Limit Order Book Modeling

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LOB ILLUSTRATIONS (APPENDIX)

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Figure 1: An order book with $K = 7$ and $q = 1$. In this case, $i_S = 2$ and $a_{i_S} = a_2 = 4 > 1 = q$. We receive a buy market order (indicated by the red lines), this merely reduces $a_{i_S}$ by $q = 1$. Thus, our resulting order book will have $a_{i_S} = 4 - q = 3$ and an un-shifted bid side $b = (b_1, ..., b_7) = (0, -1, 0, 0, 0, -3, -1)$.
Figure 2: An order book with $K = 7$, $q = 1$ and $a = (0, 1, 0, 0, 3, 4, 1)$, $b = (0, -1, 0, 0, -3, -1)$. In this case, $i_S = 2$, $A^{-1}(q) = 5$ and $a_{i_S} = a_2 = 1 = q$. We receive a buy market order (indicated by the red lines), this annihilates $a_{i_S}$, and consequently shifts the bid side of the book by an amount $A^{-1}(q) - i_S = 5 - 2 = 3$. Thus, our resulting order book will have a shifted bid side $b = (0, 0, 0, -1, 0, 0)$. And so the first $A^{-1}(q) - i_S = 3$ levels of $b$ turned to 0 (giving a smaller size to the expression of (73), from the dissertation).
Figure 3: An order book with $K = 7$, $q = 1$, $b_\infty = -2$, $a_\infty = 4$, and $b = (0,0,0,-1,0,0)$. In this case, $i_S = 5$, and we receive a sell limit order at level $i = 2$ (depicted by the pink box). As $i = 2 < 5 = i_S$, this sell limit order, $dL_2^+$, is in the spread. As a result, the bid side is shifted and now becomes $J^L_2(b) = (0,-1,0,0,-2,-2,-2)$. 
Figure 4: An order book with $K = 7$, $q = 1$ and $i_S = 2$. We receive a sell limit order at level $i = 5$ (depicted by the pink box). This order does not cause a shift in the bid side of the book because it’s not in the spread.
Figure 5: An order book with $K = 7$, $q = 1$ and $i_S = 2$. In this case, $a_{i_S} = a_2 = 4 > 1 = q$. So, when a cancellation of a sell limit order at level $i = i_S = 2$, $dC_i^+$, arrives (depicted by the red lines), it leaves the bid side un-shifted i.e. $J_{C_i^+}(b) = b$. 
Figure 6: An order book with \( K = 7 \), \( q = 1 \) and \( i_S = 1 \). We receive a cancellation of a sell limit order at level \( i = 4 > 1 = i_S \), \( dC_i^+ \) (depicted by the red lines). This leaves the bid side, \( b \), un-shifted i.e. \( JC_i^+(b) = b \).