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Dynamic limit order placement strategies: survival analysis with a multiple-spell duration model

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Abstract
This study investigates the multiple events that occur in the life of each limit order by utilising a survival analysis methodology with a multiple-spell duration model. The estimates suggest that the hazard rates of limit order event transitions are determined by a number of factors and their impacts depend on whether the initial order event is a limit order submission, partial execution or revision. The differences in estimates across initial order events increase as exchange latency reduces in recent years. Using a multiple-spell duration model to examine the full spectrum of events that occur in the life of a limit order is thus shown to be informative and essential in modelling dynamic limit order placement strategies.

Keywords Tick-by-tick data · Dynamic order placement strategies · Survival analysis · Multiple-spell duration · Australian securities exchange (ASX)

JEL classfication C35 · G15

1 Introduction

Limit order is one of the most essential elements in equity trading because most markets are designed as an electronic limit order book (Foucault 1999; Hollifield et al. 2004). Time is an important piece of information in trading (Easley and O'Hara 1992) yet extant theoretical limit order book studies including Kyle (1985), Glosten (1994), Foucault et al. (2005) and Roşu (2009) focus on order placement decision and provide limited guidance for modelling limit-order execution times and time-to-next-order-event. The empirical evidence on time between order events (execution, revision and cancellation activities) is also scant.

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After a limit order has been placed, the order may be fully executed, partially executed, revised, or cancelled. This study contributes to the literature by using multiple-spell duration model to study the determinants of the duration of limit order events, taking into account the full spectrum of events that occur in the life of each limit order.[1] Existing studies in the duration of limit order event such as Lo et al. (2002) assume that revision and cancellation events are censored observations. They analyze time-to-execution using a single-spell duration model hence they are unable to account for successive limit order events and their determinants.

This study is the first, to our knowledge, to employ a multiple-spell duration model to study dynamic limit order placement strategies in order to take into account the full spectrum of order events. By allowing for duration dependence and addressing the unobserved heterogeneity, a multiple-spell duration model of survival analysis is a more appropriate econometric tool to address the dynamic of limit order placement strategies. This is because order placement strategies are constructed from a series of order events rather than single, independent events.

Our empirical results from the multiple-spell duration model reveal a number of factors that determine the duration of various limit order events. For example, larger opposite-side liquidity motivates traders to intensify their revision and cancellation activities, and hence a higher occurrence probability of revision and cancellation limit order events. Importantly, the sensitivity of duration to these factors depends on whether the starting point is an order submission, partial execution or revision.

We use Australian Securities Exchange (ASX) order data from the Securities Industry Research Centre of Asia–Pacific (SIRCA) which allows us to identify various events in the life of a limit order. The ASX had two major technological upgrades during our sample period. Contrasting estimates based on data from different technological regimes (in years 2000, 2007 and 2011) illustrate that the differential impact of determinants of durations across order submissions, order revisions and partial executions persists and grows stronger in the latter lower latency periods. These results are robust across buy limit orders and sell limit orders as well as for large-capitalisation stocks and small-capitalisation stocks. An implication of our research findings is that ignoring order revision, cancellation, partial execution and considering only order submission and execution as in previous studies might lead to missing out important information in the trading process.

This study is related to the literature of limit order placement strategies, which has grown over the past two decades (see, for example, Foucault 1999; Sandas 2001; Lo et al. 2002; Cao et al. 2008; Hasbrouck and Saar 2013). The primary focus of this literature is on order submission strategies where traders choose among different order types (such as market orders vs. limit orders) and they tend to assume limit orders cannot be revised or cancelled once submitted (see Liu (2009) and the reference therein). Due to an increase in order cancellation activity observed in many markets,[2] studies began to emerge over the past decade to examine the decision to cancel and revise (Hall and Hautsch 2006; Hasbrouck and Saar 2009; Liu 2009; Fong and Liu 2010; Chan and Ma 2013; Hasbrouck and Saar 2013; Bień-Barkowska 2014; Van Ness et al. 2015). Order revision is an important element of dynamic order placement strategies where traders have an option to change the

[1] Multiple-spell duration models have been applied extensively in examining labour market dynamics. For a survey of different types of duration model, see van den Berg (2001).

[2] Hasbrouck and Saar (2009) report that 93% of submitted limit orders are subsequently cancelled on INET. They show that orders that are cancelled in the system within only 2 s of their submissions account for as much as 37% of limit order placements. Fong and Liu (2010) also report that more than 60% of limit orders are cancelled or revised on the Australian Stock Exchange.

price, the size, or both, of an existing order once they are placed into the limit order book (Harris 1998; Liu 2009; Fong and Liu 2010; Menkhoff and Schmeling 2010; Tseng and Chen 2015; Viljoen et al. 2015). As the advancement of communication and computational technology in trading lowers the costs of monitoring and managing orders, the value of considering order events accurately increases.

2 ASX order data

2.1 Trading systems of the Australian securities exchange (ASX)

The Australian Securities Exchange (ASX) is a highly transparent market that relies solely on the liquidity provided by investors. There are no designated market makers or dealers on the ASX. The ASX had employed the fully computerised Stock Exchange Automated Trading System (SEATS) from 1987 to 2006. In October 2006, SEATS was replaced by the Integrated Trading System (ITS), which is a fully-electronic trading system utilised for its efficiency in dealing with fast transactions. ITS kept the same trading rules and market structure of the ASX, but provided a number of operational improvements over SEATS. From November 2010, ASX Trade, an ultra-low latency trading platform replaced ITS. Powered by NASDAQ OMX's Genium INET platform, ASX Trade provided one of the fastest integrated equities and derivative platforms in the world at that time.

2.2 Limit order data

This study investigates the dynamic order placement activities of 40 index stocks listed on the ASX over the three sample periods, year 2000, year 2007 and year 2011. Each sample consists of 20 large and 20 small stocks, ranked by market capitalisation. Large-cap stocks are the top 20 common stocks that are traded on the ASX200 index. For the purpose of this study, small-cap stocks are chosen as the 20 common stocks ranked from 111th to 130th on the ASX200 index. Year 2000 is chosen since it was the year that the ASX200 index was formed and started its operation. Years 2007 and 2011 are chosen as they were the years that immediately followed the inceptions of ITS and ASX Trade, respectively.

In each sample period, the month of August is chosen as the investigation period of this study as most preliminary end-of-year earnings reports are released in August. As a result, more trading activities are expected in August. The order book dataset (known as the AusEquities) is provided by SIRCA. It records the details of each order including the date, time, stock code, price, transacted volume and order type. Each order is assigned with a cross reference identifier which allows us to track the entire life of the limit orders, i.e. orders that are revised (either an order-price revision, or an order-volume revision, or both) as well as orders that are cancelled, partially or fully executed after submissions. Our sample comprises a total of 12,791,710 order events. Market orders account for about 55% and limit orders constitute about 45% of the order submissions. Apart from the number of executions, revision order events make up about 50% of limit orders, whereas cancellation events represent about 20% of all limit orders. The statistics clearly indicate that investigating the limit order placement strategies cannot be thoroughly and properly carried out without paying special attention to the revision and cancellation activities.

Table 1 provides the summary statistics for the time between order events in each of the years: 2000, 2007 and 2011, respectively. Figures 1 and 2 compare the time between

Table 1 Summary statistics of the time between order events

Limit order spell	Buy					Sell				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Panel A: Year 2000										
Submission to full execution	20,977	21.2	47.7	0	333.2	20,345	21.5	47.5	0	352.2
Submission to partial execution	48,787	3.9	19.9	0	349.5	48,836	3.8	19.4	0	352.4
Submission to revision	16,445	18.5	41.8	0	356.6	14,652	23.6	49.5	0	349.8
Submission to cancellation	8098	37.9	64.8	0	353.3	6953	35.5	64.1	0	355.3
Revision to full execution	11,135	4.3	18.4	0	303.4	9829	4.9	20.0	0	338.5
Revision to partial execution	10,561	3.5	15.3	0	317.9	9690	3.8	15.9	0	330.5
Revision to revision	6737	12.8	28.4	0	304.1	5844	14.9	33.9	0	339.8
Revision to cancellation	1725	28.6	53.6	0	344.9	1505	29.9	55.3	0	319.5
Partial execution to full execution	33,245	3.1	13.2	0	353.9	33,745	3.1	12.5	0	350.7
Partial execution to partial execution	39,590	2.9	11.1	0	345.4	39,202	3.1	11.4	0	324.5
Partial execution to revision	7467	8.5	23.2	0	302.9	6964	9.5	25.9	0	337.3
Partial execution to cancellation	3077	15.5	41.9	0	329.5	2670	16.1	40.4	0	345.7
Panel B: Year 2007										
Submission to full execution	291,270	6.9	26.1	0	348.7	255,917	4.1	17.1	0	354.0
Submission to partial execution	85,549	6.2	23.6	0	348.7	106,295	4.9	19.6	0	345.7
Submission to revision	224,667	5.7	22.1	0	353.3	215,325	5.5	22.8	0	352.9
Submission to cancellation	286,279	5.5	22.4	0	356.4	287,422	4.6	20.1	0	354.5
Revision to full execution	153,126	2.2	11.8	0	334.9	135,499	1.8	8.6	0	303.4
Revision to partial execution	46,208	1.9	10.9	0	299.2	54,116	1.7	9.6	0	334.9
Revision to revision	466,683	2.2	9.3	0	348.3	458,100	2.2	9.9	0	351.8
Revision to cancellation	39,069	6.6	23.3	0	352.5	44,387	4.8	19.1	0	344.2
Partial execution to full execution	97,340	1.1	6.8	0	286.6	118,080	0.8	5.5	0	323.6
Partial execution to partial execution	97,059	0.9	5.9	0	319.7	161,964	0.8	5.6	0	319.8
Partial execution to revision	17,503	2.7	11.8	0	316.9	21,664	2.8	13.7	0	321.2

Table 1 (continued)

Limit order spell	Buy					Sell				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Partial execution to cancellation	14,558	3.6	17.1	0	335.7	18,917	3.3	16.6	0	346.9
Panel C: Year 2011										
Submission to full execution	30,943	0.0	1.5	0	225.4	162,180	2.3	13.4	0	353.7
Submission to partial execution	103,174	1.1	7.5	0	335.9	309,581	2.5	12.4	0	338.4
Submission to revision	510,101	1.6	9.9	0	349.1	543,063	1.5	9.4	0	354.2
Submission to cancellation	1,366,473	2.0	12.0	0	357.9	128,3983	2.0	12.0	0	359.4
Revision to full execution	80,893	0.7	6.1	0	292.0	66,053	0.9	5.8	0	294.3
Revision to partial execution	60,112	0.7	5.8	0	286.1	164,818	1.0	5.2	0	270.1
Revision to revision	1,415,126	0.5	3.7	0	321.9	1,605,498	0.5	3.4	0	332.9
Revision to cancellation	257,857	1.1	7.5	0	347.3	277,179	0.9	6.5	0	336.0
Partial execution to full execution	21,695	0.1	1.4	0	156.9	152,958	0.5	3.4	0	338.0
Partial execution to partial execution	65,772	0.2	1.8	0	194.1	105,423	0.3	3.2	0	289.2
Partial execution to revision	23,710	0.6	4.8	0	286.7	27,807	0.7	6.4	0	314.2
Partial execution to cancellation	25,291	1.5	11.4	0	340.8	26,944	1.4	11.0	0	329.9

This table presents the summary statistics for the time (in minute) between order events

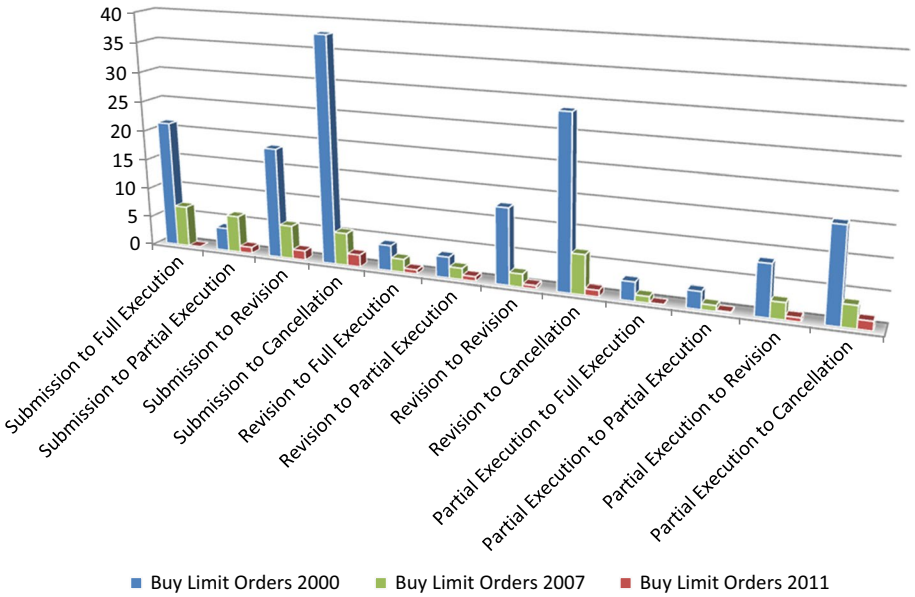

Fig. 1 Combined charts of average time between order events for buy limit orders. This figure presents a comparison for buy limit orders between the periods before ITS, after ITS and after ASX TRADE

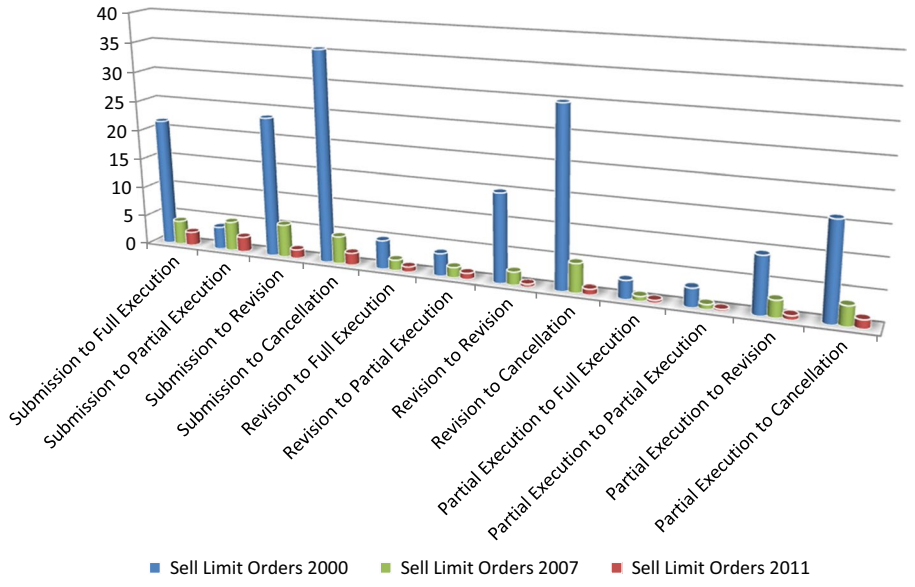

Fig. 2 Combined charts of average time between order events for sell limit orders. This figure presents a comparison for sell limit orders between the periods before ITS, after ITS and after ASX TRADE

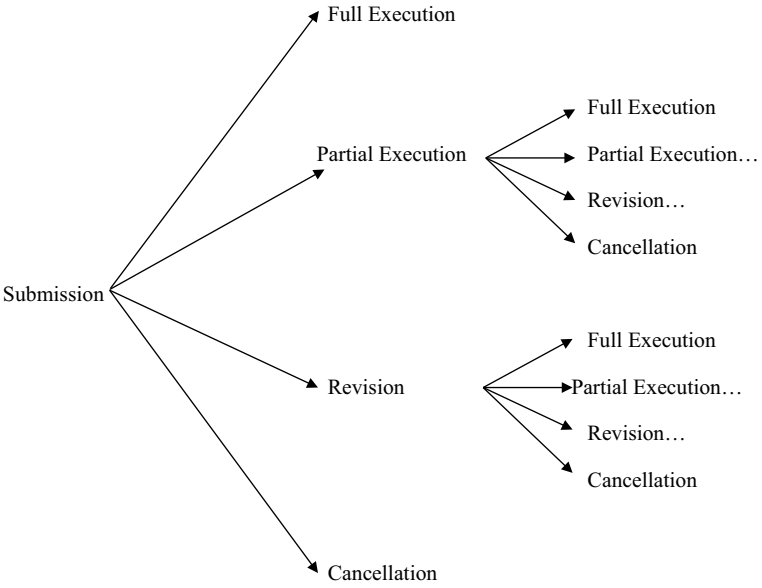

Fig. 3 The general transitions of limit order events

order events for buy and sell limit orders, respectively, across three years: 2000, 2007 and 2011. Preliminary observations seem to suggest that technological advancement shortens the average time between order events as it enables the market to trade faster and trade more frequently.

3 Empirical methodology

3.1 Construction of full order history

We begin the empirical analysis by constructing the complete life of each limit order placed in the limit order book during the sample periods. The full life of a limit order consists of a series of order events, including submission, execution, revision and cancellation. A limit order's life is ended when it is fully executed or fully cancelled from the limit order book. Using the unique cross reference identifier that is assigned to each order, we are able to trace the relevant events pertaining to each limit order. Following its submission into the limit order book, a limit order can be fully executed, partially executed, revised, or cancelled. If the limit order is partially executed or revised, the possible subsequent events will be the same as in the first phase. That is, the partially executed or revised order can be followed by a full execution, a partial execution, a revision or a cancellation. Figure 3 provides a snapshot of the general transitions of limit order events. We have a total of 6,246,955 unique limit orders in our sample, and 2,226,475 (35.64%) of these orders experience more than one order event after their submission.

3.2 Survival analysis with a multiple-spell duration model

In this section, we outline the multiple-spell duration model that is used to examine the determinants of multiple order events that occur throughout the entire life of limit orders.[3]

Survival analysis involves a nonnegative random variable which represents the length of a limit order spell. Let T be this random variable. It represents the time it takes for a limit-order to transit from one event to another (time-to-an-order-event). If $h(t)$ is the hazard rate of T at time t, then $h(t)dt$ shows the probability that an order which has survived (being placed with one event) through time t will fail (being placed with another event) in the interval $[t, t+dt)$. Let $f(t)$ be the probability density function of T and let $F(t)$ be the cumulative density function of T, then the hazard function can be defined as:

$$h(t) = \frac{f(t)}{1 - F(t)} \tag{1}$$

The hazard rate is the rate at which an order spell is completed (an order is completely transited from one event to another) after t, given that they last at least until time t. The survival function is defined as $S(t) \equiv 1 - F(t)$. It shows the probability that the length of an order spell will be at least t.

In order to estimate hazard function and survival function, a non-parametric or a parametric survival analysis can be utilised. The non-parametric approach does not rely on any parametric assumption when estimating the survival function. On the other hand, the parametric approach assumes a particular parametric distribution of failure times and the survival function can be estimated using maximum likelihood based on the distributional assumption. This research employs a parametric survival analysis in the estimation of both the hazard function and the survival function due to its dominance over the non-parametric counterpart (see, for example, Lo and Farmer 1999; Lo et al. 2002; Lancaster 1979; Van den Berg 2001). The model assumes the (non-negative) arrival rate to be constant per unit time.[4] Preliminary analysis (unreported) shows that our duration data exhibits exponential distribution. We estimate both the hazard function and the survival function parametrically using the exponential distribution as it is one of the most widely used distributions for duration analyses (Kalbfleisch and Prentice 2011).

Our econometric specification of the multiple-spell duration model is similar to Gagliarducci (2005) who used the model to study the path to a permanent job from a sequence of temporary contracts and periods of unemployment. Gagliarducci's labour market setting possesses some similarities with placement activities of order events. Similarly to labour market transitions, following the initial submission, a limit order can pass through a sequence of multiple events before it can be fully filled or completely cancelled from the system.

In our case, we consider twelve event transitions.[5] They include (1) submission-to-full-execution, (2) submission-to-partial-execution, (3) submission-to-revision, (4)

[3] Multiple-spell duration model has been used more widely in biomedical science and labour economics (see Van den Berg 2011 for review).

[4] One might argue that this assumption is not innocuous because arrival rate changes when information arrives. See Engle (2000). In our study, we choose a period where there are a large number of information events (earning announcements), hence arrival rate of order events should be fairly stable during this period.

[5] In these transitions, the order events on the left-hand side are said to be in the *origin states* and the order events on the right-hand side are said to be in the *destination states*.

submission-to-cancellation, (5) partial-execution-to-full-execution, (6) partial-execution-to-partial-execution, (7) partial-execution-to-revision, (8) partial-execution-to-cancellation, (9) revision-to-full-execution, (10) revision-to-partial-execution, (11) revision-to-revision, and (12) revision-to-cancellation.

Let t_i be a sequence of adjacent periods of time (spells) spent in different states. For each series of limit order events, a sequence $t_i=\{t_i^c\}$ is observed. The duration spent is denoted by t, the particular series of limit order events occur for an individual stock is denoted by the subscript i. cth spell in a specific state is denoted by the superscript c. This multiple-spell duration model specification captures the dynamic aspect of transition between different states.

The *hazard rate*, θ_{kj}, is defined as the intensity of the transition to the *destination state* (denoted by j) after a visit in the *origin state* (denoted by k). The function of the *hazard rate*, θ_{kj}, for the series i at its cth spell is expressed as the following:

$$\theta_{kj}\left(t_i^c|X_{ikj};\beta\right) = h_{kj}\left(t_i^c\right)\exp\left(\beta_{kj}' X_{ikj}\right)v_{ikj} \tag{2}$$

where $h_{kj}\left(t_i^c\right)$ is a baseline hazard; X_{ikj} is a set of explanatory variables which incorporate both stock market conditions and limit order characteristics that can influence the duration remaining in the origin state or the probability of transitioning from state k to state j[6]; and v_{ikj} is a random individual effect to capture the unobserved heterogeneity. All the individual covariates, X_{ikj}, which determine the hazard rate of transition between limit order events, are fixed to their values at the beginning of each spell. The construction of the explanatory variables is described in further details in Sect. 3.3.

3.3 Incorporating explanatory variables in the duration models

The duration models employed in this study allow for the inclusion of explanatory variables which describe the limit order characteristics and the stock market conditions in which the order events occur. Since the survival times of limit orders depend on several factors such as limit order price, order size, market depth and market liquidity, the limit order characteristics and market conditions are highly influential on the decisions and strategies of traders in placing orders in the market. In the multiple-spell duration model, explanatory variables are measured at the beginning of each limit order spell. The variables are defined and calculated separately for buy and sell limit orders.[7]

Let P be the most recent transaction price, L be the limit price, B be bid price, A be the ask price, MQ be the mid-quote price, S_b be the bid size, S_a be the ask size and S_l be the limit order size. For buy limit orders, the explanatory variables are defined as follows:

[6] Since duration is inversely related to the transition probability, the interpretation is loosely interchangeable.

[7] The set of explanatory variables are defined in a similar way to those used in Lo et al. (2002).

PRICEGAP	$=MQ-L$	
INITRADE	$=1$	if the previous transaction price is greater than *MQ*
	$=-1$	if the previous transaction price is less than *MQ*
	$=0$	if the previous transaction price is equal to *MQ*
SSLIQUIDITY	$=(1+B-L)\times\log S_b$	if $L\leq B$
	$=0$	if $L>B$
MKDPR	$=(P-L)\times SSLIQUIDITY$	if $P\geq L$
	$=0$	if $P<L$
OSLIQUIDITY	$=\log S_a/(1+A-L)$	if $A\geq L$
	$=\log S_a$	if $A<L$
ORDSIZE	$=\log S_l\,(1+A-L)$	if $A>L$
	$=\log(S_l-S_a)$	if $A=L$ and $S_l>S_a$
	$=0$	if otherwise

The above explanatory variables capture the characteristics of the limit orders as well as the conditions of the stock market where the orders are placed. The variable *PRICEGAP* measures the distance of the limit buy price from the mid-point of the prevailing quotes. The variable *INITRADE* indicates if the previous transaction is a buyer-initiated trade or a seller-initiated trade. *SSLIQUIDITY* is the same side (buying side) liquidity and is constructed as a measure of the market depth scaled by the distance between the bid price and the limit buy price. The variable *MKDPR* is an interactive term added to the model to capture nonlinearities between market depth and market price relative to the limit price. *OSLIQUIDITY* shows the liquidity that is available in the market on the opposite side (selling side). *OSLIQUIDITY* decreases as the limit buy price drops further below the ask price. The variable *ORDSIZE* is a measure that captures the number of shares demanded by the limit order and the measure is scaled by the difference between the limit buy price and the ask price.

The explanatory variables for sell limit orders are defined in a similar way as buy limit orders, but some of the effects are in the opposite direction. As a result, four of the above explanatory variables are redefined as follows:

PRICEGAP	$=L-MQ$	
SSLIQUIDITY	$=(1+L-A)\times\log S_a$	if $L\geq A$
	$=0$	if $L<A$
MKDPR	$=(P-L)\times SSLIQUIDITY$	if $P\leq L$
	$=0$	if $P>L$
OSLIQUIDITY	$=\log S_b/(1+L-B)$	if $B\leq L$
	$=\log S_b$	if $B>L$
ORDSIZE	$=\log S_l\,(1+L-B)$	if $L>B$
	$=\log(S_l-S_b)$	if $L=B$ and $S_l>S_b$
	$=0$	if otherwise

The summary statistics of the time between order events are presented in Table 1. With enhanced trading and monitoring technology, the time between successive order events has reduced remarkably. For example, the average time between limit buy order submission and the first revision fell by more than tenfold from 19 min in 2000 to

Table 2 Summary statistics of explanatory variables

	PRICEGAP	*INITRADE*	*SSLIQUIDITY*	*MKDPR*	*OSLIQUIDITY*	*ORDSIZE*
Buy limit orders						
Mean	0.017	−0.001	4.875	0.722	8.128	8.374
Median	0.005	0.000	6.313	0.000	8.247	8.602
25th percentile	−0.005	−1.000	0.000	0.000	6.979	7.529
75th percentile	0.015	1.000	8.896	0.087	9.331	9.369
Number of observations	162,795	162,795	162,795	162,795	162,795	162,795
Sell limit orders						
Mean	0.019	−0.003	4.967	−4.560	8.146	8.435
Median	0.005	0.000	6.435	0.000	8.268	8.602
25th percentile	−0.005	−1.000	0.000	−0.088	6.939	7.537
75th percentile	0.015	1.000	8.912	0.000	9.393	9.395
Number of observations	158,210	158,210	158,210	158,210	158,210	158,210

This table presents the summary statistics for the explanatory variables used in survival analyses. The proportional hazard model estimates the effects that limit order characteristics and market conditions have on the duration of order events

1.6 min in 2011, while the corresponding time to cancellation fell by 19 times from 38 to 2 min. Table 2 presents the summary statistics of the explanatory variables.

In addition, the survival analysis with multiple-spell duration in this study also includes *PREVDUR* as an additional explanatory variable to ensure that the duration dependence between successive spells is taken into account in the analysis. This variable *PREVDUR* is defined as the time spent previously in the preceding states prior to the current limit order spell.

4 Empirical results

4.1 Survival analysis with a multiple-spell duration model

Table 3 presents the results for the multiple-spell duration analysis of buy limit orders (in Panel A) and sell limit orders (in Panel B) in the pooled sample of the initial period (August 2000). Limit order dynamics are specified as sequences of multiple limit order events. The estimation model used in this analysis, as abovementioned, is the proportional hazard model under the exponential distribution for limit order times.

The first explanatory variable of interest is *PRICEGAP*. The coefficient estimates of this variable are mostly negative and significant for all order spells in both samples of buy limit orders and sell limit orders. The result implies a negative relationship between the hazard rate of order events and the distance from the limit price to the mid-quote price. In other words, the closer the limit price is placed from the mid-quote (i.e. the smaller *PRICEGAP*), the higher the transition-specific hazard rate, implying a higher probability of transition from one event to another. This is consistent with the argument put forth by Liu (2009) and Fong and Liu (2010), who assert that traders monitor their limit orders closely, particular when a limit order is submitted with a more aggressive price due to high non-execution (NE) and free-option (FO) risks.

Table 3 Multiple-spell duration analysis of limit orders of the pooled sample in the initial period (August 2000)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	−0.737***	−0.437***	−0.216*	−0.104	−0.347***	−0.304***	0.084	−0.680***	0.005	−0.035***	−0.140***	0.070
	(0.032)	(0.031)	(0.114)	(0.140)	(0.042)	(0.038)	(0.079)	(0.189)	(0.012)	(0.010)	(0.028)	(0.044)
INITRADE	−0.353***	−0.278***	−0.152***	−0.206***	−0.343***	−0.178***	−0.098***	−0.135***	−0.172***	−0.125***	−0.110***	−0.204***
	(0.015)	(0.019)	(0.014)	(0.022)	(0.033)	(0.035)	(0.021)	(0.043)	(0.013)	(0.012)	(0.030)	(0.044)
SSLIQUIDITY	−0.790***	−0.513***	−0.521***	−0.710***	−0.569***	−0.494***	−0.403***	−0.184***	0.014	−0.055***	−0.360***	−0.040
	(0.015)	(0.015)	(0.022)	(0.044)	(0.031)	(0.033)	(0.031)	(0.049)	(0.012)	(0.010)	(0.025)	(0.041)
MKDPR	0.038	−0.045***	0.562***	0.463***	−0.049	−0.070**	0.125**	0.587***	0.072***	0.057***	−0.036	0.025
	(0.035)	(0.017)	(0.114)	(0.168)	(0.043)	(0.034)	(0.060)	(0.227)	(0.013)	(0.012)	(0.031)	(0.040)
OSLIQUIDITY	−0.079***	−0.059***	0.082***	0.015	−0.005	−0.077***	0.018	−0.079*	0.383***	0.239***	0.702***	0.711***
	(0.014)	(0.016)	(0.015)	(0.025)	(0.024)	(0.026)	(0.022)	(0.047)	(0.033)	(0.028)	(0.073)	(0.105)
ORDSIZE	0.140***	0.299***	0.132***	0.367***	0.130*	0.158*	0.115**	0.025	−0.117***	−0.107***	−0.224***	−0.207**
	(0.013)	(0.051)	(0.038)	(0.067)	(0.073)	(0.082)	(0.045)	(0.071)	(0.031)	(0.028)	(0.070)	(0.100)
PREVDUR					−0.007***	−0.009***	−0.009***	−0.006***	−0.007***	−0.007***	−0.008***	−0.014***
					(0.001)	(0.001)	(0.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	−1.073***	−0.159***	−1.380***	−1.960***	0.054	0.150**	−1.044***	−1.820***	0.929***	0.557***	−0.274***	−0.518***
	(0.016)	(0.042)	(0.017)	(0.029)	(0.093)	(0.062)	(0.028)	(0.058)	(0.012)	(0.011)	(0.027)	(0.045)
UNOBHET	0.110***	0.053***	0.047***	0.246***	−0.045	−0.113***	−0.134***	−0.009	0.109***	−0.092***	0.146***	0.298***
	(0.014)	(0.018)	(0.017)	(0.023)	(0.033)	(0.034)	(0.029)	(0.053)	(0.010)	(0.011)	(0.023)	(0.035)
N	20,977	48,787	16,445	8098	11,135	105,661	6737	1725	33,245	39,590	7467	3077
LR chi2	6670.10	2625.70	675.73	365.33	1059.08	774.91	575.50	101.73	1714.12	1453.27	689.98	350.31
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.927***	−3.690***	−3.500***	−0.980***	−3.033***	−0.196***	−2.460***	−1.563**	0.006	−0.052***	−0.144***	0.036
	(0.032)	(0.220)	(0.232)	(0.286)	(0.265)	(0.038)	(0.231)	(0.742)	(0.012)	(0.011)	(0.029)	(0.045)
INITRADE	0.358***	0.269***	0.065***	0.114***	0.308***	0.114***	0.039*	0.109**	0.132***	0.141***	0.128***	0.113**
	(0.015)	(0.018)	(0.016)	(0.024)	(0.036)	(0.036)	(0.023)	(0.049)	(0.013)	(0.011)	(0.030)	(0.055)

Table 3 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.797***	−0.576***	−0.124***	−1.616***	−0.611***	−0.433***	−0.538***	−0.072***	0.069***	0.108***	−0.417***	−0.144***
	(0.014)	(0.015)	(0.005)	(0.107)	(0.034)	(0.035)	(0.038)	(0.018)	(0.013)	(0.011)	(0.027)	(0.044)
MKDPR	−0.242***	−0.038**	−0.003***	−2.339***	0.020	0.150***	−2.483***	−0.001***	−0.094***	−0.099***	−0.053*	0.006
	(0.034)	(0.018)	(<.001)	(0.252)	(0.038)	(0.029)	(0.224)	(<.001)	(0.014)	(0.012)	(0.031)	(0.058)
OSLIQUIDITY	−0.099***	−0.030*	−0.004	0.056**	−0.037	−0.035	−0.134***	−0.025	0.359***	0.270***	0.616***	0.881***
	(0.014)	(0.016)	(0.008)	(0.027)	(0.025)	(0.028)	(0.026)	(0.025)	(0.034)	(0.029)	(0.081)	(0.127)
ORDSIZE	0.166***	0.482***	0.101***	0.164	0.121	0.001	0.411***	−0.042	−0.102***	−0.092***	−0.124	−0.315***
	(0.013)	(0.051)	(0.011)	(0.138)	(0.077)	(0.086)	(0.062)	(0.038)	(0.033)	(0.028)	(0.077)	(0.121)
PREVDUR					−0.006***	−0.008***	−0.007***	−0.006***	−0.009***	−0.011***	−0.009***	−0.016***
					(<.001)	(0.001)	(<.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	−1.141***	−0.116***	−1.260***	−1.799***	0.226**	0.081	−1.060***	−0.564*	0.940***	0.658***	−0.259***	−0.446***
	(0.016)	(0.042)	(0.098)	(0.030)	(0.095)	(0.062)	(0.031)	(0.335)	(0.012)	(0.011)	(0.029)	(0.050)
UNOBHET	0.087***	0.103***	0.090***	0.267***	−0.027	−0.098***	−0.052*	0.081	0.123***	−0.007	0.212***	0.357***
	(0.015)	(0.017)	(0.018)	(0.025)	(0.033)	(0.035)	(0.030)	(0.054)	(0.010)	(0.011)	(0.024)	(0.037)
N	20,345	48,836	14,652	6953	9829	9690	5844	1505	33,745	39,202	6964	2670
LR chi2	7015.70	2541.69	1183.43	346.91	1130.64	674.82	735.94	95.71	2006.36	2732.19	667.26	338.55
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 40. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

The coefficient estimates of *INITRADE* for buy limit orders are all significantly negative, whereas those for sell limit orders are all significantly positive. This result suggests that if the previous transaction is a seller-initiated trade, a buy limit order tends to experience a higher probability of execution (both full and partial execution), as well as revision and cancellation. On the other hand, a sell limit order is likely to experience a higher chance of execution, revision or cancellation if the prior transaction is a buyer initiated trade.

Two different types of liquidity are captured by the two explanatory variables *SSLIQUIDITY* and *OSLIQUIDITY*. The variable *SSLIQUIDITY* shows the relation between the same-side depth of the limit order book and the hazard rate of order events. The results are mostly negative and significant for both buy limit orders and sell limit orders. This negative relation suggests that the deeper the limit order book on the same-side, the lower the probability of transition to subsequent order events. As the limit order book is congested with same-side orders, any arriving limit orders will find it harder to be executed (Parlour 1998). Moreover, the significantly negative coefficient estimates of the variable *SSLIQUIDITY* also suggest that when the depth of the limit order book on the same-side increases, unless the limit order is revised more aggressively, revision or cancellation (and resubmission) would cause these orders to lose their time priority. As a result, these existing limit orders will tend to have a lower probability of being revised or cancelled.

The coefficient estimates of *OSLIQUIDITY* show some differences in the results among the categories of submission, revision and execution, for both buy and sell limit orders. The coefficient estimates are generally positive and significant for spells that transit to an order revision. The effect, however, is stronger for buy limit orders than sell limit orders. This result is in line with the view that as the opposite-side liquidity increases, traders tend to revise their limit orders so that the orders can avoid being adversely executed in an unfavourable market. Traders can try to gain a better execution outcome by revising the limit order to a better price. Consequently, it results in a higher probability of transition into limit order revisions. Moreover, the significantly positive relationship between the opposite-side liquidity and the intensity of limit order cancellation is also worth noticed, especially for orders originating from submission or partial execution. This result is consistent with Ranaldo (2004) who finds evidence to indicate that there is a higher level of defensive trading activities when the opposite side book is thicker. When experiencing an adverse situation in the market, traders might choose to cancel their existing limit orders as a way to avoid unwanted executions.

Regarding the order characteristic measures, the *ORDSIZE* coefficient estimates are mostly positive and significant for both buy and sell limit orders, except in the category of orders originating from partial execution. This result indicates that the limit order with a larger size has a higher probability of being executed, revised or cancelled following its previous submission or revision. The limit order, however, has a lower chance to be transited to these three order events if it has been remained in the limit order book as a result from a partial execution. The coefficient estimate results observed for *ORDSIZE* confirm the intuition regarding opportunity costs of large orders. Larger size limit orders tend to be monitored more closely since the cost of non-execution is higher than that of smaller orders (see, for example, Fong and Liu 2010), and they are revised in response to changing market conditions in order to improve the chance of execution.

The coefficient estimates of the duration dependence variable, *PREVDUR*, are significantly negative across limit order events that are originated from both limit order revision and partial execution. This result suggests that the longer the limit order's previous duration, the lower the probability that the order will be transited to another state. In other

Table 4 Multiple-spell duration analysis of limit orders of large-cap stocks in the initial period (August 2000)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	−0.784***	−0.458***	−0.246**	0.111	−0.388***	−0.321***	−0.006	−0.589***	0.001	−0.019*	−0.141***	0.076*
	(0.035)	(0.034)	(0.118)	(0.153)	(0.045)	(0.041)	(0.096)	(0.136)	(0.012)	(0.010)	(0.030)	(0.046)
INITRADE	−0.355***	−0.250***	−0.120***	−0.168***	−0.342***	−0.178***	−0.095***	−0.090*	−0.187***	−0.138***	−0.113***	−0.213***
	(0.015)	(0.019)	(0.015)	(0.025)	(0.034)	(0.036)	(0.022)	(0.046)	(0.013)	(0.012)	(0.032)	(0.045)
SSLIQUIDITY	−0.814***	−0.510***	−0.573***	−0.708***	−0.637***	−0.522***	−0.417***	−0.182***	0.005	−0.029***	−0.320***	−0.039
	(0.015)	(0.015)	(0.024)	(0.054)	(0.033)	(0.034)	(0.033)	(0.052)	(0.012)	(0.010)	(0.026)	(0.041)
MKDPR	0.016	−0.061***	0.493***	0.265	−0.050	−0.073*	0.178**	0.427***	0.067***	0.057***	−0.028	0.023
	(0.038)	(0.018)	(0.119)	(0.175)	(0.047)	(0.037)	(0.076)	(0.132)	(0.013)	(0.012)	(0.032)	(0.041)
OSLIQUIDITY	−0.028*	−0.022	0.117***	0.113***	0.019	−0.043	0.039*	−0.099**	0.416***	0.287***	0.683***	0.710***
	(0.015)	(0.016)	(0.016)	(0.028)	(0.024)	(0.027)	(0.023)	(0.050)	(0.033)	(0.028)	(0.076)	(0.110)
ORDSIZE	0.208***	0.382***	0.386***	0.343***	0.268***	0.227***	0.178***	0.023	−0.087***	−0.103***	−0.196***	−0.174*
	(0.014)	(0.052)	(0.044)	(0.078)	(0.075)	(0.085)	(0.049)	(0.062)	(0.032)	(0.028)	(0.074)	(0.105)
PREVDUR					−0.006***	−0.008***	−0.009***	−0.008***	−0.005***	−0.006***	−0.008***	−0.014***
					(0.001)	(0.001)	(0.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	−0.960***	−0.042	−1.304***	−1.702***	0.008	0.254***	−1.010***	−1.742***	0.988***	0.598***	−0.270***	−0.497***
	(0.016)	(0.043)	(0.018)	(0.032)	(0.093)	(0.063)	(0.029)	(0.061)	(0.012)	(0.011)	(0.028)	(0.046)
UNOBHET	0.030*	−0.011	0.003	0.278***	−0.119***	−0.144***	−0.178***	0.013	−0.045***	−0.200***	0.050*	0.265***
	(0.016)	(0.020)	(0.018)	(0.025)	(0.036)	(0.037)	(0.031)	(0.055)	(0.012)	(0.012)	(0.027)	(0.037)
N	18,194	42,086	13,981	6513	9392	9058	5964	1504	29,183	36,082	6308	2821
LR chi2	6536.52	2406.19	679.98	223.28	1023.81	672.46	518.51	105.36	1774.90	1354.45	614.46	345.99
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.984***	−3.839***	−2.111***	−0.715***	−3.202***	−0.187***	−3.033***	−1.438*	0.003	−0.038***	−0.135***	0.013
	(0.035)	(0.263)	(0.098)	(0.072)	(0.301)	(0.040)	(0.283)	(0.821)	(0.012)	(0.011)	(0.030)	(0.046)
INITRADE	0.383***	0.278***	0.074***	0.140***	0.301***	0.125***	0.054**	0.141***	0.170***	0.176***	0.108***	0.126**
	(0.016)	(0.020)	(0.016)	(0.026)	(0.038)	(0.037)	(0.024)	(0.052)	(0.014)	(0.012)	(0.032)	(0.056)

Table 4 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.761***	−0.556***	−0.499***	−0.490***	−0.619***	−0.467***	−0.578***	−0.091***	0.086***	0.163***	−0.407***	−0.150***
	(0.014)	(0.016)	(0.021)	(0.033)	(0.035)	(0.036)	(0.042)	(0.019)	(0.013)	(0.011)	(0.029)	(0.046)
MKDPR	−0.233***	−0.013	−1.945***	−0.812***	0.068*	0.158***	−2.992***	−0.001***	−0.097***	−0.104***	−0.036	0.007
	(0.037)	(0.022)	(0.094)	(0.062)	(0.041)	(0.030)	(0.275)	(<.001)	(0.015)	(0.013)	(0.032)	(0.060)
OSLIQUIDITY	−0.009	0.034**	0.022	0.025	−0.002	−0.004	−0.105***	0.002	0.386***	0.279***	0.588***	0.938***
	(0.014)	(0.016)	(0.017)	(0.028)	(0.025)	(0.029)	(0.026)	(0.026)	(0.035)	(0.029)	(0.084)	(0.128)
ORDSIZE	0.238***	0.644***	0.425***	0.005	0.268***	0.218**	0.529***	−0.060	−0.094***	−0.048*	−0.089	−0.340***
	(0.014)	(0.052)	(0.038)	(0.036)	(0.080)	(0.087)	(0.068)	(0.040)	(0.033)	(0.028)	(0.080)	(0.123)
PREVDUR					−0.005***	−0.007***	−0.006***	−0.006***	−0.007***	−0.009***	−0.008***	−0.016***
					(0.001)	(0.001)	(<.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	−1.019***	−0.097**	−1.406***	−1.661***	0.160	0.064	−0.984***	−0.364	1.016***	0.732***	−0.233***	−0.389***
	(0.016)	(0.044)	(0.020)	(0.032)	(0.097)	(0.063)	(0.033)	(0.361)	(0.012)	(0.011)	(0.031)	(0.052)
UNOBHET	0.020	0.010	0.021	0.239***	−0.089**	−0.214***	−0.130***	0.073	−0.003	−0.119***	0.111***	0.315***
	(0.016)	(0.020)	(0.020)	(0.027)	(0.037)	(0.041)	(0.033)	(0.057)	(0.012)	(0.012)	(0.027)	(0.039)
N	17,615	42,008	12,494	5885	8404	8197	5057	1317	29,377	34,177	5839	2410
LR chi2	6594.99	2348.93	1442.73	494.34	1016.56	586.08	637.84	95.31	1880.10	2576.80	574.20	316.85
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

Table 5 Multiple-spell duration analysis of limit orders of small-cap stocks in the initial period (August 2000)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	−0.314***	−0.247***	−0.606***	−0.520***	−0.165*	−0.128	−2.183***	−1.424	0.116***	−0.105***	−0.113	−0.170
	(0.063)	(0.063)	(0.098)	(0.108)	(0.094)	(0.097)	(0.488)	(1.359)	(0.038)	(0.035)	(0.074)	(0.163)
INITRADE	−0.258***	−0.273***	−0.259***	−0.146***	−0.285***	−0.117	−0.139**	−0.286***	−0.218***	−0.101**	−0.175**	−0.156
	(0.037)	(0.045)	(0.037)	(0.040)	(0.090)	(0.090)	(0.064)	(0.107)	(0.043)	(0.045)	(0.089)	(0.209)
SSLIQUIDITY	−0.680***	−0.454***	−0.280***	−0.401***	−0.339***	−0.465***	−0.376***	−0.134	0.085**	−0.068*	−0.751***	−0.229
	(0.039)	(0.038)	(0.042)	(0.048)	(0.071)	(0.083)	(0.083)	(0.140)	(0.040)	(0.037)	(0.078)	(0.192)
MKDPR	−0.073	−0.015	0.786***	0.465***	−0.090	−0.114	2.510***	2.455*	0.074	0.022	−0.102	0.074
	(0.067)	(0.040)	(0.084)	(0.104)	(0.061)	(0.071)	(0.480)	(1.366)	(0.045)	(0.046)	(0.085)	(0.202)
OSLIQUIDITY	−0.008	0.003	0.043	0.029	−0.010	−0.024	−0.068	0.114	0.499***	0.102	1.133***	0.689**
	(0.041)	(0.048)	(0.043)	(0.052)	(0.074)	(0.072)	(0.071)	(0.135)	(0.098)	(0.086)	(0.209)	(0.317)
ORDSIZE	0.027	0.196	−0.484***	−0.128***	−0.137	0.583**	−0.167	−0.806***	−0.311***	0.098	−0.389**	−0.336
	(0.034)	(0.152)	(0.041)	(0.049)	(0.218)	(0.252)	(0.102)	(0.311)	(0.092)	(0.082)	(0.195)	(0.283)
PREVDUR					−0.005***	−0.005***	−0.005***	−0.002	−0.005***	−0.003***	−0.002	−0.007*
					(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)
CONST	−2.448***	−1.682***	−2.079***	−3.323***	−0.809**	−1.420***	−1.611***	−2.438***	−0.503***	−0.810***	−0.559***	−1.145***
	(0.040)	(0.130)	(0.043)	(0.056)	(0.343)	(0.189)	(0.093)	(0.159)	(0.040)	(0.041)	(0.080)	(0.193)
UNOBHET	−0.325***	−0.298***	−0.107**	−0.469***	−0.273**	−0.483***	−0.109	−0.445**	0.107***	−0.124***	0.389***	0.365***
	(0.052)	(0.060)	(0.047)	(0.085)	(0.118)	(0.116)	(0.092)	(0.199)	(0.034)	(0.041)	(0.056)	(0.136)
N	2783	6701	2464	1585	1743	1503	773	221	4062	3508	1159	256
LR chi2	685.62	292.34	368.88	174.77	100.49	96.08	95.87	26.27	199.01	105.30	161.56	20.30
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0050
Panel B: Limit sell orders												
PRICEGAP	−0.484***	−0.407***	−0.535	1.430***	−0.438***	−0.081	−0.412**	−0.432	0.066**	−0.051*	−0.133	0.372**
	(0.085)	(0.060)	(0.508)	(0.260)	(0.106)	(0.104)	(0.193)	(0.348)	(0.033)	(0.029)	(0.091)	(0.176)
INITRADE	0.278***	0.274***	0.059	0.051	0.404***	0.148	0.032	0.055	0.089***	0.134***	0.411***	−0.293
	(0.039)	(0.043)	(0.037)	(0.056)	(0.095)	(0.100)	(0.064)	(0.137)	(0.033)	(0.027)	(0.083)	(0.289)

Table 5 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.909***	−0.643***	−0.112***	−0.049***	−0.594***	−0.247**	−0.409***	−0.151	0.043	−0.028	−0.529***	−0.163
	(0.041)	(0.042)	(0.011)	(0.016)	(0.098)	(0.096)	(0.073)	(0.145)	(0.036)	(0.032)	(0.080)	(0.149)
MKDPR	−0.177**	−0.091***	−0.001***	−0.001***	−0.144*	0.201***	−0.185	−0.322	−0.112***	−0.107***	−0.159*	0.514*
	(0.086)	(0.032)	(<.001)	(<.001)	(0.085)	(0.077)	(0.186)	(0.314)	(0.030)	(0.025)	(0.090)	(0.290)
OSLIQUIDITY	−0.024	0.058	0.024	0.148***	−0.112	0.039	−0.201***	−0.278*	0.265***	0.138	0.861***	−0.054
	(0.044)	(0.046)	(0.019)	(0.027)	(0.088)	(0.084)	(0.075)	(0.157)	(0.095)	(0.087)	(0.249)	(0.453)
ORDSIZE	0.131***	−0.028	−0.012	−0.239***	0.366	−0.675***	0.143**	−0.019	0.012	0.030	−0.158	0.339
	(0.037)	(0.144)	(0.028)	(0.035)	(0.253)	(0.260)	(0.068)	(0.155)	(0.089)	(0.083)	(0.233)	(0.420)
PREVDUR					−0.004***	−0.005***	−0.003***	−0.001	−0.003***	−0.004***	−0.003**	−0.010***
					(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(<.001)	(0.002)	(0.003)
CONST	−2.402***	−1.183***	−1.931***	−1.818***	−1.328***	−0.882***	−2.184***	−2.952***	−0.522***	−0.764***	−0.748***	−1.502***
	(0.042)	(0.123)	(0.237)	(0.318)	(0.336)	(0.196)	(0.091)	(0.184)	(0.038)	(0.033)	(0.091)	(0.169)
UNOBHET	−0.198***	−0.113**	−0.233***	−0.097	−0.169	−0.151	−0.195**	−0.342	0.045	−0.172***	0.431***	0.359***
	(0.049)	(0.053)	(0.058)	(0.075)	(0.105)	(0.095)	(0.092)	(0.220)	(0.034)	(0.034)	(0.060)	(0.117)
N	2730	6828	2158	1068	1425	1493	787	188	4368	5025	1125	260
LR chi2	852.12	379.90	151.49	72.09	123.07	80.00	85.63	8.83	176.92	180.95	137.74	33.96
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2650	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

words, limit orders which spend more time in the previous spells tend to have a smaller chance of being executed, revised or cancelled. This result could be explained by the fact that if the revised or partially executed order stays in the limit order book for an extended period, traders are demotivated in taking further action on the order, which is somewhat in line with the job search literature.[8]

For completeness and robustness check, we also conduct separate multiple-spell duration analyses for two groups of large and small stocks. Panels A in Tables 4 and 5 present the estimation results for buy limit orders of large-cap and small-cap stocks, respectively. The majority of the results are consistent with the pooled sample and thus the coefficient estimates can also be interpreted in a similar way. Some exceptions, however, are found in the sample of large-cap stocks, in which the coefficient estimates of *OSLIQUIDITY* are insignificant (rather than negatively significant) for explaining the probability of transition from submission to partial execution and that from revision to partial execution. It is significantly positive (rather than insignificant) for probability of transition from submission to cancellation and that from revision to revision. In small-cap stocks, the coefficient estimates of *OSLIQUIDITY* are insignificant for all limit buy order events that followed a limit order submission and for most of the limit buy order events that followed a limit order revision. The difference is also observed for the coefficient estimates of *ORDSIZE* for most of the limit buy order events.

Panels B in Tables 4 and 5 report the estimation results for sell limit orders for large-cap and small-cap stocks, respectively. The results obtained in the sample of large-cap stocks are mostly consistent with the pooled sample and thus the coefficient estimates can be interpreted in a similar way. However, there are some differences in the sample of small-cap stocks, which are captured in the coefficient estimates of *OSLIQUIDITY* and *ORDSIZE*. Specifically, the coefficient estimates of *ORDSIZE* are insignificant for all limit sell order events that followed a limit order partial execution.

4.2 Multiple-spell survival analysis of dynamic limit order placement strategies following the two major structural changes of the ASX

In October 2006, ASX replaced SEATS by the ITS and in November 2010, the ITS was replaced by the ASX Trade. The structural changes have reduced the market latency significantly, providing an environment for high-frequency trading in the marketplace. The results of multiple-spell duration model for the sample of the ITS period (August 2007) are reported in Table 6: Panels A and B for buy and sell limit orders, respectively. The results for the sample of the ASX Trade period (August 2011) are presented in Table 9: Panels A and B for buy and sell limit orders, respectively.

The sign of the *PRICEGAP* coefficient estimates is perhaps one of the most noticeable differences in the results of the two periods following the major structural changes as compared to the initial period of year 2000. Specifically, most of the *PRICEGAP* estimates are positive and significant in both samples of the ITS and ASX Trade periods. This positive effect is especially more evident in the sample of buy limit orders. The *PRICEGAP* estimates are, however, mostly negative in the year 2000 period. This observation could be explained by a higher trading intensity which is a result of improvements in latency. The decision by the ASX to upgrade its trading platform to ITS in October 2006 significantly

[8] In labour economics, negative coefficient estimate for the lagged duration dependence variable suggests that workers start reducing their job search intensity if the subsidised job lasts too long. See Van Ours (2004) for further details.

Table 6 Multiple-spell duration analysis of limit orders of the pooled sample in the ITS period (August 2007)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	0.217***	0.215***	0.068***	0.125***	0.130***	0.207***	0.033***	0.005	0.024***	0.077***	0.081***	0.107***
	(0.004)	(0.008)	(0.004)	(0.005)	(0.007)	(0.022)	(0.003)	(0.012)	(0.007)	(0.008)	(0.014)	(0.025)
INITRADE	−0.145***	−0.112***	−0.030***	−0.083***	−0.060***	−0.057***	−0.015***	−0.004	−0.083***	−0.191***	−0.116***	−0.426***
	(0.004)	(0.007)	(0.004)	(0.004)	(0.005)	(0.012)	(0.002)	(0.011)	(0.008)	(0.010)	(0.014)	(0.021)
SSLIQUIDITY	−0.704***	−0.597***	−0.592***	−1.359***	−0.597***	−0.594***	−0.212***	−0.017	−0.356***	−0.583***	−0.209***	−0.743***
	(0.005)	(0.012)	(0.012)	(0.012)	(0.010)	(0.028)	(0.004)	(0.025)	(0.009)	(0.014)	(0.015)	(0.022)
MKDPR	−0.595***	−0.815***	1.070***	1.109***	−0.601***	−0.524***	0.076***	1.044***	−0.044***	−0.005	−0.004	0.020
	(0.009)	(0.019)	(0.016)	(0.025)	(0.012)	(0.019)	(0.005)	(0.028)	(0.008)	(0.009)	(0.013)	(0.018)
OSLIQUIDITY	0.075***	−0.065***	−0.051***	−0.231***	−0.061***	−0.109***	−0.125***	0.136***	0.043***	0.053***	0.047***	0.206***
	(0.004)	(0.009)	(0.004)	(0.005)	(0.005)	(0.013)	(0.003)	(0.012)	(0.007)	(0.010)	(0.014)	(0.021)
ORDSIZE	−0.010**	0.006	−0.591***	0.390***	0.116***	−0.074***	0.109***	−1.130***	0.128***	−0.106***	0.015	0.173***
	(0.004)	(0.010)	(0.011)	(0.012)	(0.007)	(0.024)	(0.004)	(0.027)	(0.008)	(0.010)	(0.014)	(0.020)
PREVDUR					−0.020***	−0.014***	−0.003***	−0.014***	−0.003***	−0.003***	−0.009***	−0.013***
					(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	0.626***	1.026***	0.215***	1.111***	1.137***	1.497***	0.806***	1.107***	2.328***	2.740***	0.596***	2.098***
	(0.004)	(0.009)	(0.004)	(0.005)	(0.007)	(0.017)	(0.003)	(0.014)	(0.008)	(0.010)	(0.016)	(0.023)
UNOBHET	0.251***	0.448***	0.051***	0.471***	−0.169***	0.096***	−0.159***	0.425***	0.279***	0.457***	−0.139***	0.635***
	(0.004)	(0.006)	(0.004)	(0.003)	(0.007)	(0.013)	(0.003)	(0.010)	(0.006)	(0.007)	(0.017)	(0.014)
N	291,270	85,549	224,667	286,279	153,126	46,208	466,683	39,069	97,340	97,059	17,503	14,558
LR chi2	43423.35	9028.06	10291.46	29485.27	17315.65	3800.16	8669.35	6944.02	2252.99	4102.47	486.97	1818.44
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.109***	−0.233***	0.033**	0.250***	−0.136***	−0.185***	−0.028	0.078***	−0.073***	0.029	−0.041	−0.158***
	(0.011)	(0.030)	(0.016)	(0.006)	(0.012)	(0.045)	(0.017)	(0.010)	(0.019)	(0.021)	(0.037)	(0.048)
INITRADE	0.063***	0.017***	−0.002	−0.056***	−0.017***	−0.012	−0.038***	−0.049***	0.063***	0.114***	0.133***	0.287***
	(0.004)	(0.006)	(0.004)	(0.004)	(0.005)	(0.010)	(0.002)	(0.011)	(0.007)	(0.005)	(0.014)	(0.019)

Table 6 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.758***	−0.819***	−3.045***	−0.522***	−0.603***	−0.700***	0.007	−0.006***	−0.243***	−0.461***	−0.273***	−0.672***
	(0.005)	(0.010)	(0.039)	(0.001)	(0.009)	(0.020)	(0.018)	(0.001)	(0.008)	(0.010)	(0.013)	(0.018)
MKDPR	1.009***	0.734***	−2.962***	−0.097***	0.527***	0.490***	−0.051***	−0.052***	0.050***	−0.001	−0.014	0.024
	(0.013)	(0.013)	(0.038)	(0.001)	(0.008)	(0.016)	(0.014)	(0.009)	(0.007)	(0.004)	(0.014)	(0.019)
OSLIQUIDITY	0.040***	−0.087***	−0.132***	−0.197***	−0.038***	−0.117***	−0.150***	−0.019***	0.043***	0.058***	0.070***	0.260***
	(0.004)	(0.008)	(0.005)	(0.002)	(0.006)	(0.011)	(0.003)	(0.005)	(0.007)	(0.007)	(0.013)	(0.018)
ORDSIZE	0.135***	0.249***	−0.077***	−0.023***	0.169***	0.182***	−0.039***	−0.005***	0.096***	−0.024	0.060	0.246***
	(0.011)	(0.031)	(0.015)	(0.001)	(0.013)	(0.049)	(0.015)	(0.001)	(0.019)	(0.021)	(0.038)	(0.050)
PREVDUR					−0.015***	−0.012***	−0.003***	−0.018***	−0.004***	−0.004***	−0.008***	−0.015***
					(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	0.680***	1.009***	0.480***	2.970***	1.064***	1.452***	0.889***	1.668***	2.351***	2.500***	0.865***	2.235***
	(0.004)	(0.007)	(0.005)	(0.015)	(0.007)	(0.014)	(0.003)	(0.033)	(0.007)	(0.007)	(0.015)	(0.019)
UNOBHET	0.039***	0.328***	0.157***	0.461***	−0.283***	−0.003	−0.112***	0.428***	0.155***	0.266***	0.003	0.603***
	(0.004)	(0.006)	(0.004)	(0.003)	(0.007)	(0.012)	(0.003)	(0.009)	(0.006)	(0.005)	(0.014)	(0.012)
N	255,917	106,295	215,325	287,422	135,499	54,116	458,100	44,387	118,080	161,964	21,664	18,917
LR chi2	44282.50	14557.27	10036.74	16674.98	18186.92	5074.43	6854.43	5646.98	1954.04	4775.57	779.74	2021.56
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 40. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

reduced the latency from 85 to 30 ms and created a low-latency environment with a higher level of intensive trading activities. Meanwhile, the ASX Trade, ASX's new platform for equities and derivatives trading which was launched in November 2010, has improved the exchange's latency from 30 to 300 ms. Furthermore, capacity has been upgraded to 100,000 orders per second from 20,000 orders per second before. ASX Trade is claimed to be among the fastest in the world (The Trade nd).

A higher value of *PRICEGAP* indicates the initial position of a limit order as being more defensive (a lower limit price for a buy order and a higher limit price for a sell order). A positive relationship with the hazard rates, especially for spells that transit to revision and cancellation events, seems to indicate active trading and monitoring activities in these periods. Whenever the order placement starts from a defensive position, there is a higher probability that the limit order will be revised or cancelled.

The market environment with improved technology is characterised by a significant amount of trading that has been carried out by machines (also known as algorithmic trading) to reduce the labour effort devoted to monitoring activities. With virtually unlimited information processing capacity, machines have the advantage of responding more quickly to the arrival of information, working out an optimal solution quicker based on a number of input parameters. With better access to markets and information via electronic connections, algorithmic trading has led to a significant reduction in monitoring cost. This also helps reduce the submission risks for limit orders. However, high-frequency trading (HFT) could cause the stock market to become significantly volatile at times where new opportunities for defensive traders are presented, or their opportunity costs are reduced, or their positions are adversely affected. Consequently, traders respond to these market conditions by intensifying their revision and cancellation activities.

Due to the fundamental volatility of many types of financial securities and their rapidly changing prices in the market, it is important for traders to improve their speed of trading. The ability to trade faster than other traders can create potential profit opportunities by enabling a prompt response to the arriving news of the market. This observation creates an arms race in which traders utilise technology innovations and position their trading computers closer to the exchange location with an effort to gain a quicker access to the market. As a result, it can be observed in the financial markets today that there are intensive trading activities in the low-latency market environment.

The coefficient estimates of *PREVDUR*, the duration dependence variable, show consistent results with the earlier period. Specifically, they are significantly negative across limit order events that are originated from both revisions and partial executions. Negative duration dependence is a common finding in many studies on survival analysis with multiple-spell duration (see, for example, Booth et al. 2002; De Graaf-Zijl et al. 2011; Esteve-Perez et al. 2013). Even after the structural changes, the limit order spells experience a similar pattern where the probability of completing a spell is lower if the limit order's previous duration is longer.

Our results support the view in Fong and Liu (2010) that non-execution cost is a major source of risk in limit order placements. Whenever it is uneasy to buy or sell in the market place (for instance, in an illiquid market), traders are likely to adjust their orders faster to make sure that their orders can be filled. Alternatively, traders can cancel the orders to reduce opportunity costs. This result is also in harmony with Biais et al. (1995), Ahn et al. (2001) and Fong and Liu (2010) that traders' order placement strategies tend to vary with market conditions. Specifically, when the spreads are wide, there would be more limit orders. Meanwhile, when the spreads are narrow, there would be more market orders.

Table 7 Multiple-spell duration analysis of limit orders of large-cap stocks in the ITS period (August 2007)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	0.226***	0.197***	0.067***	0.135***	0.136***	0.200***	0.029***	0.013	0.026***	0.082***	0.072***	0.130***
	(0.004)	(0.009)	(0.005)	(0.006)	(0.007)	(0.023)	(0.003)	(0.013)	(0.007)	(0.009)	(0.015)	(0.028)
INITRADE	−0.150***	−0.102***	−0.032***	−0.090***	−0.043***	−0.050***	−0.008***	−0.012	−0.063***	−0.135***	−0.108***	−0.416***
	(0.004)	(0.008)	(0.004)	(0.005)	(0.005)	(0.012)	(0.003)	(0.012)	(0.009)	(0.011)	(0.014)	(0.023)
SSLIQUIDITY	−0.654***	−0.435***	−0.557***	−1.456***	−0.505***	−0.458***	−0.169***	−0.063**	−0.279***	−0.495***	−0.130***	−0.734***
	(0.005)	(0.012)	(0.013)	(0.016)	(0.010)	(0.028)	(0.005)	(0.030)	(0.010)	(0.016)	(0.015)	(0.024)
MKDPR	−0.696***	−0.972***	1.069***	1.126***	−0.749***	−0.598***	0.066***	1.039***	−0.078***	−0.049***	−0.021	0.019
	(0.010)	(0.021)	(0.020)	(0.026)	(0.014)	(0.021)	(0.005)	(0.033)	(0.008)	(0.010)	(0.013)	(0.021)
OSLIQUIDITY	0.160***	0.035***	0.054***	−0.058***	−0.012**	−0.049***	−0.030***	0.237***	0.125***	0.052***	0.065***	0.199***
	(0.004)	(0.009)	(0.004)	(0.005)	(0.005)	(0.013)	(0.003)	(0.014)	(0.007)	(0.011)	(0.014)	(0.022)
ORDSIZE	0.026***	−0.018*	−0.613***	0.480***	0.144***	−0.069***	0.082***	−1.071***	0.163***	−0.029***	0.017	0.084***
	(0.004)	(0.011)	(0.013)	(0.015)	(0.007)	(0.023)	(0.005)	(0.032)	(0.009)	(0.011)	(0.014)	(0.022)
PREVDUR					−0.018***	−0.014***	−0.003***	−0.015***	−0.002***	−0.001***	−0.008***	−0.008***
					(<.001)	(0.001)	(<.001)	(<.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	0.775***	1.190***	0.334***	1.415***	1.162***	1.529***	0.848***	1.254***	2.359***	2.739***	0.620***	2.029***
	(0.005)	(0.009)	(0.005)	(0.006)	(0.007)	(0.018)	(0.003)	(0.016)	(0.009)	(0.011)	(0.016)	(0.025)
UNOBHET	0.236***	0.373***	0.021***	0.534***	−0.301***	−0.028*	−0.255***	0.421***	0.141***	0.317***	−0.265***	0.551***
	(0.004)	(0.007)	(0.005)	(0.004)	(0.008)	(0.015)	(0.004)	(0.011)	(0.007)	(0.008)	(0.019)	(0.016)
N	243,704	69,089	187,593	199,803	129,114	39,084	388,466	31,391	80,261	75,217	15,059	11,200
LR chi2	35087.53	6470.96	6921.95	13647.27	15164.23	3123.40	4380.89	5862.14	1668.63	1971.05	267.59	1451.24
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.110***	−0.182***	0.023	0.151***	−0.135***	−0.163***	−0.029*	0.064***	−0.073***	0.004	−0.035	−0.144***
	(0.012)	(0.033)	(0.018)	(0.006)	(0.013)	(0.048)	(0.018)	(0.010)	(0.020)	(0.023)	(0.039)	(0.054)
INITRADE	0.067***	0.016**	0.007	−0.055***	−0.051***	−0.028***	−0.034***	−0.039***	0.065***	0.144***	0.137***	0.258***
	(0.004)	(0.007)	(0.004)	(0.005)	(0.005)	(0.011)	(0.003)	(0.012)	(0.007)	(0.006)	(0.014)	(0.022)

Table 7 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.681***	−0.621***	−0.934***	−0.017***	−0.477***	−0.505***	0.020*	−0.006***	−0.146***	−0.279***	−0.202***	−0.665***
	(0.005)	(0.011)	(0.044)	(0.001)	(0.009)	(0.020)	(0.011)	(0.001)	(0.008)	(0.010)	(0.013)	(0.019)
MKDPR	0.200***	0.875***	−0.860***	−0.381***	0.639***	0.588***	−0.027***	−0.001***	0.079***	0.001	0.004	0.040
	(0.015)	(0.015)	(0.044)	(0.042)	(0.008)	(0.017)	(0.008)	(<.001)	(0.009)	(0.004)	(0.015)	(0.025)
OSLIQUIDITY	0.101***	0.003	−0.041***	−0.123***	−0.004	−0.056***	−0.070***	0.019***	0.123***	0.121***	0.093***	0.245***
	(0.005)	(0.008)	(0.005)	(0.002)	(0.006)	(0.011)	(0.003)	(0.005)	(0.007)	(0.007)	(0.014)	(0.020)
ORDSIZE	0.149***	0.216***	−0.052***	−0.013***	0.176***	0.170***	−0.021	−0.004***	0.117***	0.012	0.057	0.237***
	(0.012)	(0.033)	(0.016)	(0.001)	(0.014)	(0.051)	(0.016)	(0.001)	(0.020)	(0.022)	(0.040)	(0.056)
PREVDUR					−0.013***	−0.012***	−0.004***	−0.018***	−0.002***	−0.003***	−0.009***	−0.014***
					(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	0.826***	1.193***	0.597***	2.601***	1.077***	1.482***	0.934***	1.438***	2.397***	2.570***	0.896***	2.214***
	(0.005)	(0.008)	(0.005)	(0.018)	(0.007)	(0.014)	(0.003)	(0.036)	(0.007)	(0.007)	(0.015)	(0.021)
UNOBHET	−0.008*	0.255***	0.129***	0.539***	−0.428***	−0.136***	−0.198***	0.393***	0.033***	0.133***	−0.119***	0.539***
	(0.005)	(0.007)	(0.005)	(0.004)	(0.009)	(0.013)	(0.004)	(0.010)	(0.007)	(0.006)	(0.016)	(0.014)
N	214,696	87,450	179,668	197,340	115,021	45,665	384,485	35,086	98,636	124,864	18,561	14,697
LR chi2	34529.46	9963.10	5493.75	4309.62	16443.84	3934.67	4241.33	4770.20	1178.77	1707.30	526.74	1638.98
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

Table 8 Multiple-spell duration analysis of limit orders of small-cap stocks in the ITS period (August 2007)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	0.155***	0.240***	0.073***	0.125***	0.111***	0.124***	0.081***	0.039*	0.049***	0.192***	0.108***	0.026
	(0.009)	(0.017)	(0.010)	(0.007)	(0.013)	(0.029)	(0.007)	(0.022)	(0.018)	(0.020)	(0.041)	(0.039)
INITRADE	−0.011	−0.038**	0.029***	−0.018***	0.002	0.059*	−0.024***	0.046*	−0.192***	−0.322***	−0.139***	−0.447***
	(0.009)	(0.017)	(0.009)	(0.007)	(0.014)	(0.032)	(0.007)	(0.024)	(0.025)	(0.027)	(0.043)	(0.052)
SSLIQUIDITY	−0.829***	−0.916***	−0.300***	−0.578***	−0.977***	−1.022***	−0.297***	−0.020	−0.655***	−0.995***	−0.756***	−0.712***
	(0.011)	(0.028)	(0.012)	(0.009)	(0.033)	(0.095)	(0.008)	(0.030)	(0.027)	(0.032)	(0.049)	(0.054)
MKDPR	−0.544***	−0.640***	0.081***	0.076***	−0.368***	−0.489***	0.014**	0.102**	−0.058**	−0.012	0.013	0.026
	(0.013)	(0.023)	(0.009)	(0.016)	(0.014)	(0.028)	(0.007)	(0.043)	(0.024)	(0.024)	(0.040)	(0.049)
OSLIQUIDITY	−0.067***	−0.025	−0.237***	−0.350***	−0.092***	−0.165***	−0.446***	−0.028	0.091***	0.233***	0.305***	0.148***
	(0.010)	(0.021)	(0.011)	(0.009)	(0.015)	(0.037)	(0.008)	(0.028)	(0.021)	(0.021)	(0.047)	(0.050)
ORDSIZE	0.205***	0.091***	−0.106***	0.097***	0.260***	0.135*	0.218***	−0.823***	0.116***	−0.351***	0.083*	0.497***
	(0.010)	(0.023)	(0.010)	(0.009)	(0.022)	(0.078)	(0.008)	(0.029)	(0.024)	(0.023)	(0.044)	(0.048)
PREVDUR					−0.013***	−0.007***	−0.001***	−0.007***	−0.003***	−0.003***	−0.002*	−0.016***
					(0.001)	(0.001)	(<.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.002)
CONST	−0.427***	−0.185***	−0.541***	0.394***	0.419***	0.650***	0.502***	0.316***	1.643***	2.328***	0.183***	2.293***
	(0.010)	(0.021)	(0.011)	(0.008)	(0.024)	(0.058)	(0.009)	(0.033)	(0.024)	(0.024)	(0.053)	(0.052)
UNOBHET	−0.043***	0.308***	−0.031***	0.263***	−0.140***	0.136***	0.069***	0.297***	0.447***	0.601***	0.217***	0.853***
	(0.010)	(0.016)	(0.012)	(0.007)	(0.018)	(0.034)	(0.008)	(0.024)	(0.016)	(0.014)	(0.043)	(0.027)
N	47,566	16,460	37,074	86,476	2,401,218,331	71,244,169	78,217	7678	1,707,915,782	2,184,219,101	2444	3358
LR chi2	10288.66	3224.02	2977.78	13634.67	2751.97	671.18	8654.35	1483.50	1002.82	2644.85	285.08	422.65
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.510***	−0.757***	−0.089***	−0.575***	−0.329***	−0.956***	−0.309***	2.483***	−0.071**	0.380***	0.002	−0.515***
	(0.025)	(0.065)	(0.034)	(0.045)	(0.032)	(0.112)	(0.019)	(0.163)	(0.030)	(0.030)	(0.057)	(0.113)
INITRADE	−0.037***	−0.096***	−0.079***	−0.062***	0.011	−0.030	−0.038***	−0.089***	0.125***	0.164***	0.102**	0.387***
	(0.009)	(0.015)	(0.010)	(0.007)	(0.015)	(0.029)	(0.007)	(0.024)	(0.020)	(0.016)	(0.042)	(0.041)

Table 8 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−0.936***	−1.169***	−0.836***	−0.249***	−1.248***	−1.686***	−0.360***	−0.086***	−0.531***	−0.648***	−0.662***	−0.665***
	(0.011)	(0.023)	(0.023)	(0.004)	(0.032)	(0.081)	(0.009)	(0.014)	(0.025)	(0.022)	(0.045)	(0.046)
MKDPR	0.425***	0.578***	−0.699***	−0.357***	0.307***	0.347***	−0.258***	0.239*	0.039**	−0.024*	−0.039	0.016
	(0.015)	(0.019)	(0.024)	(0.176)	(0.016)	(0.025)	(0.010)	(0.138)	(0.017)	(0.014)	(0.040)	(0.032)
OSLIQUIDITY	0.035***	0.028	−0.299***	−0.149***	0.047***	−0.065**	−0.282***	−0.087***	0.092***	0.095***	0.236***	0.249***
	(0.010)	(0.019)	(0.012)	(0.004)	(0.016)	(0.032)	(0.009)	(0.013)	(0.019)	(0.015)	(0.044)	(0.044)
ORDSIZE	0.592***	0.841***	−0.027	0.038***	0.475***	1.124***	0.297***	−0.201***	0.141***	−0.414***	0.131**	0.590***
	(0.024)	(0.068)	(0.027)	(0.004)	(0.033)	(0.121)	(0.018)	(0.011)	(0.032)	(0.028)	(0.057)	(0.113)
PREVDUR					−0.012***	−0.006***	−0.002***	−0.012***	−0.002***	−0.001***	−0.001	−0.016***
					(0.001)	(0.001)	(<.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.003)
CONST	−0.386***	−0.312***	−0.278***	3.425***	0.498***	0.717***	0.541***	3.691***	1.623***	1.866***	0.442***	2.306***
	(0.010)	(0.018)	(0.012)	(0.031)	(0.023)	(0.047)	(0.010)	(0.114)	(0.022)	(0.017)	(0.050)	(0.046)
UNOBHET	−0.189***	0.158***	0.081***	0.187***	−0.230***	0.038	0.081***	0.486***	0.305***	0.423***	0.367***	0.792***
	(0.012)	(0.016)	(0.011)	(0.007)	(0.020)	(0.032)	(0.008)	(0.020)	(0.016)	(0.011)	(0.035)	(0.024)
N	41,221	18,845	35,657	90,082	20,478	8451	73,615	9301	19,444	37,100	3103	4220
LR chi2	10134.85	5013.88	4438.61	13818.75	2859.07	1041.54	6525.29	1523.20	744.25	2154.77	242.00	417.75
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

Table 9 Multiple-spell duration analysis of limit orders of the pooled sample in the ASX trade period (August 2011)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	−0.030***	0.214***	0.100***	0.025***	0.252***	0.222***	0.079***	0.001	0.020	0.132***	0.113***	0.090***
	(0.010)	(0.007)	(0.003)	(0.002)	(0.015)	(0.013)	(0.002)	(0.005)	(0.023)	(0.015)	(0.030)	(0.022)
INITRADE	0.130***	0.012*	−0.066***	−0.054***	−0.028**	0.059***	−0.058***	−0.128***	0.082***	−0.161***	−0.364***	−0.212***
	(0.010)	(0.007)	(0.003)	(0.002)	(0.012)	(0.011)	(0.003)	(0.005)	(0.029)	(0.022)	(0.024)	(0.026)
SSLIQUIDITY	0.248***	−1.390***	−0.516***	−0.238***	−2.916***	−1.503***	−0.525***	−0.044***	−0.328***	−0.888***	−1.157***	−0.866***
	(0.014)	(0.008)	(0.004)	(0.002)	(0.024)	(0.020)	(0.003)	(0.007)	(0.044)	(0.026)	(0.047)	(0.032)
MKDPR	−0.604***	−0.806***	0.005	0.161***	−0.578***	−0.695***	−0.157***	−0.139***	−0.557***	−0.340***	−0.107***	−0.150***
	(0.019)	(0.013)	(0.008)	(0.003)	(0.015)	(0.016)	(0.005)	(0.006)	(0.026)	(0.030)	(0.040)	(0.023)
OSLIQUIDITY	−0.022**	0.036***	−0.378***	−0.311***	0.338***	−0.047***	−0.446***	−0.304***	−0.017	0.025	−0.064***	−0.222***
	(0.011)	(0.007)	(0.004)	(0.002)	(0.014)	(0.012)	(0.003)	(0.006)	(0.027)	(0.017)	(0.023)	(0.024)
ORDSIZE	0.414***	0.730***	0.448***	−0.140***	0.783***	0.991***	0.725***	0.312***	0.187***	−0.038**	1.488***	1.329***
	(0.012)	(0.008)	(0.004)	(0.002)	(0.017)	(0.013)	(0.003)	(0.007)	(0.034)	(0.018)	(0.066)	(0.035)
PREVDUR					−0.026***	−0.021***	−0.016***	−0.035***	−0.016***	−0.004***	0.007***	−0.022***
					(0.001)	(0.001)	(<.001)	(<.001)	(0.001)	(0.001)	(0.002)	(0.002)
CONST	8.024***	3.316***	2.316***	1.762***	5.889***	3.549***	5.002***	3.571***	9.230***	6.914***	6.595***	6.914***
	(0.012)	(0.009)	(0.004)	(0.002)	(0.022)	(0.017)	(0.004)	(0.007)	(0.029)	(0.020)	(0.027)	(0.025)
UNOBHET	0.133***	0.522***	0.439***	0.347***	0.712***	0.468***	0.988***	0.705***	1.216***	1.247***	1.386***	1.488***
	(0.010)	(0.006)	(0.003)	(0.002)	(0.008)	(0.010)	(0.002)	(0.004)	(0.011)	(0.007)	(0.009)	(0.008)
N	30,943	103,174	510,101	1,366,473	80,893	60,112	1,415,126	257,857	21,695	65,772	23,710	25,291
LR chi2	3156.05	41019.36	54393.55	71488.74	22172.61	14094.72	165089.76	10263.66	877.12	2444.84	1080.98	2036.85
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	0.080***	−0.025***	−0.563***	0.413***	−0.239***	−0.089***	−1.726***	−0.196***	−0.018	−0.601***	−0.604***	−0.921***
	(0.017)	(0.007)	(0.014)	(0.009)	(0.034)	(0.009)	(0.014)	(0.009)	(0.019)	(0.025)	(0.062)	(0.071)
INITRADE	0.058***	0.044***	0.027***	0.015***	−0.028***	0.019***	0.006**	0.043***	0.337***	0.871***	0.404***	0.247***
	(0.006)	(0.003)	(0.003)	(0.002)	(0.011)	(0.005)	(0.003)	(0.005)	(0.009)	(0.015)	(0.022)	(0.024)

Table 9 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−1.982***	−1.289***	−2.350***	−0.730***	−1.491***	−0.977***	−0.292***	−0.090***	−1.230***	−0.421***	−0.556***	−0.612***
	(0.006)	(0.005)	(0.022)	(0.005)	(0.013)	(0.007)	(0.005)	(0.006)	(0.012)	(0.006)	(0.025)	(0.029)
MKDPR	2.030***	1.203***	−2.466***	−0.437***	2.791***	1.874***	−0.560***	−0.819***	0.003	0.004	0.023*	0.092***
	(0.057)	(0.022)	(0.022)	(0.006)	(0.107)	(0.055)	(0.010)	(0.025)	(0.015)	(0.007)	(0.013)	(0.017)
OSLIQUIDITY	0.080***	−0.007	−0.398***	−0.289***	0.330***	−0.033***	−0.114***	−0.273***	0.009	0.211***	−0.138***	−0.066***
	(0.006)	(0.004)	(0.003)	(0.002)	(0.011)	(0.006)	(0.003)	(0.006)	(0.010)	(0.006)	(0.022)	(0.023)
ORDSIZE	−0.034**	0.042***	0.398***	−0.414***	0.378***	0.107***	1.909***	0.184***	0.010	0.086***	0.680***	1.178***
	(0.017)	(0.008)	(0.010)	(0.008)	(0.035)	(0.009)	(0.015)	(0.010)	(0.018)	(0.003)	(0.068)	(0.094)
PREVDUR					−0.013***	−0.023***	−0.014***	−0.034***	−0.001***	−0.006***	0.007***	−0.021***
					(0.001)	(0.001)	(<.001)	(<.001)	(<.001)	(0.001)	(0.002)	(0.002)
CONST	3.861***	1.539***	2.239***	1.892***	3.885***	1.948***	5.257***	3.426***	5.763***	6.877***	6.540***	7.097***
	(0.008)	(0.004)	(0.004)	(0.003)	(0.014)	(0.006)	(0.004)	(0.006)	(0.011)	(0.052)	(0.026)	(0.024)
UNOBHET	0.747***	0.166***	0.361***	0.423***	0.716***	−0.063***	1.059***	0.640***	1.189***	1.329***	1.380***	1.500***
	(0.004)	(0.004)	(0.003)	(0.002)	(0.007)	(0.006)	(0.001)	(0.004)	(0.004)	(0.005)	(0.009)	(0.008)
N	162,180	309,581	543,063	1,283,983	66,053	164,818	1,605,498	277,179	152,958	105,423	27,807	26,944
LR chi2	85254.02	116715.83	45571.34	69717.42	16151.37	30346.51	63296.07	11559.95	19219.88	5709.63	865.87	1001.16
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 40. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

For completeness and robustness check, survival analyses with multiple-spell duration model are also conducted for the two samples of large-cap and small-cap stocks in both periods following ASX's structural changes. For the ITS period (the August 2007 sample), Panels A in Tables 7 and 8 present the estimation results for buy limit orders. The results obtained in the samples of both large-cap and small-cap stocks are generally consistent with the pooled sample. There are only a few exceptional cases in the sample of small-cap stocks, which are captured in the coefficient estimates of *INITRADE*, *OSLIQUIDITY* and *ORDSIZE*. Panels B in Tables 7 and 8 report the estimation results for sell limit orders for large-cap and small-cap stocks, respectively. Overall, the results obtained in both samples of large-cap and small-cap stocks are mostly consistent with the pooled sample (Table 9).

Similarly, for the ASX Trade period (the August 2011 sample), Panels A in Tables 10 and 11 present the estimation results for buy limit orders for large-cap and small-cap stocks, respectively. The results obtained in the sample of large-cap stocks are mostly consistent with the pooled sample and the coefficient estimates can thus be interpreted in a similar way. On the other hand, there are some minor differences observed in the sample of small-cap stocks, which are captured in the coefficient estimates of *INITRADE* and *OSLIQUIDITY*. Panels B in Tables 10 and 11 report the estimation results for sell limit orders for large-cap and small-cap stocks, respectively. The majority of the results in the sample of large-cap stocks are, again, similar with those obtained from the pooled sample. The only exception is in the coefficient estimates of *INITRADE* for most of the limit buy order events that follow a limit order revision. On the contrary, there are some further differences in the sample of small-cap stocks as compared with the pooled sample, which are captured in the coefficient estimates of *INITRADE*, and *OSLIQUIDITY*.

5 Conclusion

Limit order revision and cancellation activities play a critical role in forming dynamic order placement strategies. However, the existing literature only employs single duration models which mainly concern with the time-to-execution and thus could not take into account all limit order events and the factors that determine the occurrence of these events. This is because order placement strategies are constructed from a series of multiple order events rather than from single, independent events. This study is probably the first of its type to examine the full spectrum of order events that occur in a life of an order by using a multiple-spell duration model to investigate dynamic limit order placement strategies.

Our empirical results indicate that a number of factors determine the hazard rates of limit order event transitions. These factors include limit order size, limit price, market liquidity, previous duration of the limit order spell, as well as other unobserved factors. For example, the probability of a limit order being revised or cancelled is higher when there is a higher level of opposite-side liquidity. Importantly, the impact of these factors depends on whether the initial limit order event is a limit order submission, partial execution or revision.

The study also examines the dynamic limit order placement strategies following the two major structural changes in the ASX (namely, the adoption of the ITS in 2016 and the ASX Trade in 2010). The results indicate that the improvement in latency has shown to definitely increase the responsiveness of dynamic order placement strategies across most types of limit order transitions. Hence the value of modelling limit order events as they are would produce more accurate results in the lower latency environment.

Table 10 Multiple-spell duration analysis of limit orders of large-cap stocks in the ASX trade period (August 2011)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	−0.038***	0.220***	0.098***	0.025***	0.281***	0.226***	0.090***	0.009*	−0.007	0.138***	0.095***	0.100***
	(0.012)	(0.008)	(0.003)	(0.002)	(0.018)	(0.014)	(0.003)	(0.005)	(0.026)	(0.017)	(0.033)	(0.024)
INITRADE	0.178***	0.022***	−0.071***	−0.049***	−0.001	0.070***	−0.020***	−0.133***	0.079**	−0.068***	−0.346***	−0.214***
	(0.012)	(0.008)	(0.003)	(0.002)	(0.013)	(0.012)	(0.003)	(0.005)	(0.032)	(0.023)	(0.026)	(0.028)
SSLIQUIDITY	0.403***	−1.239***	−0.462***	−0.147***	−2.618***	−1.238***	−0.530***	−0.109***	−0.125**	−0.748***	−0.965***	−0.841***
	(0.016)	(0.009)	(0.005)	(0.003)	(0.025)	(0.020)	(0.003)	(0.007)	(0.050)	(0.028)	(0.052)	(0.035)
MKDPR	−0.705***	−0.903***	−0.036***	0.254***	−0.718***	−0.794***	−0.156***	−0.208***	−0.572***	−0.500***	−0.114**	−0.150***
	(0.021)	(0.014)	(0.004)	(0.005)	(0.018)	(0.017)	(0.005)	(0.006)	(0.029)	(0.035)	(0.046)	(0.024)
OSLIQUIDITY	−0.080***	0.062***	−0.268***	−0.195***	0.369***	−0.061***	−0.403***	−0.220***	0.029	0.071***	−0.161***	−0.295***
	(0.012)	(0.008)	(0.004)	(0.002)	(0.015)	(0.012)	(0.003)	(0.006)	(0.029)	(0.018)	(0.024)	(0.026)
ORDSIZE	0.377***	0.663***	0.498***	−0.327***	0.749***	0.869***	0.707***	0.487***	0.052	−0.089***	1.314***	1.253***
	(0.015)	(0.008)	(0.004)	(0.003)	(0.018)	(0.013)	(0.003)	(0.007)	(0.039)	(0.020)	(0.076)	(0.041)
PREVDUR					−0.024***	−0.020***	−0.017***	−0.035***	−0.013***	−0.002***	0.011***	−0.036***
					(0.001)	(0.001)	(<.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.004)
CONST	8.038***	3.321***	2.584***	2.164***	5.671***	3.399***	5.195***	3.670***	9.185***	6.928***	6.636***	6.997***
	(0.013)	(0.009)	(0.004)	(0.003)	(0.023)	(0.017)	(0.004)	(0.007)	(0.032)	(0.022)	(0.029)	(0.027)
UNOBHET	0.200***	0.405***	0.413***	0.362***	0.653***	0.283***	0.983***	0.648***	1.175***	1.180***	1.353***	1.459***
	(0.011)	(0.007)	(0.003)	(0.002)	(0.010)	(0.012)	(0.002)	(0.004)	(0.012)	(0.008)	(0.010)	(0.009)
N	24,320	87,012	430,582	973,247	58,802	49,099	1,255,950	228,659	16,894	50,560	20,197	20,488
LR chi2	3090.56	33253.39	34631.46	37666.66	16978.18	11743.00	135861.15	10121.31	619.48	1615.74	736.99	1560.39
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	0.155***	−0.018**	−0.613***	0.598***	−0.159***	−0.089***	−0.912***	−0.255***	0.054**	−0.650***	−0.527***	−0.702***
	(0.020)	(0.008)	(0.015)	(0.012)	(0.033)	(0.010)	(0.011)	(0.010)	(0.024)	(0.033)	(0.053)	(0.062)
INITRADE	0.065***	0.022***	0.003	0.012***	−0.027**	−0.011**	−0.058***	0.013***	0.321***	0.657***	0.399***	0.206***
	(0.007)	(0.004)	(0.003)	(0.002)	(0.011)	(0.005)	(0.003)	(0.005)	(0.009)	(0.013)	(0.024)	(0.025)

Table 10 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−1.761***	−1.122***	−2.160***	−0.585***	−1.405***	−0.813***	−0.560***	−0.031***	−1.187***	−1.002***	−0.467***	−0.563***
	(0.007)	(0.005)	(0.025)	(0.007)	(0.014)	(0.007)	(0.005)	(0.006)	(0.013)	(0.017)	(0.026)	(0.031)
MKDPR	2.227***	1.681***	−2.323***	−0.311***	3.078***	2.739***	−0.985***	−0.119***	0.005	0.003	0.027*	0.100***
	(0.064)	(0.026)	(0.025)	(0.007)	(0.119)	(0.063)	(0.011)	(0.020)	(0.017)	(0.006)	(0.014)	(0.018)
OSLIQUIDITY	0.102***	0.053***	−0.294***	−0.215***	0.330***	−0.022***	−0.340***	−0.217***	0.033***	0.398***	−0.260***	−0.115***
	(0.007)	(0.004)	(0.003)	(0.003)	(0.012)	(0.006)	(0.003)	(0.006)	(0.012)	(0.014)	(0.023)	(0.025)
ORDSIZE	−0.114***	0.041***	0.441***	−0.589***	0.291***	0.100***	0.962***	0.265***	−0.069***	0.885***	0.539***	0.814***
	(0.020)	(0.008)	(0.011)	(0.010)	(0.035)	(0.010)	(0.012)	(0.011)	(0.023)	(0.038)	(0.057)	(0.077)
PREVDUR					−0.014***	−0.022***	−0.016***	−0.034***	0.001	−0.005***	0.008***	−0.026***
					(0.001)	(0.001)	(<.001)	(0.001)	(<.001)	(0.001)	(0.002)	(0.003)
CONST	3.946***	1.777***	2.485***	2.264***	3.890***	1.986***	5.164***	3.524***	5.845***	6.544***	6.571***	7.210***
	(0.009)	(0.005)	(0.004)	(0.003)	(0.015)	(0.006)	(0.004)	(0.007)	(0.012)	(0.015)	(0.028)	(0.026)
UNOBHET	0.701***	0.054***	0.318***	0.431***	0.619***	−0.274***	0.986***	0.592***	1.104***	1.256***	1.349***	1.466***
	(0.005)	(0.004)	(0.003)	(0.002)	(0.009)	(0.008)	(0.002)	(0.004)	(0.005)	(0.006)	(0.009)	(0.009)
N	131,017	250,221	458,913	929,356	54,690	133,359	1,381,631	246,067	111,735	86,516	24,005	22,348
LR chi2	60815.33	81533.68	24594.88	28936.18	13756.98	22797.10	91370.31	6950.50	13710.82	6588.82	727.26	712.76
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

Table 11 Multiple-spell duration analysis of limit orders of small-cap stocks in the ASX trade period (August 2011)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
Panel A: Limit buy orders												
PRICEGAP	0.056**	0.307***	0.088***	0.064***	0.198***	0.241***	−0.007	0.004	0.079*	0.215***	0.420***	0.146***
	(0.022)	(0.024)	(0.007)	(0.003)	(0.033)	(0.030)	(0.006)	(0.013)	(0.047)	(0.030)	(0.059)	(0.054)
INITRADE	0.030	0.060***	0.007	−0.054***	0.023	0.121***	−0.405***	−0.140***	0.095	−0.458***	−0.392***	−0.234***
	(0.020)	(0.022)	(0.006)	(0.003)	(0.031)	(0.037)	(0.007)	(0.013)	(0.075)	(0.045)	(0.067)	(0.066)
SSLIQUIDITY	−0.208***	−1.992***	−0.282***	−0.237***	−3.482***	−2.819***	−0.071***	−0.264***	−1.079***	−1.240***	−1.670***	−0.956***
	(0.026)	(0.024)	(0.009)	(0.004)	(0.060)	(0.067)	(0.009)	(0.018)	(0.112)	(0.062)	(0.082)	(0.079)
MKDPR	−0.252***	−0.602***	0.078***	0.379***	−0.449***	−0.560***	0.436***	1.640***	−0.575***	−0.024	−0.198***	−0.130***
	(0.037)	(0.025)	(0.006)	(0.015)	(0.022)	(0.034)	(0.009)	(0.020)	(0.053)	(0.026)	(0.052)	(0.050)
OSLIQUIDITY	0.192***	0.095***	−0.251***	−0.016***	0.447***	0.276***	0.067***	−0.015	0.023	−0.091**	0.718***	0.159**
	(0.021)	(0.021)	(0.008)	(0.004)	(0.035)	(0.040)	(0.009)	(0.017)	(0.081)	(0.040)	(0.064)	(0.063)
ORDSIZE	0.416***	1.015***	−0.147***	−0.025***	0.828***	1.724***	0.477***	−0.306***	0.510***	0.144***	1.021***	1.323***
	(0.020)	(0.022)	(0.007)	(0.003)	(0.041)	(0.046)	(0.008)	(0.015)	(0.077)	(0.043)	(0.067)	(0.061)
PREVDUR					−0.023***	−0.016***	−0.007***	−0.024***	−0.018***	−0.003***	0.004	−0.014***
					(0.001)	(0.001)	(<.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)
CONST	8.005***	2.836***	0.377***	0.630***	6.174***	3.846***	2.828***	1.857***	9.310***	6.728***	5.994***	6.454***
	(0.023)	(0.025)	(0.008)	(0.004)	(0.064)	(0.051)	(0.010)	(0.017)	(0.082)	(0.046)	(0.072)	(0.065)
UNOBHET	−0.195***	0.757***	0.019**	0.092***	0.747***	0.834***	0.746***	0.473***	1.314***	1.410***	1.465***	1.572***
	(0.026)	(0.014)	(0.008)	(0.003)	(0.018)	(0.021)	(0.005)	(0.011)	(0.024)	(0.014)	(0.023)	(0.019)
N	6623	16,162	79,519	393,226	22,091	11,013	159,176	29,198	4801	15,212	3513	4803
LR chi2	695.97	8943.58	6290.49	6889.04	5645.92	3141.51	10031.39	13634.68	351.79	836.19	653.79	586.47
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel B: Limit sell orders												
PRICEGAP	−0.104***	−0.028***	0.237***	0.151***	−0.700***	−0.096***	−0.789***	0.058***	−0.126***	−1.024***	−0.383***	−1.145***
	(0.023)	(0.011)	(0.024)	(0.008)	(0.063)	(0.019)	(0.013)	(0.019)	(0.023)	(0.041)	(0.083)	(0.093)
INITRADE	−0.118***	−0.023***	−0.060***	−0.007**	−0.199***	−0.056***	0.147***	0.086***	0.389***	0.674***	0.218***	0.418***
	(0.015)	(0.008)	(0.006)	(0.003)	(0.031)	(0.013)	(0.006)	(0.013)	(0.019)	(0.037)	(0.069)	(0.067)

Table 11 (continued)

Destination	Submission				Revision				Partial execution			
	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation	Full execution	Partial execution	Revision	Cancellation
SSLIQUIDITY	−2.772***	−1.369***	−0.763***	−0.606***	−1.929***	−1.506***	0.318***	−0.263***	−1.274***	−2.062***	−1.429***	−1.080***
	(0.016)	(0.011)	(0.020)	(0.007)	(0.043)	(0.024)	(0.009)	(0.018)	(0.027)	(0.049)	(0.080)	(0.079)
MKDPR	0.885***	0.832***	−0.626***	−0.386***	0.645***	0.336***	−0.099***	−1.898***	0.009	0.042	0.411***	0.029
	(0.022)	(0.038)	(0.024)	(0.007)	(0.030)	(0.013)	(0.008)	(0.024)	(0.013)	(0.031)	(0.064)	(0.053)
OSLIQUIDITY	0.212***	0.108***	−0.220***	0.062***	0.381***	0.179***	0.570***	−0.137***	−0.043*	0.386***	0.750***	0.090
	(0.015)	(0.010)	(0.009)	(0.004)	(0.035)	(0.015)	(0.009)	(0.018)	(0.024)	(0.039)	(0.064)	(0.064)
ORDSIZE	0.271***	0.089***	−0.223***	−0.096***	1.062***	0.221***	1.344***	−0.096***	0.259***	1.812***	1.060***	1.860***
	(0.024)	(0.011)	(0.012)	(0.006)	(0.068)	(0.020)	(0.010)	(0.019)	(0.024)	(0.046)	(0.093)	(0.093)
PREVDUR					−0.009***	−0.010***	−0.009***	−0.024***	−0.002***	−0.004***	0.004	−0.010***
					(0.001)	(0.001)	(<.001)	(0.001)	(<.001)	(0.001)	(0.003)	(0.002)
CONST	3.100***	−0.057***	0.417***	0.751***	3.630***	1.178***	4.406***	1.965***	5.419***	6.794***	5.950***	6.080***
	(0.017)	(0.009)	(0.008)	(0.004)	(0.039)	(0.018)	(0.007)	(0.016)	(0.025)	(0.035)	(0.069)	(0.067)
UNOBHET	0.699***	−0.101***	0.028***	0.205***	0.979***	0.037**	0.914***	0.517***	1.359***	1.501***	1.450***	1.550***
	(0.010)	(0.010)	(0.008)	(0.004)	(0.017)	(0.015)	(0.003)	(0.011)	(0.007)	(0.010)	(0.022)	(0.020)
N	31,163	59,360	84,150	354,627	11,363	31,459	223,867	31,112	41,223	18,907	3802	4596
LR chi2	28078.68	26846.15	7092.45	11841.09	3080.14	7335.82	73194.89	11705.97	4642.34	3290.88	587.95	618.30
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This table reports the results for limit order executions (including full and partial), limit order revisions and limit order cancellations that followed a limit order submission (first 4 columns), a limit order revision (middle 4 columns) and a limit order partial execution (last 4 columns). Number of stocks: 20. Random effects models are employed. The coefficient estimates are presented for each of the variable and the standard errors are reported in the parentheses. ***, **, * denote statistical significance at the 1, 5 and 10% level, respectively

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