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Relationship between Trading at Ask Price and the End-of-Day Effect in Hong Kong Stock Exchange

Alex W.H. Chan[1]

Abstract

This paper presents an empirical study on the intraday trading behavior of Hang Seng Index constituent stocks in Hong Kong Stock Exchange. We use LOGIT model to analyze the probability of a trade occurring at the ask price and investigate its relationship with the end-of-day effect. We find some systematic patterns of trading at ask price over different trading time intervals. This systematic pattern of trading at ask price can explain around one-third of the abnormal return from the end-of-day effect.

JEL classification: G10, G12, G15
Key words: Intraday Return, Trade at Ask, End-of-Day Effect.

1. Introduction

Many empirical investigations on the U.S. stock market document systematic patterns for the intraday stock price generating process (e.g. Wood, McInish and Ord (1985), Harris (1986) and Jain and Joh (1988)) and systematic intraday trading behavior of investors. Those findings are anomalous with respect to the efficient market literature. In order to have better understanding about the anomalous intraday trading pattern in different trading systems, we investigate the intraday trading behavior in the Hong Kong stock market, which has a trading system different from the New York Stock Exchange (NYSE). Unlike NYSE, the Hong Kong Stock Exchange (HKSE) is an order-driven market. There are no formal specialists for maintaining market liquidity in HKSE. In HKSE, the market liquidity and trading activities are determined by the limit orders submitted by buyers and sellers. In view of the difference between the trading systems in NYSE and HKSE, a comparison of the intraday trading behavior in different markets may provide insight to explain the existence of this systematic pattern. This paper is an effort to have an investigation on the intraday trading behavior in the Hong Kong Stock Exchange (HKSE). We use the approach of Porter (1992) and Aitken et al. (1995) to analyze the pattern of trade at ask price for major stocks in Hong Kong in order to investigate any relationship between the probability of trade at ask price and the market anomaly of the end-of-day effect. Furthermore, we study the relationship between the probability of trade at ask price and other firm-specific variables. Several hypotheses about the intraday trading pattern are investigated. This paper contributes to provide better understanding about the trading behavior in a fast growing emerging market, Hong Kong. Hong Kong is considered as an emerging financial market; however, its importance has significantly grown over last few decades. At the end of November 2004[2], HKSE has market capitalization of US$847B, which was ranked 8th in the world. Furthermore, HKSE has raised equity funds of US$31.7B from January 2004 to November 2004; it was ranked as the 3rd in the world during that period. Even though HKSE has become more and more important, unlike NYSE, there is no sufficient research works on this market. This paper is to provide an empirical investigation on the trading behavior of HKSE. Through the research finding, we can have better understanding about the similarities and differences between HKSE and other stock exchanges, e.g. NYSE. We can also see any significant difference in the trading behavior of investors under different market operation mechanisms.

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[2] The information is obtained from the HKEx website: http://www.hkex.com.hk/news/hkexnews/050107news.xls.

1.1. Literature Review

Researchers find that returns on stocks are significantly high during the last few minutes of a trading day. This phenomenon is called the end-of-day effect. There exists literature on this end-of-day effect for stock markets in United States. Wood, McInish and Ord (1985) investigate the minute-by-minute stock returns on NYSE for two time periods, including the six months from September 1971 to February 1972 and the whole year of 1982. They conclude that unusually high returns and standard deviations of returns are found at the beginning and the end of the trading day. Harris (1986) examines the 15-minute intraday returns in NYSE from December 1, 1981 to January 31, 1983 and shows that there is a significant increase in stock price on the last trade of trading day. Jain and Joh (1988) investigate the hourly returns of common stocks in NYSE with a longer time period of data from 1979 to 1983 and find similar evidence of stock price increase at the end of trading day.

Apart from the above studies, there exist other similar researches on stock markets outside United States. McInish and Wood (1990) analyze the stocks traded on the Toronto Stock Exchange. They find similar patterns of intraday returns as in U.S. stock market. Cheung (1995) investigates the end-of-day effect in Hong Kong equity market. His study analyzes the 15-minute interval data for Hang Seng Index (the major stock market index in Hong Kong) from April 26, 1986 to December 31, 1990 and concludes that there is a positive day-end return in the Hong Kong Stock Exchange (HKSE). Actually, this end-of-day effect generally exists in different stock exchanges of different countries. It does not depend on any particular market structure or trading system.

As the end-of-day effect indicates some unexplained positive return, researchers try to investigate whether this return is related to any systematic trading pattern of investors. Some researchers tried to analyze whether the end-of-day effect results from any systematic pattern of a trade at the bid price or the ask price. They used LOGIT models to analyze the probability of a trade at ask price over different trading time intervals and conditional on different firm-specific variables. Porter (1992) analyzes the probability of trading at ask price by the intraday data of United States and Canadian stock exchanges. He finds that the probability of a trade occurring at ask price in the last three minutes of trading day is significantly higher than any other time period. The results hold for both United States and Canadian stock market data. Furthermore, Porter argues that the systematic pattern in probability of trade at ask price can explain nearly all of the abnormal end-of-day return found in Wood, McInish and Ord (1985)[1].

Similar to the approach of Porter (1992), Aitken et al. (1995) use LOGIT models to investigate the probability of trade at the ask price for stocks listed in the Australian stock exchange. They find some systematic patterns in the probability of trading at the ask price, which are consistent with those well-known market anomalies, such as day-of-week effect, end-of-day effect, and turn-of-year effect.

1.2. Outline of This Paper

This paper is an attempt to look at any relationship between the systematic pattern of trading at ask price and the end-of-day effect in the Hong Kong Stock Exchange. We investigate the intraday market prices of major companies in the Hong Kong market from 1998 to 2004. We first examine the end-of-day effect in Hong Kong stocks; and then, we study the pattern of trading at the ask price by the LOGIT model in order to analyze any relationship between the end-of-day effect and the pattern of trading at ask price. The outline of this paper is as follows. Section 2 describes the development of hypotheses to be tested. Section 3 describes the data set and methodology for empirical testing. Section 4 presents the empirical results. Section 5 concludes the paper.

[1] Porter argues that the systematic trading pattern can explain all end-of-day effect from data of 1972 and 1982; also it can explain 44% of the opening return from data of 1972 data and 100% of the opening return from data of 1982.

2. Hypothesis Testing

In this section, we develop a number of hypotheses about the intraday trading behavior in the Hong Kong Stock Exchange. Some of the following hypotheses are related to Porter (1992) for the investigation about United States and Canadian stock markets, and Aitken et al. (1995) for the investigation about Australian stock market.

H1. The probability of a trade at ask price is higher when the trading time is closer to the end of a trading day.

Existing literature indicates that the stock price increases at the end of trading day, e.g. Wood, McInish and Ord (1985), Harris (1986), Jain and Joh (1988), and Cheung (1995). This end-of-day effect may result from some systematic bias of trade at ask price at the end of trading day. Porter (1992) finds that there are significantly more trades at ask price over the last 3 minutes of trading day than other periods in both United States and Canadian data samples. Aitken et al. (1995) also find a greater probability of trade at ask price at the end of a trading day for the Australian Stock Exchange. We would like to investigate whether a similar pattern exists in Hong Kong market.

H2. The probability of a trade at ask price is lower on Monday.

French (1980) investigates the daily returns on the Standard and Poor's composite portfolio from 1953 to 1977. He finds that the average return for Monday was significantly negative. Similarly, Gibbons and Hess (1981) find a negative Monday effect for the constituent stocks of Dow Jones Industrial Index. Keim and Stambaugh (1984) use data of longer time period and also find a consistently negative Monday effect on stock return. Harris (1986) examines 14 months (from December 1, 1981 to January 31, 1983) stock transaction data at New York Stock Exchange (NYSE) and finds similar results. Some researchers have provided potential explanations to the Monday effect. Chen and Singal (2003) investigate the relationship between the Monday effect and speculative shortselling activities. They argue that the inability to trade over the weekend induces the short sellers to close their speculative position on Fridays and re-open their positions on Monday. They find empirical evidence supporting their arguments through analyzing the initial public offering, stocks with zero short interest, and some highly volatile stocks. Another recent study from Chan, Leung and Wang (2004) documents a relationship between the Monday effect and the participation of institutional investors. They found that the Monday effect is stronger for stocks with low institutional holdings. On the other hand, the Monday return is not significantly different from other weekday for stocks with high institutional holdings. Their results indicate that the Monday effect may be related to trading behavior of less sophisticated individual investors in the market. In view of the negative Monday effect in the stock markets, we would like to investigate how this Monday effect is related to the probability of trade at ask price in Hong Kong market.

H3. The probability of a trade at ask price is higher for a stock with a higher market price.

Porter (1992) finds that the probability of a trade at ask price is monotonically increasing across 5 price-stratified portfolios (from the lowest price to the highest price). We would like to investigate the existence of this relationship in Hong Kong market.

H4. The probability of a trade at ask price is lower for a stock with a larger market value.

As the end-of-day effect is stronger for smaller firms, the probability of trade at ask price should be negatively related to the firm size. Aitken et al. (1995) find that the firm size is negatively related to the probability of trade at ask price for the Australian stock market.

H5. The probability of trade at ask price is positively related to the magnitude of the limit order imbalance, which is defined as the ratio of total quantity volume in five best bid queues to total quantity volume in five best ask queues.

The buying pressure and selling pressure for a stock can be measured by the quantity of limit-buy orders and the quantity of limit-sell orders respectively. If most investors have positive expectation on a stock, the total quantity of limit-buy orders should be higher than the total quantity of limit-sell orders. Hence, it is more likely that the next trade will be taken at ask price. Following Aitken et al. (1995), we measure the limit order imbalance by the ratio of total quantity volume in five best bid queues to total quantity volume in five best ask queues; and then we test

any relationship between the probability of trade at ask price and the magnitude of this limit order imbalance.

H6. The probability of trade at ask price is negatively related to the number of spread steps between the best bid and ask prices.

Existing literature indicates that there is a relationship between the bid/ask spread and the probability of trade at ask price[1]. The number of spread steps between bid and ask prices indicates the transaction cost or the liquidity of a stock. The larger the spread is, the higher the transaction cost (or the lower the liquidity) is. As we expect that investors are more willing to buy or hold a stock with a low transaction cost (or high liquidity), it is more likely that a trade is taken at the ask price.

3. Data and Methodology

3.1. Hong Kong Stock Exchange

The Hong Kong Stock Exchange (HKSE) is an order-driven market. Unlike the New York Stock Exchange (NYSE), there are no formal specialists for maintaining market liquidity. In HKSE, the market liquidity and trading activities are determined by the limit orders submitted by buyers and sellers. Buy/sell limit orders are placed through stockbrokers and consolidated together through an electronic automated trading system, called Automatic Order Matching and Execution System (AMS). Trading day of HKSE is from Monday to Friday. The trading hours are divided into two sessions: A morning session is from 10:00am to 12:30pm; and an afternoon session is from 2:30pm to 4:00pm[2].

3.2. Data

In this study, we investigate the trading behavior of constituent stocks of Hang Seng Index (HSI). Hang Seng Index is composed of 33 constituent stocks, which are basically the most liquid stocks and the largest companies listed in the Hong Kong Stock Exchange. The data of intra-day bid/ask records and trade records are obtained from the BID AND ASK RECORD and TRADE RECORD database from the Hong Kong Exchanges and Clearing Limited. The TRADE RECORD database provides all transaction price and transaction volume data with a time stamp to the nearest second. The BID AND ASK RECORD database provides the information of limit (buy and sell) orders up to five best queues (including information of queue lengths and queue quantities for current bid/ask prices, and also queue lengths and queue quantities over the next four spread steps from the current bid/ask prices). This information is recorded over every thirty-second interval. Apart from those intraday data, we also need the market value data of individual company for analysis. They are obtained from PACAP database.

This study uses the intraday data from the beginning of February 1998 to the end of December 2004, but excluding the month of August 1998. As Hong Kong Stock Exchange changed the trading time of the afternoon session (to 2:30pm-4:00pm) from February 1998[3], we chose February 1998 as the beginning of investigation period in order to have better consistency in setting dummy variables for trading time intervals. Furthermore, our ultimate objective in this research is to investigate the normal trading behavior of market players. However, in August 1998, Hong Kong faced a serious financial crisis. Speculators were attacking the Hong Kong dollar exchange rate system and taking huge short position in Hang Seng Index futures contracts to bet the fall of Hong Kong stock market. Eventually, Hong Kong government decided to use government's reserve to defend the Hong Kong dollar exchange rate link and the Hong Kong stock market. During this month, Hong Kong government spent over US$15 billion on buying HSI constituent stocks to fight against speculators and became the most dominant market player. As this government inter-

[1] See Aitken et al. (1995).

[2] This trading hour arrangement started from February 1998 and remains unchanged up to the present.

[3] The trading hour of the afternoon session in HKSE has been changed many times. From July 1994, the trading hour of afternoon session was 2:30pm - 3:45pm. From September 1995, the trading hour of afternoon session was changed to 2:30pm - 3:55pm. From February 1998, the trading hour of afternoon session was changed to 2:30pm - 4:00pm.

vention seriously distorted the trading characteristics of the Hong Kong stock market, we decided to exclude the trading data over this month from our analysis in order to have a cleaner and more accurate picture about the normal trading behavior of market players in HKSE.

As the constituent stocks of HSI may be adjusted from time to time, we obtain information of historical changes of constituent stocks from the official website of HSI Service Limited[1]. Over the period of investigation, HSI Service Limited has made some changes in the composition of Hang Seng Index. The details about the changes are provided in Table 1.

Table 1

Information on Changes in Constituent Stocks of Hang Seng Index

This table presents the information on changes in constituent stocks of Hang Seng Index from February 1998 to December 2004.

Date of Change	Companies Added	Companies Removed
December 6, 1999	(179) Johnson Electric	(45) Hong Kong & Shanghai Hotels, Limited
	(223) Dao Heng Bank	(54) Hopewell Holdings Limited
	(315) SmarTone Telecom. Holdings Limited	(270) Guangdong Investment Limited
August 2, 2000	(494) Li & Fung	(41) Great Eagle Holdings
	(992) Legend Holdings	(69) Shangri-La Asia
August 9, 2000	(1186) Pacific Century Cyberwork	(8(a)) Cable Wireless Hong Kong Telecom
August 17, 2000	(8(b)) Pacific Century Cyberwork	(1186) Pacific Century Cyberwork
June 1, 2001	(66) MTR Corporation	(142) First Pacific
	(762) China Unicom	(315) Smartone Telecom Holdings Limited
July 31, 2001	(883) CNOOC	(223) Dao Heng Bank
December 2, 2002	(330) Esprit Holdings	(10) Hang Lung Group
	(2388) BOC Hong Kong	(14) Hysan Development
June 9, 2003	(551) Yue Yuen Industrial	(17) New World Development
	(1199) COSCO Pacific	(3) Sino Land
September 6, 2004	(144) China Merchants Holdings	(363) Shanghai Industrial Holdings
	(203) Denway Motors	(511) Television Broadcast

In total, we have to analyze 48 companies. A summary of observations used in this study is presented in Table 2.

HKSE is a centralized market with electronic matching system for stock transactions. Nearly most of the transactions are executed through the automated trading system – Automatic Order Matching and Execution System (AMS). However, a few orders[2] are done through manual matching by stockbrokers. Those manually matched transactions may be taken at a price deviated from the prevailing market price. In order to avoid any misleading implication from those manually matched transactions through stockbrokers, we only consider those transactions through the automated trading system (AMS) in this research.

[1] Web-site: http://www.hsi.com.hk/

[2] The number of manually matched transactions is just 1.86% of total trade records.

Table 2. Information on Intraday Stock Price Data Set

This table presents the information on dataset for this analysis. The "Stock ID" is a unique identification code for each company. "HKEx stock code" is the stock code for trading in Hong Kong Stock Exchange. "Start Date" and "End Date" are the first and last observation dates of a company in the dataset of this analysis. "Number of trading day Obs" shows the number of trading day observations covered in the data set.

Obs	Stock ID	HKEx Stock Code	Company Name	Start Date	End Date	Number of Trading day Obs
1	2155010	1	Cheung Kong	19980202	20041231	1690
2	2009010	2	CLP Hldgs	19980202	20041231	1690
3	2078010	3	HK & China Gas	19980202	20041231	1690
4	2071010	4	Wharf(Hldgs)	19980202	20041231	1690
5	2034010	5	HSBC Hldgs	19980202	20041231	1689
6	2271010	6	HK Electric	19980202	20041231	1690
7	2378010	8(a)	CWHKT	19980202	20000808	604
8	2847010	8(b)	PCCW	20000809	20041231	1078
9	2144010	10	Hang Lung Dev	19980202	20021129	1172
10	2114010	11	Hang Seng Bank	19980202	20041231	1690
11	2293010	12	Henderson Land	19980202	20041231	1688
12	2278010	13	Hutchison	19980202	20041231	1690
13	2297010	14	Hysan Dev	19980202	20021129	1173
14	2133010	16	SHK Prop	19980202	20041231	1690
15	2164010	17	New World Dev	19980202	20030606	1294
16	2077010	19	Swire Pacific 'A'	19980202	20041231	1690
17	2082010	20	Wheelock	19980202	20041231	1683
18	2004010	23	Bank of East Asia	19980202	20041231	1690
19	2191010	41	Great Eagle Hldgs	19980202	20000801	600
20	2035010	45	HK & S Hotels	19980202	19991203	438
21	2125010	54	Hopewell Hldgs	19980202	19991203	438
22	1009060	66	MTR Corporation	20010601	20041231	886
23	2686010	69	Shangri-La Asia	19980202	20000801	598
24	2290010	83	Sino Land	19980202	20030606	1298
25	2157010	97	Henderson Inv	19980202	20041231	1688
26	2075010	101	Amoy Prop	19980202	20041231	1689
27	2399010	142	First Pacific	19980202	20010531	802
28	2600010	144	China Merchants Hldgs	20040906	20041231	81
29	2314010	179	Johnson Elec H	19991206	20041231	1251
30	2671010	203	Denway Motors	20040906	20041231	81
31	2753010	223	Dao Heng Bank	19991206	20010726	397
32	2329010	267	CITIC Pacific	19980202	20041231	1690
33	2273010	270	Guangdong Inv	19980202	19991203	436
34	2190010	291	China Resources	19980202	20041231	1680
35	2334010	293	Cathay Pac Air	19980202	20041231	1690
36	2965010	315	SmarTone Telecom	19991206	20010531	365
37	2755010	330	Esprit Hldgs	20021202	20041231	516
38	2933010	363	Shanghai Ind Hldgs	19980202	20040903	1607
39	2595010	494	Li & Fung	20000802	20041231	1090
40	2409010	511	TVB	19980202	20040903	1606
41	2596010	551	Yue Yuen	20030609	20041231	391
42	1007590	762	China Unicom	20010601	20041231	887
43	1011060	883	CNOOC	20010731	20041231	849
44	3078010	941	China Mobile	19980202	20041231	1690
45	2777010	992	Legend Hldgs	20000802	20041231	1086
46	2949010	1038	CKI Hldgs	19980202	20041231	1689
47	2858010	1199	COSCO Pacific	20030609	20041231	392
48	1018580	2388	BOC Hong Kong	20021202	20041231	516

3.3. Determination of Trade at Bid or Trade at Ask

The TRADE RECORD database provides all transaction price and transaction volume data with a time stamp to the nearest second. However, the BID AND ASK RECORD database only provides the information of limit orders over every thirty-second interval. For each transaction record from TRADE RECORD database, we have to match the latest available bid/ask price information (just on or before the transaction time) from BID AND ASK RECORD database in order to determine whether the trade is taken at the bid price or the ask price. If the transaction price is equal to the best bid (ask) price from the latest available bid/ask price information, we consider the trade is taken at the bid (ask) price. If the transaction price cannot be matched with the best bid or the best ask from the latest available bid/ask price information, we delete this trade observation from analysis because we have no sufficient information to determine whether it is a trade at bid price or ask price[1].

3.4. Method

In this paper, we adopt the LOGIT model similar to Porter (1992) and Aitken et al. (1995) to analyze the intraday trading behavior. We run the following LOGIT regression model:

$$y_t = \alpha + \sum_{i=1}^{k} \left\{ \beta_i \times x_{it} \right\} + \varepsilon_t \ , \tag{1}$$

where

$$y_t = \begin{cases} 1 & \text{if the trade } (t) \text{ is taken place at ask price} \\ 0 & \text{if the trade } (t) \text{ is taken place at bid price} \end{cases}$$

t= index for each trade

i = index for each explanatory variable x_{it}, for $i = 1, \ldots, k$. We have the following explanatory variables in the LOGIT model:

During the investigation period, the trading time of Hong Kong Stock Exchange included two sessions. The morning session started from 10:00am to 12:30pm, and the afternoon session started from 2:30pm to 4:00pm. We use the following trading time dummy variables to classify all trade records into different transaction time categories:

Variables for Trading Time	Description
T103000_105959	"1" if a trade is between 10:30:00-10:59:59; otherwise, "0"
T110000_112959	"1" if a trade is between 11:00:00-11:29:59; otherwise, "0"
T113000_115959	"1" if a trade is between 11:30:00-11:59:59; otherwise, "0"
T120000_123000	"1" if a trade is between 12:00:00-12:30:00; otherwise, "0"
T143000_145959	"1" if a trade is between 14:30:00-14:59:59; otherwise, "0"
T150000_152959	"1" if a trade is between 15:00:00-15:29:59; otherwise, "0"
T153000_153959	"1" if a trade is between 15:30:00-15:39:59; otherwise, "0"
T154000_154959	"1" if a trade is between 15:40:00-15:49:59; otherwise, "0"
T155000_155459	"1" if a trade is between 15:50:00-15:54:59; otherwise, "0"
T155500_155559	"1" if a trade is between 15:55:00-15:55:59; otherwise, "0"
T155600_155659	"1" if a trade is between 15:56:00-15:56:59; otherwise, "0"
T155700_155759	"1" if a trade is between 15:57:00-15:57:59; otherwise, "0"
T155800_155859	"1" if a trade is between 15:58:00-15:58:59; otherwise, "0"
T155900_160000	"1" if a trade is between 15:59:00-16:00:00; otherwise, "0"

[1] In 1998 (February to December, excluding August), there are 4,289,354 trade records; 442,336 (10.3%) of those trade records are excluded from analysis because their transaction prices are not matched with the best bid/ask price range of latest bid/ask data. In 1999, there are 4,498,844 trade records; 438,502 (9.7%) of those trade records are excluded from analysis because their transaction prices are not matched the best bid/ask price range of latest bid/ask data.

In addition, we use the following weekday dummy variables to classify all trade records into different weekday categories:

Variables for Week Day	Description
Day1_Mon	"1" if a trade is on Monday; otherwise, "0"
Day2_Tue	"1" if a trade is on Tuesday; otherwise, "0"
Day3_Wed	"1" if a trade is on Wednesday; otherwise, "0"
Day4_Thu	"1" if a trade is on Thursday; otherwise, "0"

Similar to Porter (1992) and Aitken et al. (1995), we also consider some firm-specific variables to investigate their explanatory power on the probability of trading at ask price:

Firm-Specific Variables	Description
Price	Stock price of the transaction
Log_size	Natural log of the market value of a company at the end of last month
Imbal_vol	Ratio of total volume in (five) best bid queues to total volume in (five) best ask queues
Spread_step	Number of price spread steps between the best bid price and the best ask price

4. Result

First of all, Table 3 presents the end-of-day effect in the Hong Kong stock market. We calculate the average return per minute over different trading time intervals near to the end of a trading day[1]. As we can see, the overall average returns per minute (over the last 30 min, over the last 10 min, over the last 5 min, and over the last 1 min) are statistically positive. Furthermore, the overall average return per minute is higher when the trading time is closer to the end of trading day. This result for Hong Kong stock market is consistent with those research findings about U.S. market from Wood, McInish and Ord (1985), Harris (1986) and Jain and Joh (1988). Table 4 presents the information about percentiles of average return per minute in the last 30 minutes of trading day and in the last one minute of trading day. The results show that the distribution is positively skewed and this positive skewness becomes stronger and stronger when the time approaches to the end of trading day.

In order to investigate any systematic intraday trading pattern of investors, we use LOGIT regression models to analyze the probability of a trade taken place at the bid price or the ask price under different trading time intervals. Table 5 presents the LOGIT regression results for Model A (with only trading time dummy variables), Model B (with only the weekday variables), and Model C (with trading time dummy variables, weekday dummy variables, and also firm-specific variables). Basically, the parameter estimation results are consistent with our hypotheses. As we can see, there is a systematic pattern of the probability of trade at ask price over different trading time intervals. The parameter estimates for trading time dummy variable of the last one minute (T155900_160000) in both Models A and C are significantly positive at 1% level. It indicates that the probability of trade at ask price significantly increases during the last one minute of trading day.

[1] The following trading days consist of only the morning session but not the afternoon session: 19981224 (Christmas Eve), 19981231 (New Year Eve), 19990215 (Chinese New Year Eve), 19991224 (Christmas Eve), 20010123 (Chinese New Year Eve), 20011224 (Christmas Eve), 20011231 (New Year Eve), 20020211 (Chinese New Year Eve), 20020911 (Typhoon Signal No. 8), 20021224 (Christmas Eve), 20021231 (New Year Eve), 20030902 (Typhoon Signal No. 8), 20031224 (Christmas Eve), 20031231 (New Year Eve), 20040121 (Chinese New Year Eve), 20040716 (Typhoon Signal No. 8), 20041224 (Christmas Eve), 20041231 (New Year Eve).

Table 3

End-of-Day Effect

This table summarizes the end-of-day effect in Hong Kong Stock Exchange. It reports the average return per minute over the last *n* minutes of afternoon trading session. The "Stock ID" is a unique identification code for each company. "HKEx stock code" is the stock code for trading in Hong Kong Stock Exchange. "Number of observations" shows the number of trading days with afternoon trading sessions in the dataset of analysis. "Return per min over last *n* min" is the average return per minute over the last *n* minutes of afternoon trading session.

Obs	Stock ID	HKEx Stock code	Company Name	Number of Observations	Return per min over last 30 min	Return per min over last 10 min	Return per min over last 5 min	Return per min over last 1 min
1	2155010	1	Cheung Kong	1672	0.000818%	-0.000670%	0.001727%	0.004671%
2	2009010	2	CLP Hldgs	1672	0.000801%	0.000514%	0.000201%	-0.005925%
3	2078010	3	HK & China Gas	1672	0.003277%**	0.007147%**	0.011042%**	0.029838%**
4	2071010	4	Wharf(Hldgs)	1672	0.002587%**	0.003177%*	0.006416%*	0.013981%
5	2034010	5	HSBC Hldgs	1671	0.001438%**	0.002815%**	0.005323%**	0.008727%
6	2271010	6	HK Electric	1672	0.000151%	-0.001584%	-0.000825%	-0.008753%
7	2378010	8(a)	CWHKT	600	-0.001550%	-0.006938%**	-0.005771%	0.008995%
8	2847010	8(b)	PCCW	1064	0.003999%**	0.015941%**	0.029405%**	0.041719%*
9	2144010	10	Hang Lung Dev	1163	0.002377%*	0.003710%	0.008943%	0.059664%**
10	2114010	11	Hang Seng Bank	1672	0.001970%**	0.002739%*	0.004418%*	0.005386%
11	2293010	12	Henderson Land	1670	0.003711%**	0.007429%**	0.009359%**	0.023153%**
12	2278010	13	Hutchison	1672	0.000586%	-0.001101%	-0.000385%	0.006937%
13	2297010	14	Hysan Dev	1164	0.002932%**	0.005352%*	0.010861%*	0.017113%
14	2133010	16	SHK Prop	1672	0.002154%**	0.002376%	0.004553%	0.007634%
15	2164010	17	New World Dev	1283	0.003814%**	0.007752%**	0.019764%**	0.049458%**
16	2077010	19	Swire Pacific 'A'	1672	0.002239%**	0.001559%	0.004729%	0.012710%
17	2082010	20	Wheelock	1665	0.004973%**	0.012155%**	0.018728%**	0.048821%**
18	2004010	23	Bank of East Asia	1672	0.003326%**	0.006013%**	0.011022%**	0.018320%*
19	2191010	41	Great Eagle Hldgs	596	0.005537%*	0.010547%*	0.014726%	0.040566%
20	2035010	45	HK & S Hotels	435	0.006431%*	0.006914%	0.001655%	0.005077%
21	2125010	54	Hopewell Hldgs	435	0.000857%	-0.001014%	-0.006059%	-0.028330%
22	1009060	66	MTR Corporation	873	0.006488%**	0.012381%**	0.023697%**	0.037670%**
23	2686010	69	Shangri-La Asia	594	0.004977%*	0.002369%	0.004217%	-0.061700%
24	2290010	83	Sino Land	1287	0.028404%**	0.083424%**	0.165074%**	0.270341%**
25	2157010	97	Henderson Inv	1670	0.004666%**	0.009298%**	0.015412%**	0.030827%*
26	2075010	101	Amoy Prop	1671	0.006326%**	0.011764%**	0.026687%**	0.060144%**
27	2399010	142	First Pacific	797	0.002011%	0.007719%	0.014169%	0.034027%
28	2600010	144	China Merchants Hldgs	79	0.003089%	0.011394%	0.023616%*	0.077007%
29	2314010	179	Johnson Elec H	1236	0.003313%**	0.007803%**	0.012906%**	0.036962%*
30	2671010	203	Denway Motors	79	0.011301%**	0.031545%**	0.065785%**	0.078282%
31	2753010	223	Dao Heng Bank	395	0.004197%**	0.008140%*	0.018019%**	0.043767%
32	2329010	267	CITIC Pacific	1672	0.003011%**	0.006196%**	0.010156%**	0.033561%**
33	2273010	270	Guangdong Inv	433	0.000634%	-0.000129%	0.009773%	0.096208%**
34	2190010	291	China Resources	1662	0.002609%**	0.005171%**	0.010527%**	0.011532%
35	2334010	293	Cathay Pac Air	1672	0.004820%**	0.007973%**	0.015471%**	0.007718%
36	2965010	315	SmarTone Telecom	363	0.004886%**	0.011196%*	0.013139%	0.018655%
37	2755010	330	Esprit Hldgs	507	0.000858%	0.001518%	0.004359%	0.005064%
38	2933010	363	Shanghai Ind Hldgs	1591	0.003078%**	0.006604%**	0.011338%**	0.032054%**
39	2595010	494	Li & Fung	1076	0.003746%**	0.007158%**	0.012564%**	0.037425%*
40	2409010	511	TVB	1590	0.002773%**	0.006240%**	0.010026%**	0.022128%
41	2596010	551	Yue Yuen	384	0.004416%**	0.009670%**	0.019018%**	0.051224%*
42	1007590	762	China Unicom	874	0.006103%**	0.014949%**	0.023180%**	0.049858%**
43	1011060	883	CNOOC	836	0.002322%**	0.001850%	0.006285%	0.008595%
44	3078010	941	China Mobile	1672	0.001737%**	0.001149%	0.001700%	0.004577%
45	2777010	992	Legend Hldgs	1072	0.006402%**	0.016589%**	0.027680%**	0.054376%**
46	2949010	1038	CKI Hldgs	1671	0.001727%*	0.002962%	0.007480%**	0.026588%**
47	2858010	1199	COSCO Pacific	385	0.003900%*	0.011700%**	0.019960%**	0.049006%
48	1018580	2388	BOC Hong Kong	507	0.002705%**	0.006707%**	0.008048%*	0.022508%
			Overall	55114	0.003583%**	0.007375%**	0.013909%**	0.028453%**

Note: * and ** indicate significance at the 5% and 1% levels respectively.

Table 4

Distribution for the Average Return per Minutes and Skewness

This table summarizes the 10% percentile, lower quartile, median, upper quartile, and 90 percentile for the distribution of the average return per minute over the last 30 minutes of afternoon trading session. The "Stock ID" is a unique identification code for each company. "HKEx stock code" is the stock code for trading in Hong Kong Stock Exchange. "Number of observations" shows the number of trading days with afternoon trading sessions in the dataset of analysis.

Obs	Stock ID	HKEx Stock Code	Company Name	Number of Observations	10% Percentile	Lower Quartile	Median	Upper Quartile	90% Percentile	Skewness
1	2155010	1	Cheung Kong	1672	-0.025737%	-0.012368%	0.000000%	0.013861%	0.028373%	-0.071059
2	2009010	2	CLP Hldgs	1672	-0.018466%	-0.009311%	0.000000%	0.009719%	0.020390%	0.027357
3	2078010	3	HK & China Gas	1672	-0.019211%	-0.014429%	0.000000%	0.016544%	0.032368%	0.120016
4	2071010	4	Wharf(Hldgs)	1672	-0.025737%	-0.011037%	0.000000%	0.017074%	0.033173%	-0.311962
5	2034010	5	HSBC Hldgs	1671	-0.015395%	-0.008997%	0.000000%	0.009848%	0.017779%	0.104284
6	2271010	6	HK Electric	1672	-0.018197%	-0.007223%	0.000000%	0.009552%	0.019942%	-0.194220
7	2378010	8(a)	CWHKT	600	-0.030438%	-0.015742%	0.000000%	0.011555%	0.029734%	-1.654421
8	2847010	8(b)	PCCW	1064	-0.031893%	-0.017225%	0.000000%	0.024114%	0.038544%	0.316485
9	2144010	10	Hang Lung Dev	1163	-0.033162%	-0.020511%	0.000000%	0.022912%	0.041417%	0.001599
10	2114010	11	Hang Seng Bank	1672	-0.019322%	-0.009760%	0.000000%	0.011056%	0.023898%	0.386053
11	2293010	12	Henderson Land	1670	-0.026827%	-0.009647%	0.000000%	0.017273%	0.034899%	0.562305
12	2278010	13	Hutchison	1672	-0.028047%	-0.013174%	0.000000%	0.014185%	0.027439%	0.135211
13	2297010	14	Hysan Dev	1164	-0.033162%	-0.016583%	0.000000%	0.020706%	0.041676%	-0.114450
14	2133010	16	SHK Prop	1672	-0.028982%	-0.012414%	0.000000%	0.013919%	0.030446%	0.484705
15	2164010	17	New World Dev	1283	-0.033836%	-0.016219%	0.000000%	0.023395%	0.040413%	0.234226
16	2077010	19	Swire Pacific 'A'	1672	-0.026417%	-0.010272%	0.000000%	0.015837%	0.031304%	-0.472728
17	2082010	20	Wheelock	1665	-0.031591%	-0.017137%	0.000000%	0.026354%	0.046960%	-0.234772
18	2004010	23	Bank of East Asia	1672	-0.023146%	-0.009847%	0.000000%	0.013176%	0.029722%	0.803140
19	2191010	41	Great Eagle Hldgs	596	-0.045137%	-0.017181%	0.000000%	0.023071%	0.063113%	1.457670
20	2035010	45	HK & S Hotels	435	-0.052897%	-0.025737%	0.000000%	0.030446%	0.069471%	-1.294286
21	2125010	54	Hopewell Hldgs	435	-0.045342%	-0.024780%	0.000000%	0.024070%	0.056039%	0.839959
22	1009060	66	MTR Corporation	873	-0.016541%	0.000000%	0.000000%	0.017052%	0.031452%	0.235191
23	2686010	69	Shangri-La Asia	594	-0.063074%	-0.020766%	0.000000%	0.033339%	0.073695%	-0.433890
24	2290010	83	Sino Land	1287	0.000000%	0.000000%	0.025352%	0.043021%	0.073290%	2.454491
25	2157010	97	Henderson Inv	1670	-0.032515%	-0.016791%	0.000000%	0.026147%	0.039810%	-0.254828
26	2075010	101	Amoy Prop	1671	-0.028856%	-0.014460%	0.000000%	0.022912%	0.045362%	-0.462337
27	2399010	142	First Pacific	797	-0.056008%	-0.026770%	0.000000%	0.027667%	0.061749%	0.220717
28	2600010	144	China Merchants Hldgs	79	-0.015325%	-0.014034%	0.000000%	0.013747%	0.039301%	0.586430
29	2314010	179	Johnson Elec H	1236	-0.033273%	-0.016141%	0.000000%	0.020204%	0.040909%	-0.157329
30	2671010	203	Denway Motors	79	-0.029891%	0.000000%	0.000000%	0.029900%	0.031013%	-0.114747
31	2753010	223	Dao Heng Bank	395	-0.023335%	-0.009170%	0.000000%	0.014400%	0.032420%	0.244706
32	2329010	267	CITIC Pacific	1672	-0.024181%	-0.010193%	0.000000%	0.014702%	0.030917%	0.755313
33	2273010	270	Guangdong Inv	433	-0.055541%	-0.023389%	0.000000%	0.024070%	0.054216%	0.074482
34	2190010	291	China Resources	1662	-0.035645%	-0.017137%	0.000000%	0.021166%	0.039691%	0.483943
35	2334010	293	Cathay Pac Air	1672	-0.025937%	-0.012368%	0.000000%	0.019784%	0.040250%	-0.098559
36	2965010	315	SmarTone Telecom	363	-0.032201%	-0.013306%	0.000000%	0.017685%	0.041077%	0.315666
37	2755010	330	Esprit Hldgs	507	-0.030053%	-0.012254%	0.000000%	0.013388%	0.032526%	0.212726
38	2933010	363	Shanghai Ind Hldgs	1591	-0.030530%	-0.012869%	0.000000%	0.017288%	0.037391%	0.385192
39	2595010	494	Li & Fung	1076	-0.032201%	-0.013661%	0.000000%	0.019668%	0.039612%	0.700713
40	2409010	511	TVB	1590	-0.026726%	-0.009732%	0.000000%	0.015050%	0.034400%	0.150889
41	2596010	551	Yue Yuen	384	-0.017872%	-0.007663%	0.000000%	0.015818%	0.032212%	1.664825
42	1007590	762	China Unicom	874	-0.030162%	-0.012322%	0.000000%	0.027898%	0.042745%	-0.028910
43	1011060	883	CNOOC	836	-0.025060%	-0.015395%	0.000000%	0.019050%	0.032368%	-0.084436
44	3078010	941	China Mobile	1672	-0.025346%	-0.010822%	0.000000%	0.014155%	0.028678%	0.351522
45	2777010	992	Legend Hldgs	1072	-0.033836%	0.000000%	0.000000%	0.028617%	0.044753%	0.215292
46	2949010	1038	CKI Hldgs	1671	-0.024597%	-0.011435%	0.000000%	0.012996%	0.027552%	-0.291051
47	2858010	1199	COSCO Pacific	385	-0.031003%	-0.014587%	0.000000%	0.019104%	0.042836%	-0.116686
48	1018580	2388	BOC Hong Kong	507	-0.020766%	-0.010982%	0.000000%	0.012651%	0.021439%	-0.187563
			Overall	55114	-0.028205%	-0.011435%	0.000000%	0.018069%	0.035657%	0.374319

Table 5

Parameter Estimates from the LOGIT Regression Models

This table presents the estimation results from LOGIT regression models based on dataset from February 1998 to December 2004, but excluding August 1998. "Variable" is the trading time dummy variables, weekday dummy variables, and firm-specific variables defined in Section 3.4. "Estimate" provides the parameter estimates from different LOGIT regression models. Model A includes only the trading time dummy variables; Model B includes the weekday dummy variables; Model C includes the trading time dummy variables, weekday dummy variables, and other firm-specific variables.

Variable	Model A Estimate	Model B Estimate	Model C Estimate
Intercept	0.0076**	-0.0037**	0.1805**
T103000_105959	-0.0451**		-0.0418**
T110000_112959	-0.0480**		-0.0434**
T113000_115959	-0.0558**		-0.0514**
T120000_123000	-0.0691**		-0.0650**
T143000_145959	-0.0612**		-0.0576**
T150000_152959	-0.0447**		-0.0411**
T153000_153959	-0.0397**		-0.0387**
T154000_154959	0.0056**		0.0037*
T155000_155459	-0.0085**		-0.0153**
T155500_155559	-0.0040		-0.0132**
T155600_155659	-0.0063		-0.0173**
T155700_155759	0.0348**		0.0215**
T155800_155859	0.0526**		0.0387**
T155900_160000	0.0814**		0.0691**
Day1_Mon		-0.0221**	-0.0212**
Day2_Tue		-0.0132**	-0.0105**
Day3_Wed		-0.0382**	-0.0360**
Day4_Thu		-0.0381**	-0.0358**
Spread_step			-0.0425**
Imbal_vol			0.1038**
Price			0.0005**
Log_Size			-0.0104**
Model Chi-Square (df)	9400.16(14)**	2053.63 (4)**	160685.21(22)**

Note:

(1) * and ** indicate significance at the 5%, and 1% levels respectively.

(2) The Model Chi-Square statistic is the likelihood ratio statistic to test the null hypothesis that all coefficients except intercept are zero. The degree of freedom of the Chi-square statistic is reported in parentheses.

Figure 1 presents the probabilities of trade at ask price over different trading time intervals of a trading day. This probability is calculated from the coefficient estimate of each trading time dummy by the conversion formula of $\exp(a+bx)/(1+\exp(a+bx))$, where x is the regressor (time-dummy); (a, b) are the parameter estimates from the Model A of LOGIT regression. The result is basically consistent with results about U.S. stock market from Porter (1992). We find the probability of trade at ask price significantly increases when time approaches to the close of a trading day[1]. Hence, the empirical results show strong support to our hypothesis (H1).

Given the intraday data of HSI constituent stocks from February 1998 to December 2004, but excluding August 1998, we first fit a LOGIT regression model with only trading time dummy variables. And then, the probabilities of a trade at ask price over different trading time intervals are calculated from the coefficient estimates of trading time dummies by the conversion formula of $\exp(a+bx)/(1+\exp(a+bx))$, where x is the regressor (time-dummy); (a, b) are the parameter estimates from the Model A of LOGIT regression.

[1] In Wood, McInish, and Ord (1985) and Porter (1992), they also find that the open period has more trades at the ask price than other time periods, excluding the close period. However, we did not have this result.

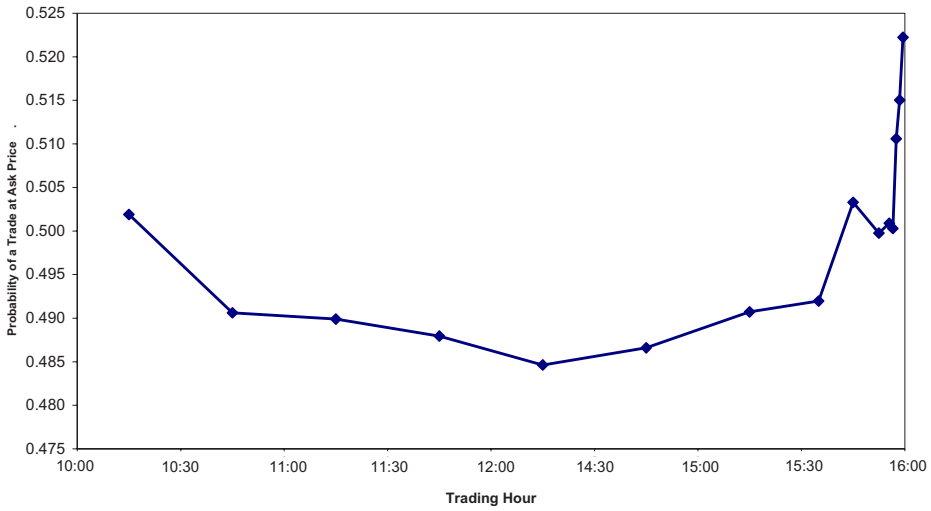

Fig. 1. Probability of a Trade at Ask Price for Major Stocks in HKSE

In addition, we also find that the parameter estimate for Monday dummy is significantly negative in both Models B and C. The probability of trade at ask price on Monday is significantly lower than that for Friday (the LOGIT regression parameter for Monday dummy is significantly negative). It is consistent with our hypothesis (H2) derived from the Monday effect. Also, we got significantly positive parameter estimates for the transaction price and the imbalance volume (the ratio of total quantity volume in five best bid queues to total volume in five best ask queues), but significantly negative parameter estimates for the market size and the number of spread step. All those results are consistent with our hypotheses (H3-H6) in Section 2. In conclusion, all the empirical findings from HKSE are consistent with the intraday trading pattern in NYSE. Even though HKSE, an order-driven market, has market mechanism different from NYSE, the trading behavior of investors in HKSE is similar to NYSE.

We can make a rough estimate of the explanatory power from the systematic trading pattern at ask price on the abnormal return from the end-of-day effect. According to our trade record data, the magnitude of bid/ask spread is, on the average, around 0.43% of the transaction price. With reference to the LOGIT regression result from Model A, we convert the parameter estimate for last one minute time dummy into the probability of trade at ask price over the last one minute, which is 0.5222. If we assume that a trade may be taken at bid or ask with equal probability under normal circumstances, the probability of trade at ask price over the last one minute of trading day is higher than the assumed normal level by 0.0222 (0.5222 – 0.5). This increase in probability of trade at ask price implies a return of +0.0095% (0.43%×0.0222), which is around one-third of the end-of-day effect (0.0285%, which is the "average return per minute over the last 1=minute" from Table 3) in the stock market of Hong Kong.

5. Conclusion

We use the approach of Porter (1992) and Aitken et al. (1995) to analyze the pattern of trade at ask price for major stocks in Hong Kong in order to investigate any relationship between the probability of trade at ask price and the market anomaly of the end-of-day effect. Basically, we find that some empirical results consistent with the research findings on other stock markets from existing literatures. We find that the probability of trade at ask price over the last one minute of trading time significantly increases. This systematic pattern (increase in probability of trade at ask price) can explain around one-third of the positive return from the end-of-day effect. Furthermore, we also find that the probability of trade at ask price for major stocks in HKSE is positively related

to the price level and the buy order imbalance, but negatively related to the number of bid-ask spread steps and the firm size.

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