The Impacts of Foreign Capital and Price Discovery Process between Taiwan and Singapore Futures Contracts

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This paper investigates the cross-market linkage between Singapore and Taiwan futures markets for the pre- and post-participation of qualified foreign institutional investors (QFIIs) in Taiwan futures’ trading. We employ error correction model and generalized impulse response function to gauge the causal transmission patterns between the two markets. The two markets cointegrated after the participation of QFIIs in Taiwanese market, suggesting that QFIIs play an important role between the two markets. We also find that Singapore futures market performs the price discovery of Taiwan stock index futures.

Keywords: foreign capital, price discovery, cross-market linkage, error correction model, generalized impulse response function.

1. Introduction

According to International Monetary Fund (IMF), the emerging Asian markets are the most attractive investment places for international investors, especially for the mutual funds and the pension funds.1 In 1980s, most of the Asian countries have capital controls imposed by local governments in order to stabilize the financial markets. However, in 1990s, the free capital markets evolutions have caused the Asian countries to liberalize financial controls.

The most important relaxation of capital control for Taiwan is to let the qualified foreign institute investors (QFIIs) begin trading stocks on December 28, 1990.2 Taiwan stock exchange (TSE) documents that foreign investors have accumulatively purchased the stocks for US $19.6 billion from 1991 through 2000. Futures contract was introduced at a time when the TSE

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1 See IMF “Emerging Markets Financing, 2000”.

2 According to regulations, QFIIs are limited to foreign banks, insurance companies, fund management institutions, securities firms, and other investment institutions meeting the qualifications set by Taiwan Securities and Futures Commission (SFC).
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began to attract more foreign investors.

In 1997, Singapore Exchange Derivatives Trading (SGX-DT) introduced the Taiwan Morgan Stanley Capital weighted stock index (TiMSCI) futures. One year later, Taiwan Futures Exchange (TAIFEX) introduced another capital weighted TSE index (TAIEX) futures on July 21, 1998. Taiwan stock index futures is one of the most actively traded futures in Singapore and Taiwan futures exchanges with an average 9,200 and 7,700 contracts per day in 2000, respectively.

The TiMSCI comprises of 77 stocks listed on the TSE and currently represents approximately 65 percent of the market value of the underlying overall stock market. The TAIEX index comprises of 531 listed stocks on the TSE. In 2000, the market capitalization for TSE is about 8,191,474 million Taiwan dollars (TWD) and the total trading value is 30,816,542 million TWD.

We believe that QFIIs prefer trading contracts in Singapore to Taiwan. The reasons are: first, Singapore provides a number of international stock indices with an easy means to transact in a liquid trading environment. Second, contract specifications and levels of regulation are different between the two exchanges. The TiMSCI futures contract is traded in U.S. dollars while the TAIFEX contract traded in TWD. To avoid the currency fluctuation the foreign traders may feel comfortable traded in Singapore. Also, the position limits for institutional traders is 1,000 contracts in TAIFEX and none for SGX-DT. Specially, the Taiwan government taxed transactions until April 2000. Moreover, the round-trip transaction fees in SGX-DT is much cheaper than that in TAIFEX. The regulation and fee structure suggest that Singapore is more flexible and cost-effective for trading than Taiwan. Consequently, we expect that foreign capital would like to trade in Singapore.

Hsu and Ho [8] propose a modified cointegration analysis to investigate the price interaction among TiMSCI futures, TAIFEX futures, and TAIEX spot index. They report that TiMSCI futures and TAIFEX futures did not cointegrate. They attribute this phenomenon to different types of traders in the market. Most of the participants in Singapore are informed traders while the uninformed traders are the major players in Taiwan futures market. The foreign capital is called as the informed trader in Taiwanese markets. Informed traders have relatively homogeneous beliefs in asset price. Therefore, they tend to buy and sell asset around its fair value. Uninformed traders have difficulties to distinguish hedging demand from fundamental information. So, we expected them to have a greater dispersion of beliefs and will trade the futures contracts in a wilder range around their fair value.
DeLong, Shleifer, Summers, and Waldmann[4] conclude that the general public (uninformed traders) can dominate the market and will exaggerate price movements in the market. Ong [16] reports that stock proprietors as well as general public usually “buy high sell low” while the foreign capital usually “buy low sell high”. Hsu and Lin[9] study the economic factors affecting the futures basis and report that the general public as well as futures proprietors enlarge the futures basis while the foreign capital narrow them down. These results indicate that foreign capital most of the time stabilized the Taiwanese markets. We expect that the foreign capital will make profits when cross-market arbitrage opportunities occur. Consequently, the cross-market information transmission will stronger after the participation of QFIIs in the Taiwan futures market.

This study finds that TiMSCI futures and TAIPEX futures cointegrated after the participation of QFIIs in TAIPEX. We also find that TiMSCI futures performs the price discovery role of the Taiwanese markets. These results are significantly different from earlier study conducted by Hsu and Ho[8]. The empirical results are important for several respects: One is that the role the QFIIs play in the cross-market linkage is important to the traders as well as the policy markers. The other is that investors can increase their profitability through this findings.

The rest of the paper is organized as follows: Section 2 is a review of literature. Section 3 describes the data. Section 4 describes the methodology and presents the results. Finally, section 5 concludes the paper.

2. Literature Review

The study on the linkage of futures price and its underlying spot price and their lead-lag relation are numerous. For example, Stoll and Whaley [20] studied on the S&P 500 and the Major Market Index; Wahab and Lashgari [22] on the S&P 500 and FTSE 100; and Huang and Shyu [11] on the TiMSCI. Stoll and Whaley[20] attributed  that the lead-lag relationship is possibly due to the differences in market structure, transaction costs, tax, market liquidity, and short sells constrains on the stock market and other regulatory constrains. Fleming, Ostdick, and Whaley[6] reported that the market with lower transaction costs will react the new information more quickly.

Prior studies also showed that the price discovery process is originated primarily from the futures exchanges; see, for examples, Stoll and Whaley[20], Chan[1], and Tse[21]. However, Huang and Shyu [11] and Hsu and Ho [9] reported that the price discovery process is originated primarily
from the stock exchange when Taiwan stock index futures was initially introduced. More recently, the interest of studies have focused on the cross-market linkages of futures contracts listed in different futures exchanges; see, for example, Craig, Dravid, and Richardson [2] and Tse, Lee, and Booth [21]. Sim and Zurbuegg [19] observed linkages on Nikkei index futures in the Japan and Australian futures markets. Roope and Zurbuegg [18] reported a common stochastic trend between Taiwan index futures and their underlying indices listed in Singapore and Taiwan exchanges.

Given the results from past studies, this paper analyzes the role of foreign capital in the cross-market linkage between the Singapore and Taiwan futures markets. We posit the following two hypotheses concerning the Singapore and Taiwan futures markets.

H1: There is a significant linkage between Singapore and Taiwan futures markets after the participation of QFIIs in Taiwan futures exchange.

H2: TiMSCI futures performs the price discovery of Taiwanese markets.

3. The Data

The sample period is from July 21, 1998 through February 19, 2001 and two sub-periods are divided. The first period is from July 21, 1998 through October 30, 1999 and the second period is from November 1, 1999 through February 19, 2001. The close time for TAIFEX and SGX-DT is at 12:15 pm from July 21, 1998 through December 31, 2000. And then close at 1:45 pm from January 2, 2001. We choose the close price as our data set. The two sub-samples are equally divided. There are a total of 690 daily observations. In order to avoid the expiration effects, the contract of nearest expiration is used until two days prior to expiration. We also construct three new price series setting the starting value of all series to be 1,000 on July 21, 1998. All price series are logarithm.

The reason for us to set apart the period is that we want to see the impact of the foreign capital on the linkage of the cross-market futures prices. QFIIs begin to trade TAIFEX futures on November 1, 1999. All the price data is from Megatime Technology Company. Table 1 presents summary statistics of the price series. The mean value of Taiwan stock futures during the sample period is on average lower than the underlying stock index. In addition, all the return series are stationary.

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3 During the sample period the average price level for Taiwanese markets is around 7,450 and 320 for TiMSCI.
Table 1  Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>TAIEX Spot</td>
<td>TAIEX futures</td>
</tr>
<tr>
<td>ADF (log prices)</td>
<td>-1.8381</td>
<td>-1.8570</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.0903</td>
<td>0.0895</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.3997</td>
<td>-0.2897</td>
</tr>
</tbody>
</table>

Note. Returns are generated by \( r_t = \log(x_t) - \log(x_{t-1}) \) where \( x_t \) are prices.

The 5% critical value from MacKinnon (1996) is -2.8699 to reject the null of a unit root.

4. Methodology and Results

A standard Johansen [12] trace test is conducted on the each pair of the series and all the three series to determine the long-run relationship. The results of this test appear in Table 2 and Table 3. Table 2 indicates before the participation of the QFIIs in the TAIFEX, the null hypothesis that there is no cointegration vector is not rejected at the 5% significance level for TiMSCI and TAIEX futures and TiMSCI futures and TAIEX spot. This means that there does not exist long-run equilibrium relationship between these series. However, after the participation of the QFIIs in the TAIFEX, all the three pairs series cointegrated, indicating that there exists long-run equilibrium relationship between these series. Table 3 displays the presence of one cointegration vector in the first sample period and two cointegration vectors in the second sample period. This provides supports to H₁ that the participation of QFIIs in TAIFEX make the two markets cointegrated.
Table 2  Johansen Tests for Different Pairs of Indices

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypothesized No. of CE(s)</td>
<td>Test Statistic</td>
</tr>
<tr>
<td>TiMSCI futures</td>
<td>None</td>
<td>11.5557</td>
</tr>
<tr>
<td>TAIFEX futures</td>
<td>Atmost 1</td>
<td>2.9639</td>
</tr>
<tr>
<td>TiMSCI futures</td>
<td>None</td>
<td>10.6482</td>
</tr>
<tr>
<td>TAIFEX Spot</td>
<td>Atmost 1</td>
<td>4.0875 *</td>
</tr>
<tr>
<td>TAIFEX futures</td>
<td>None</td>
<td>20.0399 *</td>
</tr>
<tr>
<td>TAIFEX Spot</td>
<td>Atmost 1</td>
<td>3.4949</td>
</tr>
</tbody>
</table>

Note. Results tabulated assume no trend component. ^ Indicates that the null hypothesis is rejected at the 5%-significance level. \* Indicates that the null hypothesis is rejected at the 1%-significance level.

Table 3  Johansen Test for the Three Indices

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>7/21/1998-10/30/1999</th>
<th>11/1/1999-2/19/2001</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test Statistic</td>
<td>Test Statistic</td>
</tr>
<tr>
<td>None</td>
<td>34.5418 *</td>
<td>81.2354 *</td>
</tr>
<tr>
<td>At most 1</td>
<td>10.5408</td>
<td>24.8079 *</td>
</tr>
<tr>
<td>At most 2</td>
<td>3.9231 *</td>
<td>1.0765</td>
</tr>
</tbody>
</table>

Note. Results tabulated assume no trend component. ^ Indicates that the null hypothesis is rejected at the 5%-significance level. \* Indicates that the null hypothesis is rejected at the 1%-significance level.

4.1 Error Correction Model

Engle and Granger [5] showed that cointegrated variables must have the error correction model representation. The ECM is a stochastic process in which the error correction term represents deviations from a long-run equilibrium relationship, while short-run dynamics are represented by lagged difference terms. That is, residual of last period will be modified if it deviates from the long-term equilibrium relationship. An ECM can closely examine the long-run and short-run lead-lag relationship between two variables. In this study, the ECM enables us to investigate which market performs the price discovery rule. The following ECM will be estimated:
\[ \Delta p_{t,i} = e(p_{t,i-1} - p_{t,j-1}) + \sum_{k=1}^{q} (\delta_{i,k}\Delta p_{t,j-k} + \delta_{j,k}\Delta p_{t,j-k}) + \varepsilon_i \]  

where \( p_i \) is the vector of prices; \( e \) is the speed of adjustment coefficient between prices in the two markets. \( \delta_i \) and \( \delta_j \) are vectors of autoregressive coefficients for \( k \) lags on markets \( i \) and \( j \), respectively.

In this dynamic system we conduct two regressions from equation (1) for each of the two sub-periods: LHS variable is regressed on cross-market equilibrium error and lagged difference on RHS and cross-market terms. The results of the error correction models are reported in Table 4. But only the error correction terms are reported.

LHS of Table 4 shows the results from TAIEX spot and TAIFEX futures for the first period. Both the error correction coefficients in the index futures and spot index markets are not statistically significant. But the futures response coefficient is three times more as strong as the spot market’s response coefficient, suggesting that the information flow from the spot market to the index futures market is stronger.

RHS of Table 4 shows the results from the second period. There are three error correction representations during this period. Interestingly, for this second period, TAIFEX futures and TAIEX spot have become two-way feedback relationships in the two markets. Both the error correction coefficients in the index futures and spot index markets are statistically significant, suggesting that both the index futures and spot index adjust towards the long-run equilibrium relationship when disequilibrium occurs. This is not surprising as more and more informed traders in the futures market, the information transmission between the futures and spot market will stronger.

The second error correction representation for the second period is TiMSCI futures and TAIFEX futures. The error correction coefficient is statistically significant at the 5% level in TAIFEX futures while the TiMSCI futures is not statistically significant, suggesting that most of the adjustment is made through the TAIFEX futures when disequilibrium occurs.

The third error correction representation for the second period is TiMSCI futures and TAIEX spot. The error correction coefficient is statistically significant at the 5% level in TAIEX spot while the TiMSCI futures is not statistically significant, suggesting that most of the adjustment is made through the TAIEX spot when disequilibrium occurs. The second and third error correction representations strongly suggest that the information
flow is from TiMSCI futures to Taiwanese markets. This provides supports to
H2 that TiMSCI futures performs the price discovery of Taiwanese markets.

Table 4  Results from Error Correction Models

<table>
<thead>
<tr>
<th></th>
<th>1998/7/22-1999/10/30</th>
<th>1999/11/1-2001/2/19</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Differenced Variable</strong></td>
<td><strong>Error Correction</strong></td>
<td><strong>Differenced Variable</strong></td>
</tr>
<tr>
<td>TAIEX spot</td>
<td>0.057 (0.534)</td>
<td>TAIEX spot</td>
</tr>
<tr>
<td>TAIEX futures</td>
<td>0.199 (1.670)</td>
<td>TAIEX futures</td>
</tr>
<tr>
<td>TiMSCI futures</td>
<td>0.122 (1.200)</td>
<td>TiMSCI futures</td>
</tr>
<tr>
<td>TAIEX futures</td>
<td>0.221 (2.402)</td>
<td>TiMSCI futures</td>
</tr>
<tr>
<td>TAIEX spot</td>
<td>0.184 (2.360)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Figures in parenthesis are t-statistics.

4.2 Granger Causality Test

Granger [7] provides the basis to investigate the causal relationship
between economic variables. Since cause cannot come after the effect, if a
variable affects another variable, the former must help to predict the latter.
The analysis of the effect of X on Y can be estimated as following
regressions:

\[
Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=1}^{n} \beta_i X_{t-i} + \varepsilon_t \\
X_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{i=1}^{n} \beta_i Y_{t-i} + \eta_t
\]

(2)

where \(Y_t\) and \(X_t\) are the different stationary price series and \(\varepsilon_t\) and \(\eta_t\)
are two uncorrelated white noise series.

The Granger causality test is very sensitive to the lag orders we choose.
Davidson and Mackinnon [3] suggest using more rather than fewer lags. We
choose 14 lags for our study because we feel that this is long enough for the
lags of one category volume to help to predict another.

The results from the second column of Table 5 indicate that there is a
unidirectional relationship between each market. The results also indicate the
information flow is from TiMSCI futures to Taiwanese markets. Moreover, in Taiwanese markets the information flow originates primarily from the stock exchange (i.e., spot market). This findings supports Huang and Shyu [11] and Hsu and Ho[8]. The third column of Table 5 indicates that there is a bidirectional relationship between each market. Also, the F-statistics show a stronger influence arising from futures markets to the spot markets.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TAIFEX futures does not Granger Cause TiMSCI futures</td>
<td>0.7499</td>
<td>2.1778</td>
</tr>
<tr>
<td>TiMSCI futures does not Granger Cause TAIFEX futures</td>
<td>2.2310&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.7423&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>TAIEX Spot does not Granger Cause TiMSCI futures</td>
<td>0.9898</td>
<td>2.0700&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>TiMSCI futures does not Granger Cause TAIEX Spot</td>
<td>1.9057&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.3990&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>TAIEX Spot does not Granger Cause TAIFEX futures</td>
<td>2.0727&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.9335&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>TAIFEX futures does not Granger Cause TAIEX Spot</td>
<td>1.6534</td>
<td>2.6879&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Note: <sup>a</sup> Indicates that the null hypothesis is rejected at the 5%-significance level.<br><sup>b</sup> Indicates that the null hypothesis is rejected at the 1%-significance level.

4.3 Generalized Impulse Response Analysis

In this study VAR is used to estimate the three dynamic simultaneous price equations on the structure of relationships. Both variance decompositions and impulse response functions are used in our study. The variance decompositions allow us to measure the relative importance of each market in generating unexpected variations of returns to a particular market. The impulse response functions allow us to estimate the dynamic responses of each of the markets due to a one-time standard deviation shock to a particular market. The information contained in the variance decompositions can be equivalently represented by graphs of the impulse response functions. Both variance decompositions and impulse response functions are obtained from the moving average (MA) representation of the original VAR system.

By construction, the innovations in VAR system are usually serially uncorrelated but can be contemporaneously correlated. In this case, it may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation $P$ to the innovations so that they become uncorrelated:

$$u_t = Pe_t - (0, D)$$
where $D$ is a diagonal covariance matrix. The results based on the variance decompositions and impulse response functions are generally very sensitive to the lag length and the endogenous variable ordering. In order to circumvent this problem, we employ the generalized impulse responses provided by Lee and Pesaran[15] and Pesaran et al. [17].

The pre-QFIIs and post-QFIIs generalized response impulses from one standard deviation shock to each of the three markets are traced out for each individual market in Figs. 1-3 (excluding the own shock to each market). In general the responses for the two sample periods are completed after the fifth day. Also, a shock from the post-QFIIs sample period is greater than the shock from the pre-QFIIs sample period, indicating that the informed traders make the cross-market reaction stronger.

We also conduct the generalized variance decompositions but are not report here. The result indicate that TiMSCI futures provides significant explanatory power to the forecast error variance of TAIFEX futures and TAIEX spot. This finding also supports H2 that TiMSCI futures dominates price discovery for Taiwanese markets.

$x$-axis represents days elapsed after shock; $y$-axis represents standard deviations; circled line refers to pre-QFIIs and triangled line refers to post-QFIIs.

Fig. 1. Generalized impulse responses from one St.D shock to TiMSCI futures

\[4\text{ In standard applications, these innovations are orthogonalized through Choleski decomposition.}\]
$x$-axis represents days elapsed after shock; $y$-axis represents standard deviations; circled line refers to pre-QFIIs and triangled line refers to post-QFIIs.

Fig. 2. Generalized impulse responses from one St.D shock to TAIFEX futures

$x$-axis represents days elapsed after shock; $y$-axis represents standard deviations; circled line refers to pre-QFIIs and triangled lines refer to post-QFIIs.

Fig. 3. Generalized impulse responses from one St.D shock to TAIEX spot

5. Conclusions

When futures contracts are listed in different markets, the prices linkage between the markets have become an important issue. Our study shows when the traders are different (the informed and the uninformed) in the futures markets, the uninformed traders tend to the think the Taiwan index futures as two financial instruments. Consequently, their price series behave in different ways. As more and more informed traders in the futures market, the
cross-market futures prices become cointegrated. Our results also show that
the exchange with more flexible trading regulations and lower cost will
dominate the price discovery. The Singapore exchange is the example of
playing a role in price discovery.

The results are useful to investors and Securities and Futures
Commission (SFC) in the Taiwan stock index futures market. For traders,
they can choose the optimal stock index futures to hedge their portfolios and
they can know which index securities performs the price discovery function.
For SFC, they can use these results as reference when making the regulations
and imposing technical constrains. For example, the participation of foreign
institutional investors in the Taiwan financial markets can improve the
market efficiency. In order to attract foreign institutional investors, the policy
maker can lower transaction costs as well as relax unnecessary constrains.

6. Acknowledgements

The Authors would like to thank two anonymous referees for their
comments and valuable suggestions. All errors are, of course, ours.

7. Appendix

Summary Specifications of TiMSCI Futures and TAIFEX Futures

<table>
<thead>
<tr>
<th>TAIFEX futures</th>
<th>TiMSCI futures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Size: TWD 200 × TAIFEX futures</td>
<td>Contract Size: USD100 × TiMSCI futures</td>
</tr>
<tr>
<td>Price Fluctuation: One index point (TWD 200)</td>
<td>Price Fluctuation: 0.1 index point (equivalent to USD10)</td>
</tr>
<tr>
<td>Delivery Months: Spot month, the next calendar month, and the next three quarter months</td>
<td>Delivery Months: two nearest serial months and four quarterly months on a March, June, September and</td>
</tr>
<tr>
<td>Last Trading Day: The third Wednesday of the delivery month of each contract</td>
<td></td>
</tr>
<tr>
<td>Daily Price Limit: ±7% of previous day's settlement price</td>
<td></td>
</tr>
<tr>
<td>Final Settlement Price: Special quotation provided by the Taiwan Stock Exchange</td>
<td></td>
</tr>
<tr>
<td>Trading Hours: 8:45am-1:45pm</td>
<td></td>
</tr>
<tr>
<td>Position Limit: Individuals: 300 contracts; Institutional investors: 1,000 contracts.a</td>
<td></td>
</tr>
</tbody>
</table>

a Refer to the original text for the exact number.
December cycle.

Last Trading Day: Second last business day of the contract month.
Daily Price Limit: ±7% of previous day's settlement price. Following the breach of the 7% limit, the TiMSCI futures allows for greater fluctuation after a cooling-off period.
Final Settlement Price: Official closing price of the TiMSCI spot index.
Trading Hours: 8:45 am – 1:45 pm
Position Limit: none

*a Institutional investors may apply for an exemption from the above limit on trading accounts for hedging purpose.

References


