*** (0.0001)	12.3209	191.7818*** (0.0001)	11.2248
At most one	2.81E-05 (Prob.†)	0.048829 (0.8563)	4.1299	0.048829 (0.8563)	4.1299
First Sub-period: 2003/7/1~2006/12/29		trace test (λ_{trace})		max-eigenvalue test ($\lambda_{\max}$)	
H_0	Eigenvalue	Statistic	5% Critical Value	Statistic	5% Critical Value
None	0.090645 (Prob.†)	83.6320*** (0.0001)	12.3209	82.6676*** (0.0001)	11.2248
At most one	0.001108 (Prob.†)	0.964426 (0.3780)	4.1299	0.9644 (0.3780)	4.1299
Second Sub-period: 2007/1/2~2010/6/30		trace test (λ_{trace})		max-eigenvalue test ($\lambda_{\max}$)	
H_0	Eigenvalue	Statistic	5% Critical Value	Statistic	5% Critical Value
None	0.124433 (Prob.†)	114.6505*** (0.0001)	12.3209	114.5461*** (0.0001)	11.2248
At most one	0.000121 (Prob.†)	0.104404 (0.7904)	4.1299	0.104404 (0.7904)	4.1299

†: MacKinnon-Haug-Michelis (1999) p-values.
***、** and *: indicate significance at 1%、5%, and 10% confidence levels, respectively.

5.3 Vector Error Correction Model

Engle and Granger (1987) proved that when there exists a cointegration relationship between two variables, their connection can be expressed by vector error correction model (hereafter VECM). The VECM examines the short-term dynamics between the integrated variables by including the lagged equilibrium error term obtained from cointegration equation and lagged values of the first differences of each variable. Having identified a cointegrating vector between the market price and NAV of Taiwan 50 ETF no matter in the entire or sub-periods using Johansen cointegration test, the VECM is applied and estimated to describe the long-term and short-term dynamics of prices between ETF and highly capitalized stock markets in order that the information transmission and price discovery processes can be fully comprehended. Based on Schwarz Information Criterion while determining the best lag order, I find the best lag order for the first sub-period is lag two, and that for the second sub-period is lag one. Table 6-1 and 6-2 report the VECM estimating results of the two sub-periods respectively where LN_t and LP_t are the log-NAV and log-market-price at time t respectively, and ect_{t-1} is the equilibrium error correction term derived from the cointegrating equation. Variable with "Δ" symbol is the first difference of that variable. Coefficients of the equilibrium error correction term represent the adjusting speed at which the short-run deviation from the long-run equilibrium is adjusted or corrected in the next period; and coefficients of the difference term represent the effects of independent variables on that dependent variables.

Summarizing the results of the two sub-periods, it is found that for the first sub-period NAV (which represents highly capitalized stock market) leads the market price in information transmission and price discovery processes. Market price more often and more substantially deviates from the long-run equilibrium, so its error correction behavior is very significant and shows larger amplitude. That is, the task of correcting error for the deviation from the long-run equilibrium is completed mainly by the ETF market. In the short-term interaction, NAV also shows greater impact on the market price. Therefore, for the first sub-period, no matter in the short-term or long-term dynamics, highly capitalized stock market dominates the ETF market which indicates informed traders prefer to trade by highly capitalized stocks with higher volume. However, in the second sub-period, this condition starts to change. Though in the short-term interaction, it is also the NAV could display greater impact on market price, the task of correcting error for the deviation from the long-run equilibrium is transferred to NAV; that is, the coefficient of the error correction term in the NAV equation is greater (see Table 6-2, and equation (4)) in magnitude indicating market price starts to lead NAV. And in the short-tem co-movements, there are bi-direction feedback and influence between these two markets. Therefore, with the amplification of the Taiwan 50 ETF trading volume (average daily volume of the second sub-period double that of the first sub-period) and the getting mature of the Taiwan 50 ETF market, market price gradually displays information transmission and price discovery dominance.

Table 6-1: Vector Error Correction Estimates: the first sub-period

Data Period: 2003/7/1~2006/12/29

Cointegration Equation: $LN_{t-1} = 1.000101 LP_{t-1}$

Long-Term Equilibrium: $ec_{t-1} = LN_{t-1} - 1.000101 LP_{t-1}$

Vector Error Correction Model:

$$\Delta LN_t = -0.1145 ec_{t-1} + 0.1127 \Delta LN_{t-1} - 0.2213 \Delta LN_{t-2} - 0.0805 \Delta LP_{t-1} + 0.1834 \Delta LP_{t-2} \quad (1)$$

$$\Delta LP_t = 0.3668 ec_{t-1} + 0.3425 \Delta LN_{t-1} - 0.1263 \Delta LN_{t-2} - 0.3182 \Delta LP_{t-1} + 0.0747 \Delta LP_{t-2} \quad (2)$$

Dependent / Independent	VECM (3) : ΔLN_t	VECM (4) : ΔLP_t
ec_{t-1}	-0.1145 (-0.7752)	0.3668*** (2.6133)
ΔLN_{t-1}	0.1127 (0.7772)	0.3425*** (2.4846)
ΔLN_{t-2}	-0.2213** (-1.8194)	-0.1263 (-1.0923)
ΔLP_{t-1}	-0.0805 (-0.5462)	-0.3182** (-2.2728)
ΔLP_{t-2}	0.1834* (1.5148)	0.0747 (0.6492)

***、** and *: indicate significance at 1%、5%, and 10% confidence levels, respectively.
t-statistics in ( )

Table 6-2: Vector Error Correction Estimates: the second sub-period

Data Period: 2007/1/2~2010/6/30

Cointegration Equation: $LN_{t-1} = 1.000014LP_{t-1}$

Long-Term Equilibrium: $ec_{t-1} = LN_{t-1} - 1.000014LP_{t-1}$

Vector Error Correction Model:

$$\Delta LN_t = -0.5132ec_{t-1} + 0.2852\Delta LN_{t-1} - 0.2522\Delta LP_{t-1} \quad (3)$$

$$\Delta LP_t = 0.1548ec_{t-1} + 0.3718\Delta LN_{t-1} - 0.3431\Delta LP_{t-1} \quad (4)$$

Dependent / Independent	VECM (5) : ΔLN_t	VECM (6) : ΔLP_t
ec_{t-1}	-0.5132*** (-3.0289)	0.1548 (0.8635)
ΔLN_{t-1}	0.2852** (2.0266)	0.3718*** (2.4977)
ΔLP_{t-1}	-0.2522** (-1.8233)	-0.3431*** (-2.3443)

***、** and *: indicate significance at 1%、5%, and 10% confidence levels, respectively.
t-statistics in ( )

5.4 Causality Test

Based on a vector error correction model to describe the cointegration relationship between the market price and NAV of Taiwan 50 ETF, I then employ Granger causality test to further identify the lead-lag relationship between the two variables. The results of the two sub-periods are presented in Table 7.

Table 7: Granger Causality Test

Null Hypothesis	F statistic	Probability
The first sub-period: 2003/7/1~2006/12/29		
LN_PRICE does not Granger Cause LN_NAV	2.1014	0.1229
LN_NAV does not Granger Cause LN_PRICE	22.4294***	3.E-10
The second sub-period: 2007/1/2~2010/6/30		
LN_PRICE does not Granger Cause LN_NAV	6.7348***	0.0096
LN_NAV does not Granger Cause LN_PRICE	7.5013***	0.0063

***、** and *: indicate significance at 1%、5%, and 10% confidence levels, respectively.

From the above test results I find that in the former sub-period the null hypothesis that market price does not Granger cause NAV can not be rejected, yet the null hypothesis that NAV does not Granger cause market price can be rejected. Such outcome coincide with the previous results that NAV leads or dominates the market price in the information transmission and price discovery process for the first sub-period. However, in the second sub-period, the bi-direction Granger cause effects are both significant, yet the NAV Granger cause the market price is more significant. Therefore, with the amplification of the Taiwan 50 ETF trading volume (average daily volume of the second sub-period double that of the first sub-period) and the getting mature of the Taiwan 50 ETF market, the market price enhances its information transmission and price discovery dominance; both prices, NAV and market price, have opportunity to be in the leading position.

5.5 Impulse Response Analysis and Variance Decomposition

To provide a more detailed insight into the findings of VAR model, I further implement impulse response and variance decomposition analysis to understand the reaction of each price to the impact coming from itself or other variables. The forecast error variance decomposition provides an alternative way to observe the finding of the impulse response analysis. It enables in innovating the extent to which a variable helps in explaining the other variable. From the impulse response analysis, it is found that in the first sub-period, NAV dominates the market price, yet as for the second sub-period, the influence of market value has surged beyond that of NAV. As for the results of variance decomposition, no matter in the first or second sub-period, NAV is the most dominant one. Such results present the fact that with the doubled trading volume of Taiwan 50 ETF, its NAV can not lead the market price absolutely; instead, the two prices affect each other. Therefore, the combining results of this study tend to support the market liquidity hypothesis.

Combining the empirical results of VECM, causality test, impulse response analysis and variance decomposition, Table 8 presents the most dominate price for each analysis in both sub-periods. It can be revealed that in the first sub-period, NAV dominates the price discovery process of Taiwan 50 Index in an absolute manner; yet in the second sub-period with the doubled trading volume of Taiwan 50 ETF, the market price starts to lead NAV occasionally.

Table 8: Most Dominant Price under Various Analyses

Data period	VECM		causality test	impulse response	variance decomposition
	long-run	short-Run			
First	NAV	NAV	NAV	NAV	NAV
Second	Market Price	NAV	NAV	Market Price	NAV

6. Summary and Conclusions

"Trading in basket securities" or "portfolio trading" has become a trend that modern financial markets can not ignore. Such trading possesses advantages like lower transaction costs, faster response to the market-wide information and avoiding adverse selection problems (Subrahmanyam 1991); at the same time the multi-market trading also contributed to the enhancement of overall pricing efficiency.

This study observes the lead-lag dynamics between the NAV and market price of Taiwan 50 ETF in the 7-year period after its introduction to the Taiwan security market in order that the informed traders' preference and which hypothesis for explaining information transmission being supported can be comprehended. While the latter half period, Taiwan 50 ETF trading volume has doubled that of the first half, it is interesting to explore whether the instrument, highly capitalized stocks or ETFs, that informed traders choose to trade to react to their information has ever changed; in other word, to understand the relative ability of NAV (representing highly capitalized stock market) and market prices (representing ETF market) of Taiwan 50 ETF to discover prices. The empirical results indicate that the two series of prices of Taiwan 50 ETF, market prices and NAVs, form a cointegrated system with one common long-run stochastic trend. Nevertheless, prices from the two markets, ETF market and highly capitalized stock market, do not respond to information simultaneously. In the first half of the whole 7-year data period, NAVs lead the market prices in an absolute dominant position showing that informed traders still favor trading highly capitalized stocks to respond to the private information they get because of the consideration of liquidity and market depth. However, as for the second half data period, while the trading volume of Taiwan 50 ETF in this period has doubled, its market prices' abilities of information transmission and price discovery have been greatly enhanced. The two prices, NAV and market price, lead each other alternately. Those results suggest that the liquidity appears to be the primary factor in determining the relative rates of information transmission and price discovery of the Taiwan stock market; that is, "the market liquidity hypothesis" is found to gain more support in this empirical evidence from an emerging market.

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