Arbitrage and Price Behavior of the Nikkei Stock Index Futures

Kian-Guan Lim

INTRODUCTION

The Nikkei Stock Average Futures contract started trading at the Singapore International Monetary Exchange (SIMEX) on September 3, 1986. SIMEX became the first futures exchange to trade a stock index futures outside the country where the indexed stocks are traded. The stock index is a price-weighted index of 225 stocks selected from the first section of the Tokyo Stock Exchange. The stock index futures contract at SIMEX is traded in yen at a price of 500 times the index with a minimum price movement of 2500 yen. The contract is settled on a cash basis without actual delivery of share certificates. The Eurodollar futures contract, the high-sulfur fuel oil futures contract, and the Nikkei stock index futures contract are all actively traded at SIMEX. The number of Nikkei contracts traded daily has increased from about 2000 in 1988 to about 4000 in 1989. Despite the introduction, in September 1988, of a similar Nikkei futures contract in Osaka and the Topix futures contract in Tokyo, the Nikkei contract at SIMEX continues to be actively traded with no drop in trading volume.

ARBITRAGE AND PRICE BEHAVIOR

Brenner, Subrahmanyam, and Uno (1989) studied the arbitrage relationship between the prices of Japanese stocks traded on the Tokyo Stock Exchange as reflected in the Nikkei stock index and the prices of the Nikkei futures contract traded on SIMEX. Using the cost-of-carry model with discrete dividends but continuous interest compounding, they reported that transaction costs alone could not account for the significant overpricing of the futures by the model in the period from September 1986 to April 1988. Using the cost-of-carry model with continuous interest and dividend yield, Bailey (1989) found that for the March 1987 and June 1987 Nikkei futures contracts, the theoretical prices explained the actual prices quite well. He also employed the continuous-time model as in Ramaswamy and Sundaresan (1985), and reported that the pricing errors from the continuous-time model are not substantially different from those reported for the cost-of-carry model.

These studies employ daily data during the general period of September 1986 to September 1987. Except for the Brenner, Subrahmanyam, and Uno study, the daily

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Kian-Guan Lim is a Senior Lecturer in the Department of Finance and Banking at the National University of Singapore.

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close prices for futures and the underlying stock index used are asynchronous. This is because SIMEX closes 15 minutes after the close of trading on the Tokyo Stock Exchange. This is a problem also faced by some studies using U.S. futures data. The mismatch of spot versus futures data casts doubt on the empirical results, because the pricing models are based on simultaneous spot versus futures transactions.

Apart from the problem of nonsynchroneity there is also the problem of execution impossibility at the end of the trading session. Suppose the 2 PM futures trading data at SIMEX are used as in the Brenner et al. study in conjunction with the close of session N225 index in Tokyo. Since the execution of stock portfolio purchase or sale requires finite time, it is impossible to perform arbitrage at the end of the trading session in Tokyo even if the basis is too large. Therefore, while the Bailey study may not reject the cost-of-carry model due to nonsynchroneity, the Brenner et al. study may reject the model due to the problem of execution impossibility.

To circumvent the execution impossibility problem, this study employs an interesting intraday match-time data set to test the cost-of-carry model. Transaction costs are explicitly considered in the analyses. The presence of arbitrage opportunities is carefully investigated in the light of certain institutional details that are not considered in existing studies. A second issue addressed here is the intraday price behavior of the Nikkei futures contract. More specifically, the behavior of how spot and futures prices move within the transactions bounds is examined. MacKinlay and Ramaswamy (1988) investigated the behavior of the S&P 500 futures prices and index prices. They found evidence of positive autocorrelation in the spot index price-change series but not the futures price-change series. The variability of the futures price-changes was also larger than that of the spot price-changes. They also investigated the dynamics of the mispricing error, which they defined as the difference between the market futures price and the theoretical price, all normalized by the index value. They found persistent mispricing, especially for contracts long before maturity. In particular, the mispricing values were found to be positively autocorrelated.

This article shows that many of the statistical properties of the S&P 500 spot-futures prices are not manifested in the Nikkei contract. Why such differences exist is discussed.

TRANSACTION COST MODEL

The traditional cost-of-carry model in futures pricing was rigorously adapted to stock index futures pricing by Cornell and French (1983) who introduced dividend and tax effects into the model. Different variations of the model have been used, including ones with constant dividend flows and continuous interest compounding, and others with discrete dividends falling on actual payment dates. Chung (1990) also considered execution lags and the uptick rule for short sales of stocks in the model.

On the Nikkei stock index arbitrage, Brenner et al. (1989) estimated the transactions costs for brokers to be 0.59% on stocks (including commission and impact cost) and 0.34% on the futures (including commission and impact cost). For institutional investors such as banks and major corporations, the respective costs were 2.15% and 0.34%. When stock short-sale was involved, an additional cost of 0.1% was added to account for the loan of share certificates.[1] Those costs were expressed as percentages of the actual prices. Those cost estimates are used in this study.

[1]There is no uptick rule for short sales of stock under margin transactions in Japan. The low cost of 0.1% applies only to the most favored institutional investors. It consists largely of administrative costs rather than interest costs.

Let θ, C_L, and C_S denote the costs associated with a futures transaction, a stock purchase or sale transaction, and a stock short-sale transaction. Profitable arbitrage would then occur when the market futures price falls outside the range denoted by the interval $(F_t^- F_t^+)$, where the lower bound F_t^- and the upper bound F_t^+ are given as follows.

$$F_t^+ = \left(\frac{1}{1-\theta}\right)[S_t(1 + C_L)e^{r\tau} - DIV_t] \tag{1}$$

$$F_t^- = \left(\frac{1}{1+\theta}\right)[S_t(1 - C_s)e^{r\tau} - DIV_t] \tag{2}$$

The formulation of the cost-of-carry model here is slightly different from that in Brenner et al. because the futures transactions cost is allocated directly to the futures instead of lumping it at the spot price. The term DIV_t indicates the future value at contract maturity of the accumulated dividends from time t onward. t is the current time (within the day), S_t is the spot price[2] at t, r is the risk-free interest rate (approximated by the Japanese money market or Gensaki rate), and τ is a fraction of a year denoting the time to maturity of the contract as from time t.

The actual futures price F_t^* is then compared with the bounds (1) and (2). Any arbitrage profit is defined as

$$\pi_t = \max(0, F_t^* - F_t^+, F_t^- - F_t^*)$$

per futures contract. In computing the term DIV_t in eqs. (1) and (2), two important features of Japanese corporate practice should be considered, though these are not recognized in existing studies. First, dividends declared to be payable on a particular month are customarily paid four months later. Second, it normally takes about three to five business days for stock buyers to register their names and, hence, be eligible for any declared dividends. When actual divident receipt dates are accounted for, as in this article, the DIV_t term is, in effect, smaller compared to those computed in existing studies. The future value of dividend at contract maturity can be expressed as

$$DIV_t = \sum_j D_j e^{-r\tau_j}$$

where j denotes the order of the dividend payment at a particular time between t and maturity, and τ_j is the time from contract maturity to the time the j^{th} dividend is received.

In Japan, capital gains and income earned by brokerage firms are taxed at the corporate marginal tax rate. Up to 80% of dividend income are exempt from tax, hence, tax on dividend is negligible. The inclusion of a tax effect for the Japanese stock index futures would be similar to imposing a tax rate on the arbitrage profit π_t. Since the tax rate is always less than 1, arbitrage would still take place provided

[2] In all the studies researched, this is taken to mean the spot index. For the Nikkei 225 Index, however, the actual yen value of the portfolio of 225 stocks, holding one share in each stock, is the index multiplied by the index divisor, which was about 10 in the period 1986–1988. Therefore, the actual aggregated dividend value is normalized by the index divisor before being entered as DIV_t in the formulae. The value of one futures contract traded at about the same price as the spot would be about 500/10 or 50 times the total value of this stock portfolio. For a realizable portfolio of 1000 shares in each stock, the value of the futures contract would be about only 1/20 of the portfolio's value. For arbitrage, an investor buying one lot each of the 225 Nikkei stocks would have to purchase about 20 Nikkei futures contracts.

$\pi_t > 0$. Therefore, it is not crucial to know the incident marginal tax rate for any brokerage or institutional firm for the analyses here; eqs. (1) and (2) represent a very accurate set of bounds without adjusting for taxes.

DATA

In this article, intraday trading data of the Nikkei 225 stock index futures are used. Because it is difficult to obtain the data, the study is limited to four contracts: June 1988, September 1988, June 1989, and September 1989. For each of the contracts, five trading days are randomly selected provided that they fall on different days of the week.[3] This is to eliminate any day-of-week bias as may be suggested by studies such as Ziemba (1990).

The primary data set consists of a time-stamped transactions record called the "Times and Sales" record kept by the brokerage firm. These transactions data chronicle the prices at which trades occur.[4] The corresponding traded volumes, however, are not available. Stock index quotes of the Nikkei spot index at one-minute intervals are provided by the Exchange. This index is computed by the Quotation Information Center KK (QUICK), a subsidiary of the Nihon Keizai Shimbun.

Using the data set, a five-minute interval subsequence of the futures trading data is constructed, because trading on certain days is not continuous and has gaps of up to three minutes. When such gaps are larger than five minutes, the data are excluded. This is not a recurrent problem. The last traded futures price in each five-minute interval is matched with the spot index at the end of that five-minute interval. The time is used also in time compounding of interest costs.

The dividends data of the 225 stocks in the index are from various issues of the *Japan Stock Journal*. They are time-recorded to ensure that the correct present values are taken. The Gensaki rates are from the Nihon Keisai Shimbun. The Gensaki market is an over-the-counter market that is characterized by its repurchase agreements. The short-term bills (less than six months) in this market are very actively traded, highly liquid, and largely unrestricted by the Central Bank. The securities are issued by the municipalities and backed by the government. Therefore, the rates are very close to being risk-free and are suitable for use here.[5]

SPOT-FUTURES ARBITRAGE TEST

Employing the above data, the arbitrage profit π_t is computed for each five-minute point over time for each of the 20 trading days. The empirical results are reported in Table I. From the results in Table I, it is obvious that arbitrage opportunities, i.e., making positive profit π_t, are quite rare, certainly not as common as suggested by Brenner et al. The average deviation of the futures price from its model price and normalized by the spot rate, termed the mispricing error by MacKinlay and Ramaswamy (1988), is between -1.2 and 1.2%. In most of the trading days, the

[3]The actual dates are 3/18, 3/24, 3/30, 4/4, 4/12, 8/19, 8/23, 8/29, 9/1, and 9/7 in 1988; 3/17, 3/20, 3/30, 4/4, 4/12, 8/14, 8/23, 8/29, 9/1, and 9/7 in 1989.

[4]The time-stamping is generally accepted by traders to be accurate. This could be due to the manageable volumes traded at the floor of the Exchange.

[5]Other short-term Japanese money market rates include the Bill Discount, the Call Money, and the Treasury-bill rates. The Bill Discount rates are very much controlled by the Central Bank and the rates are kept artificially low. The other rates are available only to domestic financial institutions and are highly regulated.

Table I
THEORETICAL ARBITRAGE PROFIT IN NIKKEI 225 FUTURES–SPOT TRADING (MEAN VALUES PER TRADING DAY)

	Π	Abs (Π)	Π%	Abs (Π%)	Mis%	Abs (Mis%)
June 1988 contract						
Day 1	0.00	0.00	0.00	0.00	−0.532	0.532
Day 2	0.00	0.00	0.00	0.00	−0.430	0.430
Day 3	−11.40	11.4	−0.04	0.04	−1.020	1.020
Day 4	−61.50	61.5	−0.23	0.23	−1.220	1.220
Day 5	0.00	0.00	0.00	0.00	−0.020	0.093
September 1988 contract						
Day 6	0.00	0.00	0.00	0.00	−0.531	0.531
Day 7	0.00	0.00	0.00	0.00	−0.650	0.650
Day 8	0.00	0.00	0.00	0.00	−0.094	0.171
Day 9	−0.83	0.83	−0.00	0.00	−0.280	0.303
Day 10	0.00	0.00	0.00	0.00	0.385	0.385
June 1989 contract						
Day 11	36.50	36.50	0.11	0.11	1.020	1.020
Day 12	68.00	68.00	0.21	0.21	1.180	1.180
Day 13	0.00	0.00	0.00	0.00	−0.186	0.198
Day 14	0.00	0.00	0.00	0.00	−0.006	0.115
Day 15	0.00	0.00	0.00	0.00	−0.135	0.166
September 1989 contract						
Day 16	0.00	0.00	0.00	0.00	0.179	0.184
Day 17	0.00	0.00	0.00	0.00	0.446	0.446
Day 18	0.00	0.00	0.00	0.00	0.577	0.577
Day 19	0.00	0.00	0.00	0.00	0.039	0.099
Day 20	0.00	0.00	0.00	0.00	0.276	0.276

Note: Π denotes the profit from trading in one share each of the 225 stocks; Π is in yen. Positive Π denotes profit when the arbitrageur is long in stock and short in futures. Negative Π denotes profit abs (Π) when arbitrageur is long in futures and short in stocks. Π% is Π divided by the contemporaneous futures price, in percentage terms. Mis is the mispricing of futures expressed as: (market F − average of upper and lower bound futures price) ÷ contemporaneous spot price.

average mispricings are about −0.5–0.5% which show greater deviations than what Bailey reports.[6] The results reported here are based on the broker's transactions costs (the lowest possible). When the institutional costs are applied, there is no instance in the 20 trading days when π_t is different from zero. This suggests, quite clearly, that no arbitrage profit could be made by those outside of the brokerage business. This is a strong result.

[6]Bailey's (1989) study was based on an earlier period, up to 1987. The time period studied here extends past that of Brenner et al. (1989).

For brokers, there are only five days in which π_t is positive for some t within those days. It is worth noting that when such cases arise, the positive π_t usually persists through most parts of the trading day. Two days of the June 1988 contract provide positive π_t through an underpriced futures, i.e., the arbitrageur can buy futures and short the spot, or sell existing holdings of stocks. Two days of the June 1989 contract provide overpriced futures, i.e., the arbitrageur could sell futures and buy into spot. Day 9 has an arbitrageable incidence at the opening trade only. The rest of that day returns zero profit.

Despite the positive π_t for the five trading days, examining the institutional details suggests that it is difficult to realize arbitrage profit. Suppose the rate of return is defined as π_t divided by S_t. Then the maximum rate of return from the arbitrage in these cases is about 0.3%. In more than 50% of the time points where π_t is positive, the rates of return are less than 0.1%. This implies that a change in spot prices above 0.3% during the time delay between executing the futures trade and executing the trades on the 225 Japanese stocks would wipe out the expected profit. This possibility is investigated by checking the volatilities of the spot index on the four days when π_t is positive. The average time it takes for the spot price to change by 0.3% during the active trading periods of the day is calculated.[7] Only three one-minute intervals in the four days are found. In general, the spot index changes do not exceed this level even for up to one hour. This implies that, in theory, it is possible to execute the 225 trades on the 225 stocks before the spot prices change too much to wipe out the arbitrage profit. These already rare occurrences of positive π_t or boundary violations may be even more infrequent, as suggested by Chung (1990).

Moreover, the possibility of executing futures trades in an arbitrage is investigated also. The daily trade volumes for the four days, as well as the number of trades in each of the days, are obtained. The average number of contracts traded per transaction during each day is about 10–25 contracts.

Since the number of futures contracts required to complete the arbitrage when one lot each of the 225 Nikkei stocks is traded is about 20,[8] any arbitrage feasibility is limited to about 20 futures contracts. This is also the minimum possible number of transactions in the stock market. Since the gains are so small, and perhaps even smaller in probabilistic terms when potentially many brokers vie for this profit, the arbitrage possibility is highly limited.

EMPIRICAL PRICE BEHAVIOR

Mackinlay and Ramaswamy (1988) employed first differences in the logarithm of the futures price and in the logarithm of the index value. Using a 15-minute interval, they found positive first-order autocorrelations of the index series ranging from 0.038–0.41 across 16 contracts. Using longer intervals, they indicated that the first-order autocorrelations became insignificantly different from zero. They attributed these observations to nonsynchronous (or stale) index prices across 15-minute intervals.

[7]The Japanese Tokyo Stock Exchange trades from 9:00 AM to 11:00 AM, and breaks from 11:00 AM to 1:00 PM before resuming trading at 1:00 PM to close at 3:00 PM.

[8]There are a small number of stocks traded in lots of 100 shares. These shares have higher par values, above 500 yen. This would imply that less than 20 futures contracts are required. However, this introduces an additional problem, since futures contracts have to be traded in wholes. The deviation between the futures value and the spot value implies additional risks. The number of futures contracts could also be grossed up to match the value of a larger portfolio of stocks with more than one lot in each of the 225 stocks; but, this means trades in excess of the 20 futures contracts.

If the stale price feature of the spot index is universal, then one would expect the Nikkei index to display the same positive first-order autocorrelation. This would be even more pronounced with the five-minute interval used in this study. There are few significantly positive or negative autocorrelations for both the spot index and the futures price changes for the 4 Nikkei contracts. Table II shows the averages of the statistics across the five trading days of each contract. It is observed that the autocorrelations are not significantly different from zero. The first autocorrelation of the spot series ranges from −0.36–0.38 for all contracts. The stale price feature of the S&P 500 index is not observed here. Extending the intervals in this study does not alter the results. This could imply that the index reflects accurately current traded prices of stocks within the last five minutes.

Unlike the finding by MacKinlay and Ramaswamy that the variability of the futures price change is higher than that of the spot price change of the S&P 500, the results of this study do not indicate this tendency. There are considerably many days when futures trading is less volatile.

In Table III, the time series properties of the mispricing series are shown. Similar to the observations in MacKinlay and Ramaswamy's study, the mispricing series exhibits high positive autocorrelation. On average, the first autocorrelation is significantly above 0.8 for three of the contracts. The tendency is for the series to stay

Table II
SUMMARY STATISTICS ON THE CHANGES IN LOGARITHMS OF NIKKEI 225 FUTURES AND SPOT INDEX PRICES (FIVE-MINUTE-INTERVAL TRANSACTION DATA)—THE STATISTICS ARE AVERAGES ACROSS FIVE TRADING DAYS OF EACH CONTRACT

Contract		Mean (%)	SD (%)	Autocorrelations (Lag) 1	2	3	4	No. of Observations
June 1988	F[a]	−0.003	0.050	0.04	−0.02	−0.04	−0.01	46
				(0.44)	(0.64)	(0.56)	(0.49)	
	S[b]	0.008	0.050	0.07	0.04	0.05	0.07	
				(0.37)	(0.39)	(0.40)	(0.35)	
Sept. 1988	F[a]	−0.006	0.070	−0.09	−0.03	−0.08	0.32	47
				(0.66)	(0.57)	(0.67)	(0.29)	
	S[b]	−0.010	0.062	−0.01	0.07	0.14	0.07	
				(0.57)	(0.44)	(0.19)	(0.42)	
June 1989	F[a]	0.002	0.059	−0.21	0.02	−0.01	0.16	50
				(0.80)	(0.48)	(0.53)	(0.23)	
	S[b]	−0.001	0.073	0.09	0.22	0.11	0.03	
				(0.35)	(0.11)	(0.27)	(0.40)	
Sept. 1989	F[a]	−0.001	0.059	0.03	0.04	0.07	−0.07	32
				(0.44)	(0.43)	(0.55)	(0.73)	
	S[b]	−0.006	0.085	−0.08	−0.14	−0.06	−0.08	
				(0.62)	(0.70)	(0.58)	(0.64)	

[a]Denotes the futures statistics.
[b]Denotes the spot index statistics.
The numbers in parentheses denote the average of the P-values.

Table III
SUMMARY STATISTICS ON THE MISPRICING ERRORS OF NIKKEI 225 FUTURES AND SPOT INDEX PRICES (FIVE-MINUTE INTERVAL TRANSACTION DATA)—THE STATISTICS ARE AVERAGES ACROSS FIVE TRADING DAYS OF EACH CONTRACT

			Autocorrelations (Lag)			
Contract	**Mean**	***SD***	**1**	**2**	**3**	**4**
June 1988	−0.0061	0.0009	0.8214 (0.0000)	0.6765 (0.0001)	0.5467 (0.0055)	0.4096 (0.0661)
Sept. 1988	−0.0021	0.0014	0.8512 (0.0000)	0.7529 (0.0001)	0.6206 (0.0100)	0.4939 (0.0804)
June 1989	0.0043	0.0016	0.8768 (0.0000)	0.7576 (0.0000)	0.6365 (0.0056)	0.4993 (0.0541)
Sept. 1989	0.0034	0.0011	0.6972 (0.0006)	0.4789 (0.0495)	0.3675 (0.1537)	0.2416 (0.2377)

The numbers in parentheses denote the average of the P-values.

above or below zero for the entire trading day. The overall average mispricing for the various days of the four contracts is −0.11%.

Because the results so far indicate that arbitrage activities are highly limited, it is of interest to examine the behavior of the futures and spot prices within the transactions bounds. Since it is empirically noted that futures traders largely base their actions on basis movements, the statistical properties of the basis are examined. The basis is the difference between the futures price and the spot price. From the disaggregated statistics (not reported here for lack of space), it is obvious that the sign of the basis persists through the trading day. In other words, when the futures price is above the spot index, it is unlikely for the direction to be reversed within a trading day. This is shown clearly by the high average positive autocorrelation in the basis.

Examining the basis change however, it is noted that there are significant (at 5% level one-tail) negative first order autocorrelations in the basis change. This happens in days 5, 6, 10, 11, and 19. On average, as shown in Table IV, the basis changes are negatively first-autocorrelated for all the contracts. This implies that basis increase tends to be followed by basis reduction in the subsequent five minutes, and vice versa. Beyond the initial five minutes however, the autocorrelations are not significantly different from zero in any of the trading days. There is, therefore, some evidence that the Nikkei futures market at SIMEX may not be weak-form efficient, and that profitable opportunities exist for floor traders who follow the prices minute-by-minute. On the contrary, futures speculators who trade through brokers may lose on average, as they have no means of monitoring the minute-by-minute price movements.

The cross-correlation properties of the futures price change and the spot price change are examined next. Kawaller, Koch, and Koch (1987) found that, for the S&P 500, the futures price movements consistently led index movements by 20–45 minutes, while movements in the index rarely affected futures beyond one minute. If the same observations are applicable in the Nikkei contract, then one would be

Table IV
SUMMARY STATISTICS ON THE BASIS AND CHANGE IN BASIS OF NIKKEI 225 FUTURES AND SPOT INDEX PRICES (FIVE-MINUTE INTERVAL TRANSACTION DATA)—THE STATISTICS ARE AVERAGES ACROSS FIVE TRADING DAYS OF EACH CONTRACT

				Autocorrelations (Lag)			
Contract		Mean	*SD*	1	2	3	4
June 1988	B[a]	−10.8	24.9	0.82	0.67	0.54	0.41
	C[b]	−0.47	13.18	−0.07	−0.04	0.11	0.01
				(0.60)	(0.59)	(0.27)	(0.47)
Sept. 1988	B[a]	−30.6	38.8	0.85	0.75	0.62	0.49
	C[b]	0.50	18.73	−0.09	0.03	−0.01	0.12
				(0.59)	(0.46)	(0.55)	(0.26)
June 1989	B[a]	381.9	53.7	0.85	0.75	0.63	0.50
	C[b]	0.43	24.21	−0.08	−0.00	0.04	0.10
				(0.63)	(0.52)	(0.52)	(0.25)
Sept. 1989	B[a]	192.8	39.1	0.69	0.48	0.36	0.24
	C[b]	3.22	28.62	−0.17	−0.13	0.04	−0.08
				(0.76)	(0.77)	(0.41)	(0.60)

[a] Denotes the basis statistics.
[b]Denotes the basis change statistics.
The numbers in parentheses denote the average of the P-values.

able to observe positive correlations of forward spot price changes with current futures price changes, but zero correlations of the latter with lagged spot price changes. In Table V, the average correlations of current futures price change with forward, current, and lagged spot price changes are reported for each contract. The various price-change variables are prewhitened prior to computing the cross correlations. From the disaggregated results, based on daily statistics, two observations can be made. First, and most prominent, the contemporaneous price changes of the futures and the spot are strongly and positively correlated. On average, this shows clearly in Table V. This feature was also observed in the Kawaller et al. study.

The second observation is that there is no persistent positive correlation between forward spot price changes and current futures price changes. Neither is there such a relationship between current futures price changes and lagged spot price changes. Therefore, current futures price movements do not lead spot price movements. This suggests that the spot market is efficient with respect to lagged information contained in the current futures positions, and that the futures market is efficient with respect to lagged information contained in the spot prices.

That futures price movements at SIMEX do not affect the Tokyo stock prices is not surprising given the relatively small size and transactions volulme at SIMEX. It is also noted that useful information is contained in the lagged basis but not in the lagged spot price. This suggests that it is the lagged futures price that is important to scalper's trading. This deduction is entirely consistent with anecdotal evidence of scalper's profitability in intraday trades. This profitability may arise not because of

Table V
SUMMARY STATISTICS OF THE CORRELATIONS OF CHANGES IN LOGARITHMS OF NIKKEI 225 FUTURES (F) AND SPOT INDEX PRICES (S) (FIVE-MINUTE INTERVAL TRANSACTION DATA)—THE STATISTICS ARE AVERAGE ACROSS FIVE TRADING DAYS OF EACH CONTRACT

	Cross-Correlations of S_{t+1}, F_t (t-Values)						
Contract	**−3**	**−2**	**−1**	**0**	**+1**	**+2**	**+3**
June 1988	−0.0517	−0.0512	−0.2050	0.5387	−0.2253	0.0259	−0.0378
	(0.57)	(0.57)	(0.81)	(0.00)	(0.84)	(0.50)	(0.52)
Sept. 1988	0.0072	−0.0251	−0.3293	0.6099	−0.2866	0.0289	−0.0757
	(0.44)	(0.55)	(0.95)	(0.00)	(0.94)	(0.41)	(0.67)
June 1989	−0.1138	0.1422	−0.3010	0.3849	−0.2191	0.0995	0.0033
	(0.73)	(0.22)	(0.89)	(0.08)	(0.83)	(0.29)	(0.51)
Sept. 1989	−0.0208	−0.0389	−0.1575	0.3114	−0.0452	−0.0618	0.0088
	(0.55)	(0.53)	(0.67)	(0.11)	(0.55)	(0.59)	(0.59)

Notes: The variables are prewhitened using an AR(1) fit on the deviation from the means. See Fuller (1976, p. 237).

The numbers in parentheses is the average of the P-values.

the scalper's speculation, but as a reward for his role in providing liquidity on the trading floor.

CONCLUSION

This article studies the Nikkei stock average futures contract using intraday transactions data. The study avoids the data mismatch and the execution impossibility problems of earlier studies. Much care is taken to employ the proper time-discount values of the Japanese dividends. Transaction costs are accounted for and Gensaki interest rates are appropriately used.

Using simultaneous spot and futures price trading data at five-minute intervals, it is found that arbitrage opportunities are very limited. In fact, no arbitrage profit exists for institutional traders during the days examined. This result is in contrast to earlier studies. The result is not surprising when one examines the relatively low trading volume (compared to CME's S&P 500) and when one computes the average number of contracts traded per transaction. There are about 10–25 per transaction on those few days when the mispricing errors exceed the broker's transactions costs. This means that about one lot each of the 225 Nikkei stocks is employed in an arbitrage, if any, and the profit would be small.

Examining the price behavior of the spot index and futures, no evidence of stale spot prices beyond five minutes is found, and it is concluded that the Nikkei spot market is weak-form efficient with respect to information of futures prices at SIMEX. This characterization differs from those found in the S&P 500 contracts examined in other studies. Within the transaction bounds, the futures prices at SIMEX appear to be largely influenced by two factors: First, contemporaneous spot price movements within the five-minute interval are highly positively correlated with the futures price movements; second, the basis changes are negatively correlated, and there appears to be opportunities for floor traders or "scalpers" to earn abnormal profits.

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