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The performance of imbalance-based trading strategy on tender offer announcement day

Abstract

This study examines the process how the tender offer information is incorporated into intraday relation between return and order imbalance. We first examine the relation between lagged order imbalances and stock returns. The result shows that the impacts of lagged one imbalance on returns are significantly negative. It implies a likelihood of imbalance-based strategy. We find that the relation between order imbalance and volatility is not strong enough, suggesting that market makers have power in mitigating volatility. We take a further step to examine small firm effect during price formation. The results show that information asymmetry is severe in small firms. Based on the results, we develop an imbalance-based trading strategy, which yields a statistically significant positive return and outperforms buy and hold daily return on tender offer announcement day. A nested causality approach, which examines dynamic return-order imbalance relation during price formation process, explains the imbalance based trading strategy.

Keywords: tender offer, order imbalance, information asymmetry, volatility.
JEL Classification: G14, G34.

Introduction

Over the past two decades, a considerable number of researches have been made on takeover. At first, a majority of literature focuses on the stock abnormal return immediately surrounding announcement dates (e.g. Agrawal et al., 1992; Kaniel et al., 2012). Recently, a small body of study has explored long-run post acquisition abnormal returns (e.g. Dutta and Jog, 2009; Bessembinder and Zhang, 2013). Nonetheless, to our knowledge, there is no study that explores the behavior of the market microstructure on the announcement day. According to Cao et al. (2005) and Arnold et al. (2006), the trading prior to a tender offer announcement could be mainly initiated by traders who hold private information. Nevertheless, the majority of investors are uninformed traders and they could only trade the stocks after hearing the news on the announcement day[1]. Therefore, although the trading prior to announcement is largely originated by informed traders, the trading on the announcement day could be mainly initiated by uninformed traders. The trading strategy we construct would be useful for uninformed individual investors.

Based on the form of offer, takeover could be divided into two parts: merger and tender offer. According to Agrawal and Jaffe (2000), mergers and tender offers should be investigated separately as they could have different implications for firm performance. Tender offers are different from mergers mainly in that acquiring firms of tender offers bid for target shares in the open market[2]. Based on the takeover sample during 1978-2000, Dong et al. (2006) find that the percentage of tender offer (19.4%) is only one-fifth time than that of merger (80.6%). Meanwhile, in the academic area, the studies[3] about the tender offers are less than those about mergers. Because there are inadequate researches on tender offers, in this study, we fill the gap to examine the convergence process as to how tender offer information is incorporated into the bidder's stock price on the announcement day. If tender offer information cannot be incorporated into the price immediately[4], the uninformed traders are theoretically able to develop a trading strategy, which yields a positive return during the announcement day.

Motivated by Chordia and Subrahmanyam (2004), we use intraday transaction data for the tender offer on the announcement day to examine the relationship between the order imbalances and individual stock returns. We examine the convergence process with three different time intervals (5-, 10-, 15-min). In order to make sure that volatility plays no role in the return-order imbalance relationship, we employ a time-varying GARCH (1, 1) model to examine the volatility-order imbalance relationship. We expect that a large volatility is followed by a large order imbalance. Moreover, we develop an imbalance-based trading strategy, which could earn a statistically significant abnormal return. Finally, a nested causality between the order imbalance and return is investigated to explore the intraday dynamics which is essential in the convergence process.

[1] A large previous literature finds that the average abnormal returns of takeover bidders tend to be negative or close to zero. Therefore, rational uninformed investors should sell the bidder's stocks to make a profit.

[2] According to Rau and Vermaelen (1998), in the case of tender offers, bidder firms are often considered as hostile and with cash offer. Mergers occur through discussion between the bidding firm and target firm, are often friendly, and are usually done through share offer (Loughran and Vijh, 1997; Martin and McConnell, 1991).

[3] See Mandelker (1974), Dodd and Ruback (1977), Bradley (1980), Bradley et al. (1983), Liebler (1997), Ahn et al. (2001), and Atanassov (2013).

[4] From the perspective of market inefficiency, Chordia et al. (2005) shows that the market does not converge to efficiency immediately. Grossman (1975) and Grossman and Stiglitz (1980) find that the market prices cannot fully incorporate all knowable information. They argue that someone must be able to generate returns by exploiting the deviation of prices from fundamental values.

We have several marginal contributions. First of all, the trading on the announcement day of the tender offer could be mainly initiated by uninformed traders. If the information cannot be incorporated into the price immediately, the uninformed traders could develop a trading strategy, which yields a positive return. Secondly, on the announcement day of the tender offer, market maker behavior plays a very important role in mitigating volatility from discretionary trades through inventory adjustments. Finally, we investigate the nested causality between order imbalances and returns as we explore the intraday dynamics that is essential in the convergence process of the tender offer announcement.

Our study is organized as follows. Section 1 describes data. Section 2 exhibits the return-lagged order imbalances relation. In section 3, we discuss the volatility-order imbalance GARCH (1, 1) relation. Section 4 presents the performance of order imbalance based trading strategy. In section 5, we exhibit the causality relationship in explaining return-order imbalance relation and the final section concludes.

1. Data

We include tender offer acquirers from the Securities Data Company (SDC) Merger and Acquisition database. Our sample period is from January 1, 2000 through December 31, 2007. Stocks are included or excluded in our samples according to the following criteria. First, all stocks whose transaction data are not available in both SDC and TAQ are excluded from our samples. Second, we delete assets from the following categories: certificates, American Depositary Receipts, shares of beneficial interest, units, companies incorporated outside the U.S., Americus Trust components, closed-end funds, preferred stocks and REITs, because of their different trading characteristics. Finally, we have 150 samples.

We use Lee and Ready (1991) trade assignment algorithm to derive 5-minute, 10- minute, and 15-minute order imbalances. Average return of our sample is -0.2049%, with a median of -0.2447%. The standard deviation of return is 0.032, with a maximum value is 9.3685% and the minimum is -14.2692%.

2. Return-lagged order imbalances relation

We employ a multi-regression model to examine unconditional return-order imbalance relation.

$$R_t = \alpha_0 + \sum_{i=1}^{5} \alpha_{t-i} \times OI_{t-i}, \qquad (1)$$

where R_t is the stock return at time t of the sample stock. OI_t are the lagged order imbalances at time t of the sample stocks.

We expect that whether lagged imbalances are positively related to stock returns according to Chordia and Subrahmanyam (2004). Significantly positive lagged order imbalances help us to develop an imbalance-based trading strategy. We use another multi-regression model to investigate the relation between stock returns, contemporaneous and four lagged order imbalances. We expect a significantly positive impact of contemporaneous imbalances on returns. Moreover, we conjecture how market makers dynamically accommodate the imbalances pressure by examining whether there is a trend among three different time intervals (5-, 10-, 15-min).

We run a multiple-regression model to examine return-lagged order imbalances relation. The results are presented in Table 1. At 5% significant level, we find that negatively significant percentages of lagged one imbalance are 4.00%, 4.70%, and 6.70% for 5-, 10- and 15-min intervals respectively, which are larger than those of positively significant imbalances, namely 4.00%, 2.70%, and 0.70% for 5-, 10-, and 15-min. These results are inconsistent with Chordia and Subrahmanyam (2004). They argue that lagged order imbalances, especially the lagged one order imbalances, are significantly positive related to current stock returns due to the split orders of liquidity traders.

Table 1. Unconditional lagged return-order imbalance relation

	Average coefficient	Percent positive	Percent positive and significant	Percent negative and significant
5-min interval				
OI_{t-1}	-2.7E-08	47.33%	4.00%	4.00%
OI_{t-2}	-1.9E-08	45.33%	2.70%	5.30%
OI_{t-3}	1.3E-08	46.00%	4.00%	6.00%
OI_{t-4}	-7.7E-08	44.00%	2.70%	6.70%
OI_{t-5}	-1.4E-10	58.67%	2.70%	5.30%
10-min interval				
OI_{t-1}	-5.4E-08	39.33%	2.70%	4.70%
OI_{t-2}	-2.8E-07	44.00%	2.00%	6.00%
OI_{t-3}	8.47E-09	47.33%	1.30%	4.00%
OI_{t-4}	-4.6E-09	46.67%	4.70%	2.70%
OI_{t-5}	4.37E-09	46.00%	2.70%	2.00%

Table 1 (cont.). Unconditional lagged return-order imbalance relation

	Average coefficient	Percent positive	Percent positive and significant	Percent negative and significant
15-min interval				
OI_{t-1}	-3.2E-07	42.67%	0.70%	6.70%
OI_{t-2}	-7.6E-08	46.67%	1.30%	4.00%
OI_{t-3}	-2.5E-08	44.67%	1.30%	2.70%
OI_{t-4}	-1.7E-08	48.00%	2.70%	2.00%
OI_{t-5}	6.37E-08	49.33%	4.00%	2.70%

Notes: "Significant" denotes significant at the 5% level.

The possible explanations of our empirical results are twofold. First of all, market makers have accommodated a high inventory level around the tender offer announcement day to mitigate impacts from discretionary investors. Another explanation is that, from previous empirical results, impacts of the information associated with the announcement of tender offers are not strong enough. That is why market makers do not face a great inventory pressure.

We include contemporaneous and four lagged order imbalances in our regression to examine conditional return-contemporaneous order imbalance relation. The results are exhibited in Table 2. We find that the impacts of contemporaneous order imbalances on returns are positively significant for all time intervals at all significant levels. However, the impacts of lagged one order imbalances are negative for all time intervals at 5% significant levels. These results are consistent with Chordia and Subrahmanyam (2004). They use overreaction story to explain the reason why negative coefficients of lagged one imbalance occur. Most of the information about current stock returns is overreacted in contemporaneous order imbalance, therefore lagged one order imbalances, which are autocorrelated with contemporaneous imbalances, cause the current stock returns to reverse.

Table 2. Conditional contemporaneous return-order imbalance relation

	Average coefficient	Percent positive	Percent positive and significant	Percent negative and significant
5-min interval				
OI_t	2.21021E-07	91.33%	59.30%	0.70%
OI_{t-1}	-3.64252E-08	46.00%	3.30%	9.30%
OI_{t-2}	-1.58031E-10	48.67%	4.70%	8.00%
OI_{t-3}	1.04827E-08	47.33%	4.70%	6.70%
OI_{t-4}	-5.84494E-08	47.33%	2.70%	7.30%
10-min interval				
OI_t	5.48055E-07	88.00%	43.30%	0.70%
OI_{t-1}	-3.46204E-08	40.67%	3.30%	6.00%
OI_{t-2}	-3.21594E-08	44.67%	2.00%	5.30%
OI_{t-3}	2.34486E-08	50.00%	4.70%	4.00%
OI_{t-4}	1.2866E-08	50.67%	4.70%	3.30%
15-min interval				
OI_t	5.31468E-07	90.00%	32.00%	1.30%
OI_{t-1}	-1.24641E-07	40.67%	1.30%	6.70%
OI_{t-2}	4.61188E-08	48.67%	1.30%	4.70%
OI_{t-3}	3.13351E-08	52.67%	4.70%	4.00%
OI_{t-4}	-8.94373E-09	49.33%	2.00%	0.70%

Notes: "Significant" denotes significance at the 5% level.

There is one interesting finding in our empirical results. Since the percentage of positively significant contemporaneous order imbalances is 59.30% and the percentage of negatively significant coefficients of lagged one order imbalance is only 0.70% in 5-min interval. It implies that discretionary traders have a possibility to obtain private information before the bidders announce to acquire their targets through tender offer deals. If the information they obtained is true, they are going to take a long position, which enhances a large positive imbalance and boost up stock price. Market makers with inventory and adverse selection concerns react by raising bid-ask quote together to accommodate large imbalances. This releases market makers' inventory pressure. However, from our empirical findings that inventory pressures caused by discretionary traders are not as serious as they had expected. That is why they lower the quote price to rebalance their inventory levels, which results in a negative coefficient of lagged one order imbalance. During the convergence process, we observe the decreasing influence of contemporaneous order imbalances and the percentages of positively significant coefficients, which have been decreasing from 59.3% in 5-min to 32% in 15-min.

3. Volatility-order imbalance GARCH (1, 1) relation

In order to make sure that volatility plays no role in dynamic return-order imbalance relation, we employ a time varying GARCH model to investigate volatility-order imbalance relation.

$$\begin{aligned} R_i &= \alpha + \varepsilon_t \\ \varepsilon_t \left| \Omega_t \right. &\sim N(0, h_t) \\ h_t &= A + B h_{t-1} + C \varepsilon_{t-1}^2 + \gamma OI_t , \end{aligned} \tag{2}$$

where R_t is the return at time t, and is defined as ln (P_t/P_{t-1}). OI_t denotes the explanatory variable of order imbalance. ε_t is the residual value of the stock return at time t. h_t is the conditional variance at time t. Ω_{t-1} is the information set in at time t. γ is the coefficient measuring the impact of the order imbalance on volatility of the return.

We expected that information clusters around announcement of tender offer. Information flows from different views of tender offer volatile stock returns. In order to examine volatility-order imbalance during convergence process, we employ a time varying model. The results of dynamic volatility-order imbalance relation are exhibited in Table 3.

Table 3. The dynamic volatility-order imbalance GARCH (1, 1) relation

	Positive	Percent positive and significant	Percent negative and significant
5-min interval	41.0%	6.0%	0.0%
10-min interval	33.0%	3.0%	0.0%
15-min interval	35.0%	0.0%	1.0%

Note: "Significant" denotes significance at the 5% level.

We expected that there was a positive correlation between volatility and order imbalances, that is, a large volatility is accompanied by a large order imbalance. While the results show that the relation is not as significant as we had expected. At 10% significant level, only 8.0%, 6.0%, and 4.0% of order imbalances have a significantly positive impact on price volatility for 5-, 10-, 15-min interval respectively. At 5% significant level, the significant number is even less. Moreover, there is no order imbalance has a significantly positive impact on price volatility respectively for all time intervals. As expected, we observe that the impacts of order imbalances on return volatility are weaker as the time interval getting longer.

We use market maker behaviors to explain the interesting results. From our empirical findings, we find that market makers with an inherited obligation to reduce price volatilities indeed have abilities to mitigate large order imbalance effects from discretionary traders on tender offer announcement date. Another possible explanation is that market makers have obtained private information before tender offer announcement. Therefore, they have enough inventories to mitigate large order effect.

4. Order imbalance based trading strategy

According to our results in previous sections, we find that the contemporaneous order imbalances have significantly positive influence on stock returns, and the magnitudes of impacts decrease as the time interval increases. And the average daily open-to-close return of our 150 tender offer bidders on the announcement date is -0.2049%.

In this section, we develop an order imbalance based trading strategy for three different time intervals. We trim off 90% of small order imbalances, matching with two definitions of price, namely quote and trading prices.

We buy a share at ask price when positive imbalance appears and sell it at bid price when it turns negative. We report the results in Panel A and the significance test in Panel B of Table 4. We generate an average return of -2.08%, -1.81%, and -2.01% with a 5% significance for 5-, 10-, and 15-min intervals, respectively. We conclude that the trading strategy under the basis of quote price underperforms daily return. We suspect that large bid-ask spreads play a role in the empirical results. We then calculate on the basis of transaction price.

Table 4. Trading profit under the basis of quote price

Panel A: Returns compared with zero

1. $\begin{cases} H_0 : \mu_i \geq 0 \\ H_1 : \mu_i < 0 \end{cases}$

	Sample	Mean	*P*-value
5-min return of strategy	137	-0.0208	0.0001
10-min return of strategy	87	-0.0180	0.0001
15-min return of strategy	59	-0.0201	0.0010

Table 4 (cont.). Trading profit under the basis of quote price

Panel B: Returns compared with returns of buy-and-hold strategy 2. $\begin{cases} H_0 : \mu_i \geq \mu_0 \\ H_1 : \mu_i < \mu_0 \end{cases}$		
	Mean	*P*-value
Original open-to-close return	-0.0028	
5-min return of strategy	-0.0208	0.0002
10-min return of strategy	-0.0180	0.0035
15-min return of strategy	-0.0201	0.0108
Panel C: Differences in returns among the three intervals 3. $\begin{cases} H_0 : \mu_i = \mu_j \\ H_1 : \mu_i \neq \mu_j \end{cases}$		
P-value	5-min return	10-min return
5-min return		
10-min return	0.1795	
15-min return	0.3800	0.6195

We buy a share at trading price when a positive imbalance appears and sell it at corresponding trading price when it turns negative. The results are reported in Panel A with a significance test in Panel B of Table 5. We earn significant average positive returns of 0.49%, 0.17%, and 0.43% respectively for 5-, 10-, and 15-min intervals. We conclude that they outperform daily returns.

Table 5. Trading profit under the basis of trade price

Panel A: Returns compared with zero 1. $\begin{cases} H_0 : \mu_i \leq 0 \\ H_1 : \mu_i > 0 \end{cases}$			
	Sample	Mean	*P*-value
5-min return of strategy	137	0.0049	0.0077
10-min return of strategy	87	0.0016	0.1997
15-min return of strategy	59	0.0043	0.0418

Panel B. Returns compared with returns of buy-and-hold strategy 2. $\begin{cases} H_0 : \mu_i \leq \mu_0 \\ H_1 : \mu_i > \mu_0 \end{cases}$		
	Mean	*P*-value
Original open-to-close return	-0.0052	
5-min return of strategy	0.0049	0.0021
10-min return of strategy	0.0016	0.0175
15-min return of strategy	0.0043	0.0108
Panel C: Differences in returns among the three intervals 3. $\begin{cases} H_0 : \mu_i = \mu_j \\ H_1 : \mu_i \neq \mu_j \end{cases}$		
P-value	5-min return	10-min return
5-min return		
10-min return	0.4015	
15-min return	0.3087	0.8557

In conclusion, we find that an order imbalance base trading strategy on trading price yield statistically significant positive returns and outperform the benchmark of daily returns. That is to say, when a company announces to acquire the other company by tender offer deal, we apply the imbalance based trading strategy to earn abnormal returns.

5. Causality relationship in explaining return-order imbalance relation

In order to explain the story behind imbalance-based trading strategy, we employ a nested causality to explore the dynamic causal relation between return and order imbalance. According to Chen and Wu (1999), we define four relationship between two random variables, x_1 and x_2, in terms of constraints on the conditional variances of $x_{1(T+1)}$ and $x_{2(T+1)}$ based on various available information sets, where $x_i = (x_{i1}, x_{i2},..., x_{iT})$, $i = 1, 2$, are vectors of observations up to time period T.

Definition 1: Independency, $x_1 \wedge x_2$:

x_1 and x_2 are independent if

$$Var(x_{1(T+1)} \left| \underset{\sim}{x}_1 \right.) = Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) = \quad (3)$$

$$= Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2, \underset{\sim}{x}_{2(T+1)} \right.)$$

and

$$Var(x_{2(T+1)} \left| \underset{\sim}{x}_2 \right.) = Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) = \quad (4)$$

$$= Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2, \underset{\sim}{x}_{1(T+1)} \right.)$$

Definition 2: Contemporaneous relationship, $x_1 <-> x_2$:

x_1 and x_2 are contemporaneously related if

$$Var(x_{1(T+1)} \left| \underset{\sim}{x}_1 \right.) = Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) \quad (5)$$

$$Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) > Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2, \underset{\sim}{x}_{2(T+1)} \right.) \quad (6)$$

and $Var(x_{2(T+1)} \left| \underset{\sim}{x}_2 \right.) = Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.)$ (7)

$$Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) > Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2, \underset{\sim}{x}_{1(T+1)} \right.) \quad (8)$$

Definition 3: Unidirectional relationship, $x_1 => x_2$:

There is a unidirectional relationship from x_1 to x_2 if

$$Var(x_{1(T+1)} \left| \underset{\sim}{x}_1 \right.) = Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) \quad (9)$$

and $Var(x_{2(T+1)} \left| \underset{\sim}{x}_2 \right.) > Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.)$ (10)

Definition 4: Feedback relationship, $x_1 <=> x_2$:

There is a feedback relationship between x_1 and x_2 if

$$Var(x_{1(T+1)} \left| \underset{\sim}{x}_1 \right.) > Var(x_{1(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.) \quad (11)$$

and $Var(x_{2(T+1)} \left| \underset{\sim}{x}_2 \right.) > Var(x_{2(T+1)} \left| \underset{\sim}{x}_1, \underset{\sim}{x}_2 \right.)$ (12)

To explore the dynamic relationship of a bivariate system, we form the five statistical hypotheses in the Table 6 where the necessary and sufficient conditions corresponding to each hypothesis are given in terms of constraints on the parameter values of the VAR model.

Table 6. Hypotheses on the dynamic relationship of a bivariate system

The bivariate VAR model: $\begin{bmatrix} \phi_1(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$, where x_{1t} and x_{2t} are mean adjusted variables. The first and second moments of the error structure, $\underset{\sim}{\varepsilon}_t = (\varepsilon_{1t}, \varepsilon_{2t}) \sim' \underset{\sim}{\varepsilon}_t$, are that $E(\underset{\sim}{\varepsilon}_t) = 0$, and $E(\underset{\sim}{\varepsilon}_t \underset{\sim}{\varepsilon}_{t+k}) = 0$ for $k \neq 0$ and $E(\underset{\sim}{\varepsilon}_t \underset{\sim}{\varepsilon}_{t+k}) = \Sigma$ for $k = 0$, where $\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$.

Hypotheses	The VAR test
H_1: $x_1 \wedge x_2$	$\varphi_{12}(L) = \varphi_{21}(L) = 0$, and $\sigma_{12} = \sigma_{21} = 0$
H_2: $x_1 <-> x_2$	$\varphi_{12}(L) = \varphi_{21}(L) = 0$
H_3 : $x_1 \neq> x_2$	$\varphi_{21}(L) = 0$
H_3^* : $x_2 \neq> x_1$	$\varphi_{12}(L) = 0$
H_4 : $x_1 <=> x_2$	$\varphi_{12}(L) \times \varphi_{21}(L) \neq 0$
H_5 : $x_1 \neq>> x_2$	$\varphi_{21}(L)=0$, and $\sigma_{12} = \sigma_{21} = 0$
H_6 : $x_2 \neq>> x_1$	$\varphi_{12}(L) = 0 =$, and $\sigma_{12} = \sigma_{21} = 0$
H_7 : $x_1 <<=>> x_2$	$\varphi_{12}(L) \times \varphi_{21}(L) \neq 0$, and $\sigma_{12} = \sigma_{21} = 0$

To determine a specific causal relationship, we use a systematic multiple hypotheses testing method. Unlike the traditional pair-wise hypothesis testing, this testing method avoids the potential bias induced by restricting the causal relationship to a single alternative hypothesis. To implement this method, we employ results of several pair-wise hypothesis tests. For instance, in order to conclude that $x_1 => x_2$, we need to establish that $x_1 <\neq x_2$ and to reject that $x_1 \neq> x_2$. To conclude that $x_1 <-> x_2$, we need to establish that $x_1 <\neq x_2$ as well as $x_1 \neq> x_2$ and also to reject $x_1 \wedge x_2$. In other words, it is necessary to examine all five hypotheses in a systematic way before we draw a conclusion of dynamic relationship. The following presents an inference procedure that starts from a pair of the most general alternative hypotheses.

Our inference procedure for exploring dynamic relationship is based on the principle that a hypothesis should not be rejected unless there is sufficient evidence against it. In the causality literature, most tests intend to discriminate between independency and an alternative hypothesis. The primary purpose of the literature cited above is to reject the independency hypothesis. On the contrary, we intend to identify the nature of the relationship between two financial series. The procedure consists of four testing sequences, which implement a total of six tests (denoted as (a) to (f)), where each test examines a pair of hypotheses. The four testing sequences and six tests are summarized in a decision-tree flow chart in Figure 1.

To explore dynamic return-order imbalance relation during price formation, we employ a nested causality approach. In order to investigate a dynamic relationship between two variables, we impose the constraints in the upper panel of Table 6 on the VAR model. In Table 7, we present the empirical results of tests of hypotheses on the dynamic relationship in Figure 1. Panel A presents results for the entire sample. In the entire sample, we show that a unidirectional relationship from returns to order imbalances is 9.40% of the sample firms for the entire sample, while a unidirectional relationship from order imbalances to returns is 8.72%. The percentage of firms that fall into the independent category is 30.20%. Moreover, 48.32% of firms exhibit a contemporaneous relationship between returns and order imbalances. Finally, 3.36% of firms show a feedback relationship between returns and order imbalances. The percentage of firms carrying a unidirectional relationship from order imbalances to returns is almost the same as that from returns to order imbalances, suggesting that order imbalance is not a better indicator for predicting future returns. It is not consistent with many articles, which document that future daily returns could be predicted by daily order imbalances (Brown, Walsh and Yuen, 1997; Chordia and Subrahmanyam, 2004). In addition, the percentage of firms exhibiting a contemporaneous relationship is about twelve times than that reflecting a feedback relationship, indicating that the interaction between returns and order imbalances on the current period is larger than that over the whole period.

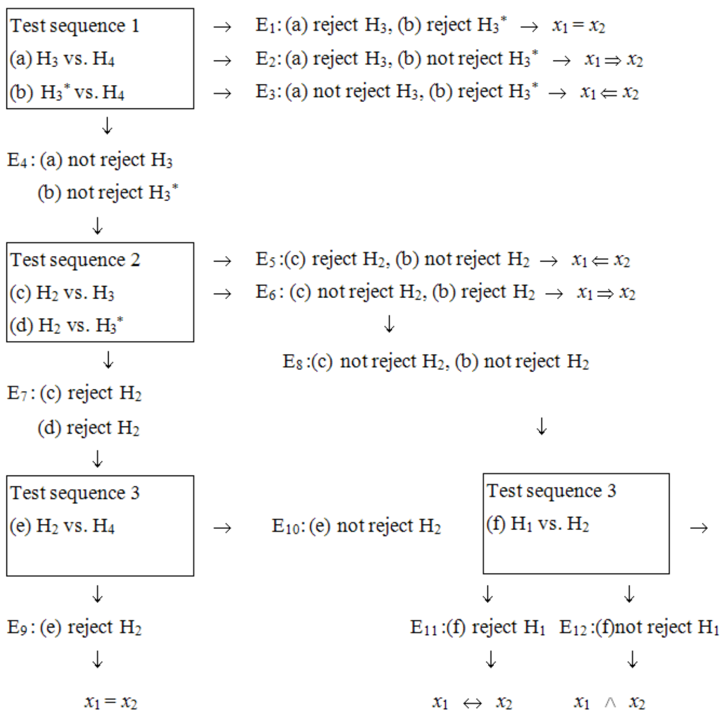

Fig. 1. Test flow chart of a multiple hypothesis testing procedure

Table 7. Dynamic nested causality relationship between returns and order imbalances

	$x_1 \wedge x_2$	$x_1 <\!-\!> x_2$	$x_1 \Rightarrow x_2$	$x_1 \Leftarrow x_2$	$x_1 <=> x_2$
Panel A: All size					
All trade size	30.20%	48.32%	9.40%	8.72%	3.36%
Panel B: Firm size					
Small firm size	30.00%	50.00%	12.00%	6.00%	2.00%
Medium firm size	34.69%	42.86%	4.08%	12.24%	6.12%
Large firm size	26.00%	52.00%	12.00%	8.00%	2.00%

In order to provide the evidence showing the impact on the relation between returns and order imbalances, in Panel B, we divide firms into three groups according to the firm size. Then we test the multiple hypotheses of the relationship between returns and order imbalances. The results in Panel B indicate that the unidirectional relationship from order imbalances to returns is 6.00% in the small firm size quartile, while the corresponding number is 8.00% in the large firm size quartile during the entire sample period. The trend of size-stratified result is not obvious.

Conclusion

Since we believe that markets do not converge to efficiency immediately during tender offers and investors are able to earn abnormal returns from exploiting deviation of prices from fundamental values. In our study, we examine public announcement of tender offer to explore the intraday relation between tender offer return, volatility and order imbalance.

We find that the impacts of lagged one imbalance on returns are negative for three different intervals. This result is inconsistent with Chordia and Subrahmanyam (2004). The result can be attributed to market maker behaviors because they have enough inventories to mitigate the effects from discretionary investors in tender offers. This is also confirmed by a low average return from tender offers. However, we find a consistent result with Chordia and Subrahmanyam (2004) when we examine conditional contemporaneous return-order imbalance relation.

In order to make sure that volatility plays no role in return-imbalance relation, we employ a time varying GARCH (1, 1) to examine relation between price volatility and order imbalance. We expect a positive relation between price volatility and order imbalances, but the results come out to be insignificant. Moreover, we observe that the impacts of order imbalances on return volatility decrease with the time interval. Our story is that market makers with an inherited obligation to mitigate market volatility play a good role during tender offer market making.

Based on the empirical results, we develop an imbalance based trading strategy. We find that an imbalance based trading strategy trading on transaction price yields a statistically significant positive return and outperform the benchmark of original daily returns. We also employ a nested causality approach to examine dynamic return-order imbalance relation during price-formation process.

This research could extend to other corporate announcement events such as seasoned equity offering or spin off stocks. In addition, Barclay and Warner (1993) and Anand and Chakravarty (2007) find that most of the cumulative stock price change is due to medium-size trades. Therefore, if we focus on medium-size trades, the performance of imbalance-based trading strategy should be better than that on all-size trades.

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