A Study on Developing a Profitable Intra-day Trading System for KOSPI 200 Index Futures Using the US Stock Market Information Spillover Effect

Sun Woong Kim* · Heung Sik Choi** · Byoung Hwa Lee***

Abstract

Recent developments in financial market liberalization and information technology are accelerating the interdependence of national stock markets. This study explores the information spillover effect of the US stock market on the overnight and daytime returns of the Korean stock market. We develop a profitable intra-day trading strategy based on the information spillover effect. Our study provides several important conclusions. First, an information spillover effect still exists from the overnight US stock market to the current Korean stock market. Second, Korean investors overreact to both good and bad news overnight from the US. Therefore, there are significant price reversals in the KOSPI 200 index futures prices from market open to market close. Third, the overreaction effect is different between weekdays and weekends. Finally, the suggested intra-day trading system based on the documented overreaction hypothesis is profitable.

Keywords : Information Spillover Effect, Overreaction Hypothesis, Weekend Effect, Intra-day Trading System

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1. Introduction

Empirical examinations of international stock market movements reveal a substantial amount of interdependence between national stock markets [Grubel and Fadner, 1971; Bessler and Yang, 2003; Awokuse et al., 2009]. Recent developments in financial market liberalization and information technology are accelerating the integration of international stock markets. For example, some Korean investors monitor the real-time movements of the US stock market all night long to forecast domestic stock market prices for the following morning. The information accumulated overnight is reflected in the opening prices of Korean stocks. If the stock market is efficient, the opening prices fully reflect the overnight information. Therefore, we cannot earn abnormal returns using the overnight information.

Several studies have presented empirical evidence of the impact of US stock market information spillover on other stock markets. Eun and Shim [1989] show that a substantial amount of interdependence exists between the world's nine major stock markets and the US stock market is found to be the most influential market in the world. Hamao et al. [1990] find that unexpected changes in foreign market indices are associated with significant spillover effects on the conditional means of the domestic markets for both open-to-close and close-to-open returns. Contrary to informational efficiency, Gato [1990] shows that lagged US returns are positively correlated with both current Japanese overnight returns and open-to-close Japanese returns. Becker et al. [1992] find a significant positive correlation between lagged S&P 500 returns and the Nikkei 225 open to 10 a.m. returns and suggest that the documented significant correlation is attributable to a sticky Japanese opening value that is associated with the use of non-synchronous index data.

The information spillover effect on the Korean stock market also has been documented. Jeon and Jang [2004] show that the response of the Korean stock market to shocks in US stock market is strongly positive. Shin [2009] shows that the Dow Jones index influences major Asian market indexes, including Korea. Kim et al. [2003] test the hypothesis of market efficiency through the information spillover effect. They show evidence of statistically significant conditional mean and volatility spillover effects from the daytime returns and volatility of NASDAQ to the overnight returns and volatility of KOSDAQ. Hong and Moon [2005] analyze the S&P 500 and NAS DAQ spillover effects upon KOSPI and KOSDAQ. They conclude that good news overnight from the US increases the Korean stock market volatility more than bad news does.

Most studies find existence of higher volatility that is associated with market opening. This may reflect the overreaction of investors to new information that has been accumulated overnight. Kim and Choi [2010] find higher volatility in daily open-to-open returns than in close-to-close returns for the KOSPI 200 index. Fung et al. [2010] find that intraday price reversals exist in Asian index futures markets,

including the KOSPI 200 index futures market. They conclude that investors in Asian stock markets overreact to overnight returns of the US stock market in determining the opening prices of stock index futures contracts. This is consistent with the argument of De Bondt and Thaler [1985] that price reversal is evidence of overreaction. Kim [2009] shows that lagged S&P 500 index returns have significant influence on the overnight and daytime returns of KOSPI. He concludes that the Korean stock market is not efficient with regard to the information spillover effects of the US stock market. While the overnight returns of the Korean stock market are positively correlated with the lagged returns of the US stock market, daytime returns are negatively correlated. Fung et al. [2010] find the so-called weekend effect in the overreaction hypothesis. They show that investors' overreaction on Mondays is reduced when investors have weekends to calm down and digest overnight news.

Investors in the Korean stock market feel that overnight information from the US stock market is the most influential factor regarding current domestic stock prices. The rise or fall of opening prices in the Korean stock market coincides with that of the overnight US stock market almost every day. If Korean investors overreact to overnight information from the US in determining the opening prices, intraday price movements after the market opens may reverse. A large number of short-term traders forecast the opening prices of the KOSPI 200 stock index futures contract based on overnight information from the US stock market and day-trade the KOSPI 200 stock index futures contract using the degree of response that is reflected in the opening prices.

Using statistical metrics to confirm that information spillover effects from one stock market to other stock markets are significant, most previous studies of the interdependence of national stock markets conclude that stock markets are inefficient. The efficiency of stock markets cannot be rejected if we cannot profit from the documented information spillover effects. Financial theory asserts that if stock market is inefficient, speculators can outperform the market by exploiting the market inefficiency [Sharpe, 1991; Lee et al., 2010]. In this study, we explore the influence of US stock market information on the overnight and daytime returns of the KOSPI 200 stock index futures contract and devise a KOSPI 200 stock index futures trading system to capitalize on the documented empirical regularities. As pointed out by Becker et al. [1992], empirical results using stock price indexes may be subject to non-synchronous problems. The use of the KOSPI 200 stock index futures prices makes our empirical results free from non-synchronous problems and enables economic analysis of the devised trading systems. Moreover, the KOSPI 200 stock index futures contract is one of the most actively traded markets in the world and as such sheds much light on the debate regarding the efficient market hypothesis.

Section 2 provides the data and testable hypotheses. The empirical results are presented in Section 3. Section 4 devises a profitable in-

tra-day trading system for KOSPI 200 index futures based on the US stock market information spillover effect. The conclusions are presented in the final section.

2. Data and Testable Hypotheses

2.1 Data

This study explores the overnight US stock market information spillover effect on the returns of the KOSPI 200 stock index futures contract. The daily closing prices of the S&P 500 index (hereafter, SP), Dow Jones Industrial Average (DJ), NASDAQ (ND), and Chicago Board Options Exchange volatility index, viz., VIX (VX) are used for the US stock market information. The daily opening and closing prices of the KOSPI 200 index (KP) and KOSPI 200 index futures contract (KF) are included for the Korean stock market data. The sample period is from January 4 1999 to July 30 2010. Each index return is calculated as the percent log difference as follows :

$$R_t^i = \{\ln(C_t^i) - \ln(C_{t-1}^i)\} \times 100, \quad (1)$$

where C_t^i *is a closing price of index* i *on day* t and $i = SP, DJ, ND, VX, KP,$ and KF.

$$r_{co,t}^i = \{\ln(O_t^i) - \ln(C_{t-1}^i)\} \times 100, \quad (2)$$
$$r_{oc,t}^i = \{\ln(C_t^i) - \ln(O_t^i)\} \times 100,$$

where $r_{co,t}^i$ *is an overnight return of index* i *on day* t, $r_{oc,t}^i$ *is a daytime return of index* i *on day* t, O_t^i *is an opening price of index* i *on day* t, and $i = KP$ and KF.

The daily return is decomposed into the overnight and daytime returns as $R_t^i = r_{co,t}^i + r_{oc,t}^i$. Trading on the KOSPI 200 index futures started in 1996. The settlement practice through theoretical pricing model distorted the opening and closing prices of the KOSPI 200 index futures contract until 1998 when the Korea Exchange modified the settlement practice. Our sample period is free from this settlement problem.

2.2 Testable Hypotheses

(1) The Information Spillover Hypothesis

Recent studies on causal linkages between national stock markets typically find that the US stock market leads other stock markets. Overnight information on the US stock market is widely known to Korean investors and this exogenous event has a regular influence on the Korean stock prices on a daily basis. To see whether adding lagged prices of the US stock market can improve the explanation for current Korean stock prices, we use the Granger causality test.

Liu et al. [2008] present test models for linear Granger causality. Suppose $X = \{x_t\}$, $Y = \{y_t\}$ are two random time series, and $X_t = \{x_{t-s}, s \geq 0\}$, $Y_t = \{y_{t-s}, s \geq 0\}$ are their entire time series up to day t. Then X is said to Granger cause Y if the prediction of a certain aspect of the probability distribution of Y_t is better using X_{t-1} and Y_{t-1} than that using only Y_{t-1}. Suppose Y_t denotes the return on Korean stock prices(US stock prices) and X_t denotes the return

on US stock prices (Korean stock prices) on day t.

$$Y_t = \alpha_{1,0} + \sum_{i=1}^{m} \alpha_{1,i} Y_{t-i} + \epsilon_{1,t} \quad (3)$$

$$Y_t = \alpha_{2,0} + \sum_{i=1}^{m} \alpha_{2,i} Y_{t-i} + \sum_{j=1}^{k} \beta_j X_{t-j} + \epsilon_{2,t}$$

Given this specification, the null hypothesis for the information spillover effect with Granger causality is :

$$H_0 : \beta_1 = \beta_2 = \cdots = \beta_k = 0. \quad (4)$$

(2) The Overreaction Hypothesis

De Bondt and Thaler [1985] argue that mean reversion in stock returns is evidence of overreaction. If investors overreact to new information, we expect an exaggerated shift in prices followed by price movements in the reverse direction. One testable implication of the overreaction argument is that any significant change in stock prices should be followed by a price correction.

If the KOSPI 200 index futures market overreacts to the overnight movement of US stock market prices, we can expect price reversals of the KOSPI 200 index futures market from market open to market close, that is, the daytime return on the KOSPI 200 index futures should be negative when overnight US stock market returns are positive and vice versa. Fung et al. [2010] suggest the following testable null and alternative hypotheses for the overreaction hypothesis :

$$H_0 : E(r^p_{oc,t} | R^q_{t-1} > 0) = 0 \quad (5a)$$

$$H_A : E(r^p_{oc,t} | R^q_{t-1} > 0) < 0$$

where $p = KP, KF$ and $q = DJ, ND, SP,$ and VX.

$$H_0 : E(r^p_{oc,t} | R^q_{t-1} < 0) = 0 \quad (5b)$$

$$H_A : E(r^p_{oc,t} | R^q_{t-1} < 0) > 0$$

where $p = KP, KF$ and $q = DJ, ND, SP,$ and VX.

The null hypotheses in (5a) and (5b) state that Korean investors fairly react to overnight information on the US stock market. The rejection of H_0 in (5a) and (5b) indicates that Korean investors overreact to the overnight performance of the US stock market.

Following the "magnitude effect" of De Bondt and Thaler [1985], we expect that larger reversals in the Korean daytime returns will follow larger overnight US returns. We run the following regression model to test the magnitude effect in the overreaction hypothesis :

$$r^p_{oc,t} = \alpha + \beta R^q_{t-1} + \epsilon_t \quad (6)$$

where $p = KP, KF$ and $q = DJ, ND, SP,$ and VX.

If $\beta < 0$ for DJ, ND, and SP and $\beta > 0$ for VX, the magnitude effect of overreaction exists.

(3) The Weekend Effect Hypothesis

The stock market opens on Mondays after a 66 hour trading halt. This non-trading time is more than thrice that of usual weekdays and can have a differential impact on Monday's returns. Kim [1988] shows this so-called weekend effect for six national stock market returns including Korea and the US. If Korean invest-

ors overreact to overnight US information, it means that Korean investors are overly pessimistic (resp., optimistic) to bad (resp., good) news overnight. This emotion cools down during weekends or holidays that provide much time for digesting the news. Therefore, we expect that the overreaction effect is reduced on days following weekends or holidays. We test the difference regarding the daytime returns of the KOSPI 200 index futures between weekdays and weekends to ascertain the weekend effect with respect to overnight US information spillover. The null and alternative hypotheses for the weekend effect hypothesis are :

$$H_0 : E(r^p_{oc,t_{NH}} | R^q_{t-1} > 0) = E(r^p_{oc,t_H} | R^q_{t-1} > 0) \quad (7a)$$

$$H_A : E(r^p_{oc,t_{NH}} | R^q_{t-1} > 0) \neq E(r^p_{oc,t_H} | R^q_{t-1} > 0)$$

where t_{NH} *is a usual weekday,*

t_H *is a day after weekends* or *holidays*,

and $p = KP, KF$ and $q = SP, DJ, ND$, and VX.

$$H_0 : E(r^p_{oc,t_{NH}} | R^q_{t-1} < 0) = E(r^p_{oc,t_H} | R^q_{t-1} < 0) \quad (7b)$$

$$H_A : E(r^p_{oc,t_{NH}} | R^q_{t-1} < 0) \neq E(r^p_{oc,t_H} | R^q_{t-1} < 0)$$

3. Empirical Results

<Table 1> reports the results of the F-test for Granger causality with a one-period lag. The results show that at the 1% significance level, there is a significant linear Granger causality between US stock index returns and Korean stock index and index futures returns. The return on the Korean stock market is strongly impacted by the overnight US stock market return for both the KOSPI 200 index and the KOSPI 200 index futures.

<Table 1> Results of the Granger Causality Test

Null Hypothesis	F-Statistic	Probability
DJ does not Granger cause KF	330.886	3.4E-70
DJ does not Granger cause KP	328.854	8.6E-70
KF does not Granger cause DJ	95.0833	3.9E-22
KP does not Granger cause DJ	82.2290	2.1E-19
ND does not Granger cause KF	400.996	8.7E-84
ND does not Granger cause KP	432.358	8.9E-90
KF does not Granger cause ND	92.4606	1.4E-21
KP does not Granger cause ND	85.2739	4.8E-20
SP does not Granger cause KF	391.232	6.5E-82
SP does not Granger cause KP	394.573	1.5E-82
KF does not Granger cause SP	103.354	6.9E-24
KP does not Granger cause SP	91.0572	2.8E-21
VX does not Granger cause KF	231.336	2.3E-50
VX does not Granger cause KP	238.416	8.5E-52
KF does not Granger cause VX	66.8812	4.2E-16
KP does not Granger cause VX	60.2079	1.2E-14

<Table 2> and <Table 3> provide test results for the overreaction hypothesis for the KOSPI 200 index and the KOSPI 200 index futures. Consistent with the information spillover hypothesis, the overnight returns on the Korean stock market have the same direction as the overnight returns on the three US stock price indexes. The relationship between the overnight returns and VX is negative, which is consistent with the widely documented volatility asymmetry. The Korean daytime returns from market open to market close are negative for both the KOSPI 200 index and the KOSPI 200 index futures when the overnight US stock market rises and vice versa. This corresponds to the overreaction hypothesis, which is significant at the 1% level. The t statistics for the KOSPI 200 index futures are generally lower than those of the KOSPI200 index. The KOSPI

200 index futures market overreacts to SP most strongly, which is somewhat different from traders' belief that the NASDAQ index has the most influence on the KOSPI 200 index futures market.

〈Table 2〉 Test Results Regarding the Overreaction Hypothesis for KP

	Overnight returns	Daytime returns	t-test	Probability
DJ up DJ down	+0.5955 -0.4755	-0.1455 +0.1043	4.4476	0.0000
ND up ND down	+0.6233 -0.5264	-0.1384 +0.1021	4.2796	0.0000
SP up SP down	+0.6384 -0.5364	-0.1594 +0.1226	5.0255	0.0000
VX up VX down	-0.4815 +0.5011	+0.0919 -0.1146	3.6497	0.0002

〈Table 3〉 Test Results Regarding the Overreaction Hypothesis for KF

	Overnight returns	Daytime returns	t-test	Probability
DJ up DJ down	+0.5829 -0.5102	-0.1133 +0.1167	3.7343	0.0001
ND up ND down	+0.5948 -0.5450	-0.1066 +0.1145	3.5896	0.0002
SP up SP down	+0.6122 -0.5575	-0.1270 +0.1345	4.2496	0.0000
VX up VX down	-0.4960 +0.4684	+0.1052 -0.0823	3.0713	0.0011

To test the magnitude effect of the overreaction hypothesis, we run the regression equation (6). The results are provided in <Table 4>. The estimated coefficients for the overnight returns on the three US stock price indexes are significantly negative and that of VX is positive. This is consistent with the magnitude effect; DJ shows the strongest magnitude effect with respect to the overreaction hypothesis.

The non-trading time between market close on Friday and market open on Monday is longer than that of usual weekdays. If traders cool down in terms of their emotions regarding the overreaction effect during the weekend or holidays, the stock prices on Mondays or after-holidays may behave differently. <Table 5> provides the test results for the weekend effect hypothesis with SP. The overnight returns on both KP and KF have the same signs as the overnight SP returns. The daytime returns on usual weekdays show significant price reversals as in the overreaction hypothesis. But the daytime returns on days after weekends or holidays behave differentially. There are additional price declines from market open to market close for both KP and KF when SP falls overnight. The reverse is also true. These findings are consistent with the weekend effect of the overreaction hypothesis.

〈Table 4〉 Estimates of β for the Magnitude Effect

	DJ	ND	SP	VX
KP	-0.1483 (-6.7153)***	-0.0762 (-5.0516)***	-0.1320 (-6.3864)***	+0.0216 (4.6185)***
KF	-0.1419 (-5.8567)***	-0.0846 (-5.1247)***	-0.1276 (-5.6281)***	0.0207 (4.0408)***

Note) *** : significant at the 1% level.

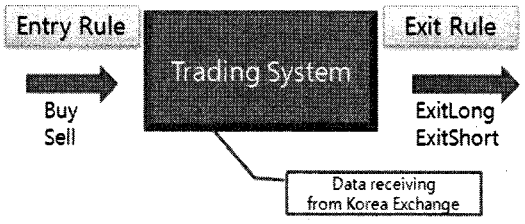
〈Table 5〉 Test Results Regarding the Weekend Effect Hypothesis for KP and KF

			Overnight returns	Daytime returns	t-test	Probability
KP	SP up	NH H	+0.6216 +0.7005	-0.2149 +0.0454	2.7908	0.0053
	SP down	NH H	-0.5252 -0.5745	+0.1921 -0.1132	3.1224	0.0018
KF	SP up	NH H	+0.5961 +0.6718	-0.1797 +0.0675	2.4404	0.0148
	SP down	NH H	-0.5499 -0.5831	+0.2115 -0.1272	3.1321	0.0018

Note) NH : returns on usual weekdays, H : returns on days after weekends or holidays.

4. Trading System Development

On usual weekdays, significant price reversals exist from market open to market close for the KOSPI 200 index futures market after the overreaction of the opening prices to the overnight US stock market information. However, contrary to the overreaction hypothesis, in the KOSPI 200 index futures market on days following weekends or holidays, we find additional daytime price movements in the same direction as for the overnight US stock price index.



〈Figure 1〉 Trading System Structure

Trading system generally consists of entry rule and exit rule. <Figure 1> shows typical trading system structure.

If the stock market is informationally inefficient, it should be possible to realize profits by exploiting the information. Based on the documented overreaction and weekend effects, we can devise a profitable intra-day trading system for the KOSPI 200 index futures contract, as shown in <Table 6>.

The strategy suggested in the trading system is simple and applicable in real trading. A trader can obtain the overnight DJ information at no cost. For example, if DJ falls overnight then he can send a market order to buy the KOSPI 200 index futures contract with the nearest maturity at the market open of weekdays. We run a system trading tool, 'YesTrader 3.1' provided by Hi Securities Company, to test the

〈Table 6〉 The Devised Intra-day Trading System

Market Conditions		Entry	Exit
If DJ rises overnight	On weekdays On weekends	Short on open Long on open	Exitshort on close Exitlong on close
If DJ falls overnight	On weekdays On weekends	Long on open Short on open	Exitlong on close Exitshort on close

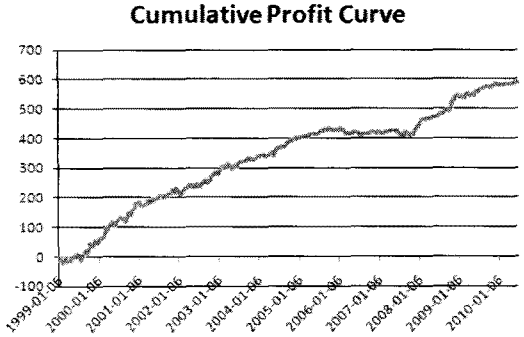
performance of the suggested trading system. The profit of trade on day t (P_t) and the cumulative profit of trades for T days (CP_T) are calculated as follows :

$$P_t = 100 \times (\ln(C_t) - \ln(O_t)) \quad \text{for } long\ on\ market\ open\ trade \quad (8a)$$

$$= 100 \times (\ln(O_t) - \ln(C_t)) \quad \text{for } short\ on\ market\ open\ trade$$

$$CP_T = \sum_{t=1}^{T} P_t \quad (8b)$$

<Figure 2> shows the cumulative profit curve of the devised trading system for the sample period. The curve is positive and upward sloping, indicating that the strategy is profitable. <Table 7> provides a performance report of the trading system for the entire sample period and three sub-periods. The total net profit for the sample period is 587.88 and the average profit per trade is 0.21%. The percentage of profitable trades is 54.79% and the profit factor is 1.40. This system earns 1.40 per 1.0 loss. The Sharpe ratio, a performance measure considering the trading risk, is as high as 1.78. The performance measures categorized by the three sub-periods show almost the same results. This system is profitable even when we consider 0.01% transaction cost per trade.



<Figure 2> The Cumulative Profit Curve

5. Conclusions

This study explores the influence of US stock market information on the overnight and day-

<Table 7> Performance Report for the Trading System

Period	1999~2010	1999~2002	2003~2006	2007~2010
Total net profit	+587.88	+282.27	+134.70	+170.91
Average profit per trade	+0.21	+0.29	+0.14	+0.20
Number of trades	2840	978	992	870
Number of winning trades	1556	535	539	482
Percentage profitable	54.79%	54.70%	54.33%	55.40%
Average winning trade	+1.31	+1.87	+0.97	+1.08
Average losing trade	-1.18	-1.70	-0.91	-0.92
Ratio	1.11	1.10	1.07	1.17
Profit factor	1.40	1.39	1.35	1.49
Sharpe ratio	1.78	2.54	1.10	1.68

Note) Total net profit : gross profit-gross loss; average winning trade : cumulated profit of winning trades/number of winning trades; average losing trade : cumulated profit of losing trades/number of losing trades; profit factor : cumulated profit of winning trades/cumulated profit of losing trades; Sharpe ratio : (annualized return-interest rate)/annualized standard deviation; a 5% interest rate is assumed.

time returns of the Korean stock market. We also develop a profitable intra-day trading strategy based on the documented overreaction hypothesis. The empirical results are as follows. First, overnight US information spillover effects are still existent with statistical significance during recent years as well as the beginning period of the futures market. Second, Korean investors overreact to overnight information on the US stock market; therefore, price reversals are significant from market open to market close. This phenomenon has not disappeared throughout our sample period. Third, there is weekend effect in the overreaction hypothesis. Price reversals are not found on days after weekends or holidays. Finally, the devised intra-day trading system for the KOSPI 200 index futures contract is profitable, indicating market inefficiency.

This study has some limitations. The devised trading system does not consider margin-based returns required in real trading. If trading capital is large, orders generated by our trading system can impact bid-ask prices unfavorably.

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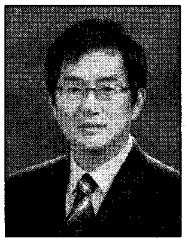

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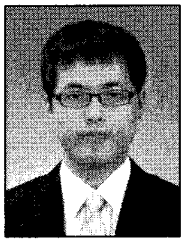

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