Essays in Market Microstructure and Investor Trading

Author: Danny Lo
Supervisor: Professor Anthony Hall

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in the

Finance Discipline Group
UTS Business School

June 2015
Declaration of Authorship

I, Danny Lo, certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text. I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signed:

Date:
Abstract

This dissertation consists of three self-contained essays examining issues pertaining to market microstructure and investor trading. The first essay contributes to our understanding of the liquidity replenishment process in limit order book markets. A measure of resiliency is proposed and quantified for different liquidity shocks through the impulse response functions generated from a high frequency vector autoregression. The model reveals a rich set of liquidity dynamics. Liquidity shocks were found to have immediate detrimental effects on other dimensions of liquidity but the replenishment process generally occurs quickly, indicating limit order books are resilient. Cross-sectionally, resiliency is found to be consistently high across all large stocks, consistent with competition for liquidity provision coming from computerised algorithms. For other stocks, greater variation in resiliency is observed, indicating more selective participation by these liquidity providers.

The second essay is motivated by concerns raised from the investment community on the impact of algorithmic trading among investors. A strong dichotomy exists between retail and non-retail investors, with non-retail investors predominantly having access to algorithmic trading technology. We compare the limit order behaviour and execution costs of retail and non-retail investors to provide insights into the extent to which technology benefits investors. Fundamental differences are found in the trading behaviours of the two groups, consistent with their inequalities in access to trading technology. We also find evidence consistent with some non-retail investors imposing adverse selection costs on the limit orders of retail investors, but our results fall short of supporting the view that algorithmic trading technology is severely disadvantaging retail investors.

The third essay examines information-based trading by institutional and retail investors around earnings announcements. Prior to the announcement, limited and weak evidence is found of earnings anticipation, which is isolated to full-service retail investors. In contrast, strong trading patterns are observed for institutional
and retail investors in response to earnings announcements, with the latter having the potential to drive the post-earnings announcement drift effect. We find that retail investor trades during the earnings announcement periods underperform their trades in non-announcement periods. This is driven mostly by the trading of discount retail investors, with top-tier institutional investors the likely beneficiaries, and cannot be attributed to the adverse selection of stale limit orders. Overall, our findings are consistent with investors having different information processing abilities. Contrary to the belief that earnings disclosures level the playing field, the release of earnings news exacerbates information asymmetries between the most and least skilled information processors.
Acknowledgements

When I completed my bachelor’s degree in 2005, I believed I would never undertake further studies at a university again. Ten years on, I am deeply grateful for the valuable support I received during my PhD candidature at the University of Technology, Sydney (UTS).

This thesis has benefited enormously from the many helpful discussions I’ve had with my supervisor, Professor Tony Hall. I am greatly indebted to Tony who not only dedicated a considerable amount of time to reviewing my work, but also provided invaluable insights, feedback and guidance. It has been a long and challenging journey but we got there.

My time at UTS has been most enjoyable thanks to my fellow research students and colleagues at the Finance Discipline Group. I would like to thank my alternative supervisors, Dave Michayluk and Jian Xin Wang for taking an interest in my research and providing helpful feedback. This thesis also benefited from editorial assistance provided by John Revington.

Furthermore, I would like to acknowledge the financial assistance received from both the Australian Postgraduate Awards (APA) and Professor Tony Hall during the early years of my PhD studies. I am also grateful to my current employer, VINVA Investment Management for providing me with enormous flexibility during the latter years of my studies. This enabled me to finish my dissertation.

The empirical studies presented in this thesis would not be have been possible without the ASX tick data and assistance provided by the Securities Industry Research Centre of Asia-Pacific (SIRCA). This research was also partially conducted on the UTS Business School High Performance Computing Cluster which has been a valuable computing resource.

Some of the results in Chapter 3 were presented to participants of the 2013 Auckland Finance Meeting. I thank the conference participants for their comments.
I am eternally grateful to my wife, Cathy Kwan for her endless support and encouragement.

Lastly, I would like to dedicate this thesis to my father, whose memory is a constant source of inspiration. To my daughter, Alicia Lo who brightens me every day, I hope this study can be a future source of inspiration.
# Contents

Declaration of Authorship i  
Abstract ii  
Acknowledgements iv  
List of Figures viii  
List of Tables ix  

1 Introduction 1  
1.1 Overview of the Australian Stock Exchange 4  
1.2 Data Description and Preparation 6  
1.3 Investor Classification 8  

2 Resiliency of the Limit Order Book 11  
2.1 Introduction 11  
2.2 Related Literature 15  
2.3 Data 18  
2.4 Method 20  
2.4.1 Variable Definition 20  
2.4.2 Model Specification 22  
2.4.3 Estimation Results 27  
2.5 Measuring Resiliency 31  
2.5.1 Identifying Liquidity Shocks 31  
2.5.2 Impulse Responses 35  
2.5.3 Responses to Liquidity Shocks 37  
2.5.4 Time to Recovery 45  
2.6 Robustness of Results 49  
2.7 Conclusion 51
## 3 Limit Order Behaviour and Execution Costs of Retail and Non-Retail Investors

3.1 Introduction .......................................................... 53
3.2 Data ................................................................. 60
3.3 Limit Order Activities Across Investors ..................... 60
   3.3.1 Statistics of Limit Order Submissions ..................... 60
   3.3.2 Statistics of Limit Order Revisions ...................... 62
   3.3.3 Order Exposure .............................................. 65
3.4 Limit Order Risks .................................................. 71
   3.4.1 Methodology .................................................. 71
   3.4.2 Empirical Results ........................................... 75
3.5 Limit Order Execution Costs ..................................... 83
3.6 Conclusion .......................................................... 91

## 4 Investor Trading and Performance Around Earnings Announcements

4.1 Introduction .......................................................... 93
4.2 Background .......................................................... 98
   4.2.1 Presence of Informed Trading ............................. 98
   4.2.2 Post-Earnings Announcement Drift ....................... 100
   4.2.3 Information Asymmetry Around Announcements ......... 101
4.3 Data and Methodology ............................................... 102
4.4 Empirical Findings ................................................. 106
   4.4.1 Trading Patterns ............................................. 106
   4.4.2 Earnings Anticipation ..................................... 117
   4.4.3 Investor Trade Performance .............................. 121
   4.4.4 Stale Limit Orders .......................................... 126
4.5 Conclusion .......................................................... 130

## 5 Concluding Remarks

5.1 Time to Recovery - Ask Side Shocks ............................ 135
5.2 Robustness of Implementation Shortfall Results .......... 137
5.3 Additional Results on Net Investor Trading .................. 139

Bibliography ............................................................... 143
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Investor Categories</td>
<td>10</td>
</tr>
<tr>
<td>2.1</td>
<td>Plots of Order Book Depth</td>
<td>23</td>
</tr>
<tr>
<td>2.2</td>
<td>Illustration of Liquidity Shocks</td>
<td>34</td>
</tr>
<tr>
<td>2.3</td>
<td>Response to a Liquidity Shock - Scenario MO</td>
<td>38</td>
</tr>
<tr>
<td>2.4</td>
<td>Response to a Liquidity Shock - Scenario OC</td>
<td>40</td>
</tr>
<tr>
<td>2.5</td>
<td>Response to a Liquidity Shock - Scenario AMO</td>
<td>41</td>
</tr>
<tr>
<td>2.6</td>
<td>Response to a Liquidity Shock - Scenario AOC</td>
<td>43</td>
</tr>
<tr>
<td>2.7</td>
<td>Response to a Liquidity Shock - Scenario OCBM</td>
<td>44</td>
</tr>
<tr>
<td>2.8</td>
<td>Cumulative Price Impact of Trading vs Order Cancellations</td>
<td>44</td>
</tr>
<tr>
<td>3.1</td>
<td>Number of Limit Order Revisions</td>
<td>63</td>
</tr>
<tr>
<td>3.3</td>
<td>Ex post Cost of Executed Limit Orders</td>
<td>84</td>
</tr>
<tr>
<td>3.4</td>
<td>Implementation Shortfall of Non-Marketable Limit Orders</td>
<td>89</td>
</tr>
</tbody>
</table>
## List of Tables

1.1 Market Trading Schedule on ASX Equities .......................... 6
2.1 Descriptive Statistics on the Sample ................................. 19
2.2 Variable Definition .................................................... 21
2.3 Stationarity Tests on Endogenous Variables .......................... 25
2.4 Estimation Results: Bid Market Depth ................................. 28
2.5 Estimation Results: Ask Market Depth .................................. 29
2.6 Estimation Results: Spread ............................................... 30
2.7 Estimation Results: Duration between Order Events ................. 30
2.8 Shock Vectors Representing Liquidity Shocks .......................... 33
2.9 Time to Recovery ......................................................... 47
2.10 Robustness of Recovery Estimates to Lag Order Mis-specification .. 50
3.1 Frequency of Limit Order Events .......................................... 61
3.2 Transition Matrix of Revised Orders ...................................... 64
3.3 Cumulative Incidence Function Estimates ................................. 68
3.4 Limit Order Placement: Fleeting vs Non-Fleeting Orders .............. 70
3.5 Time to Limit Order Execution By Initiating Investor and Price Aggressiveness ................................................. 72
3.6 List of Competing Risk Events .............................................. 73
3.7 Hazard Model of Upward Limit Order Revisions ($AMEND+$) ....... 77
3.8 Hazard Model of Downward Limit Order Revisions ($AMEND−$) .... 79
3.9 Hazard Model of Order Cancellations ($DELETE$) ....................... 80
3.10 Hazard Model of Upward Limit Order Revision to Market Order ($AMEND + MKT$) .................................................. 82
3.11 Regressions of Ex post Cost ............................................... 85
3.12 Ex post Cost of Retail Limit Orders ...................................... 86
3.13 Ex post Cost of Non-Retail Limit Orders ................................. 87
3.14 Regressions of Implementation Shortfall .................................. 88
4.1 Descriptive Trade Statistics by Investor Category ..................... 104
4.2 Net Institutional and Retail Investor Trading around Earnings Announcements .................................................. 107
4.3 Net Investor Trading around Earnings Announcements by Investor and Order Type ............................................. 110
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4</td>
<td>Explaining Post-Announcement Net Trading</td>
<td>112</td>
</tr>
<tr>
<td>4.5</td>
<td>Predictability of Future Net Investor Trading on News and Non-News Days</td>
<td>115</td>
</tr>
<tr>
<td>4.6</td>
<td>Return predictability Using Net Investor Trading Prior to Earnings Announcements</td>
<td>119</td>
</tr>
<tr>
<td>4.7</td>
<td>Return Predictive Regressions using Net Investor Trading prior to Earnings Announcements</td>
<td>120</td>
</tr>
<tr>
<td>4.8</td>
<td>Trading Performance around Earnings Announcements - Institutional and Retail Investors</td>
<td>122</td>
</tr>
<tr>
<td>4.9</td>
<td>Investor Trading Performance around Earnings Announcements by Investor and Trade Type</td>
<td>125</td>
</tr>
<tr>
<td>4.10</td>
<td>Incidence of Stale Limit Order Executions</td>
<td>128</td>
</tr>
<tr>
<td>4.11</td>
<td>Retail Limit Order Trading Performance Excluding Stale Limit Orders</td>
<td>129</td>
</tr>
<tr>
<td>4.12</td>
<td>Predictability of Future Net Investor Trading on News and Non-News Days</td>
<td>129</td>
</tr>
<tr>
<td>A.1</td>
<td>Time to Recovery - Ask Side Shocks</td>
<td>136</td>
</tr>
<tr>
<td>B.1</td>
<td>Regressions of Implementation Shortfall - Alternative Definition</td>
<td>138</td>
</tr>
<tr>
<td>C.1</td>
<td>Net Retail Investor Trading around Earnings Announcements</td>
<td>140</td>
</tr>
<tr>
<td>C.2</td>
<td>Explaining Post-Announcement Net Trading - Institutional and Retail Investors</td>
<td>141</td>
</tr>
</tbody>
</table>