

NZX Equity Market Transactions

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This document is accompanied by screenshots of NZX limit order books: AIR, FBU, PPH, USF, and WBC010.¹ Please let me know if you find any errors (tcrack@otago.ac.nz; timcrack@alum.mit.edu).

New Zealand stock exchange (NZX) transactions take place via different platforms. Please see pp. 211–223, 235–236, 546 of *Foundations for Scientific Investing (FFSI)* 15th Edition for a discussion of the centralized limit order book (CLOB), privately negotiated off-market crossings, and the new unlit Mid-Point Order Book.

There are a successive levels of complexity in understanding the operations of the NZX CLOB. My review below works generally from the least complex to the most complex.

Viewing the CLOB

Otago University pays the NZX for a Company Research data subscription. This means that Otago University faculty and students can view the NZX order book for any stock, ETF, or fixed income product using the following links (these examples use the stock AIA; I usually just edit the ticker symbol in the URL to get different instruments).

- Links **OFF** campus: https://companyresearch-nzx-com.ezproxy.otago.ac.nz/deep_ar/newpage.php?pageid=orderbook&default=AIA
- Links **ON** campus: http://companyresearch.nzx.com/deep_ar/newpage.php?pageid=orderbook&default=AIA

The fact that you can view these books makes them part of the “lit” market. That is, they are easily able to be viewed by public subscribers (unlike the “unlit” or “dark” markets, discussed below). My NZ broker’s Web site also lets me view the CLOB.

Types of Orders

We will look only at **market orders** and **limit orders** (your broker may allow more complex orders). See pp. 211–212 of *FFSI* for a discussion of market orders, limit orders, and marketable limit orders. Examples will appear below.

Content of the CLOB

The CLOB holds **limit orders only**. It is called the centralized limit order book (CLOB) because it is a bringing together in one centralized place of all limit orders that have been submitted to brokers, but have not yet been filled. They are said to “rest” in the book. Some resting limit orders may have

¹ Thank you to Cindy Chou for finding an error. Note that I asked the NZX to make more than 10 changes to the way they display their limit order book, in order to bring it into line with international best practice. So far, they have made nine of my requested changes. The only request remaining is that they display all prices to the same number of decimal places. They said they were working on it, but that was over five years ago.

gotten partial fills already. For example, maybe a customer wanted to buy 1,000 shares, but has only been able to buy 600 so far. In that case, the unfilled portion of 400 shares rests in the book.

Ordering Precedence in the Order Book

Read pp. 214–216, 235 of *FFSI* on order precedence. The NZX CLOB uses **price priority** and **time priority** rules (other rules exist in other types of markets, e.g., **quantity priority**, as discussed at the page references mentioned).

For example, in the order book for PPH, 1 customer is offering 6,200 shares of PPH at \$1.65 per share and this customer's order ranks ahead of the 1 customer who is offering 5,000 shares of PPH at \$1.66 per share (because the offer price is more attractive to a trader with an incoming order to buy); this ranking is an example of **price priority**.

We can see that 4 customers are collectively bidding for a total of 1,421 shares of PPH at \$1.64. You can think of those four customers as waiting in line to be served. Whoever submitted their order first gets served first; this is an example of **time priority**. The total number of shares bid or offered at any price is called the **depth**. Often we are most interested in the depth at the best bid or the depth at the best ask, or perhaps just beyond that if we have a slightly larger order.

Tick Sizes (Price Steps)

The minimum allowable price variation is called the “tick size” almost everywhere in the world except N.Z., where we call it the “price step.” The NZX confirmed that the price steps are (correct as of April 2020):

\$0.001 for price per share < \$0.20, and

\$0.005 for $\$0.20 \leq \text{price per share} \leq \0.50 , and

\$0.010 for $\$0.50 < \text{price per share}$,

with exceptions for some dual-listed stocks and property stocks (and some off-market crossings, as discussed on p. 236 of *FFSI*). Note that options, warrants, rights, ETFs and a few special cases have a \$0.001 price step. The following stocks have a permanent \$0.005 price step TWR, VHP, SPK, SPY, PFI, PCT, NZO, NPT, MCY, MEL, KPG, IFT, GMT, CNU, CDI, AUG, ARG, AIR, AIA, GNE.

For example, you can see that PPH is priced on pennies but USF (an ETF) is priced on tenths of a penny. Note, however, that these rules are subject to change, and you should not be surprised to see smaller tick sizes in the near future. Smaller ticks are not always a good idea, because they can fragment orders, widen bid-ask spreads, and reduce liquidity at any given price.

Bid-Ask Spread

The most attractive limit orders rest at the top of the order book. The best bid and the best ask together form the **quotes**. The difference between the best bid and the best ask is the **bid-ask spread** (note that that is a hyphen, not a minus sign in the phrase “bid-ask spread”). For example, the best bid for PPH is \$1.64 per share and the best ask is \$1.65 per share. So, the bid-ask spread is

one penny per share. Note that for equities, the ask is larger than the bid during regular trading hours.

Market Open and Market Close

You can see that FBU is presenting a crossed order book (i.e., the bid is larger than the ask). The NZX regular trading hours (RTH) are from about 10:00AM to about 4:45PM, but outside of regular trading hours the book is not live (<https://www.nzx.com/services/nzx-trading/hours-boards>). See pp. 220–221 for a discussion of the opening auction algorithm used to clear the overlap at the beginning of the trading day. A worked spreadsheet example of the opening auction algorithm appears on the University of Otago FINC302 BlackBoard site if you are interested (it contains one of the nicest supply-demand curves I have seen; it is like a 100-level ECON class in practice).

Osborne Effect

Look at the PPH order book. At the limit prices \$1.60 per share (a multiple of \$0.10) and at \$1.75 per share (a multiple of \$0.25) you can see an unusually large number of traders and depth. This is the **Osborne Effect** (see pp. 431–432 of *FFSI*). Traders are human (or programmed by humans) and humans are attracted to round numbers. This has consequences for reversals (see p. 431 of *FFSI*) and order placement strategy (see p. 432 of *FFSI*).

DMMs in ETFs

In 2026, the NZX uses DMMs in ETFs only (see p. 220 of *FFSI*). At the time of writing, the NZX sponsors 44 ETFs (<https://www.smartinvest.co.nz/funds-and-performance/etfs>). The order book for USF (which invests in the Vanguard S&P 500 ETF) is shown.² If you look at the depths, you will see a block of 10,000 shares and a block of 25,000 shares bid a penny apart. Similarly on the ask side. These are the actions of the market maker from *Craigs Investment Partners* (as discussed on p. 220 of *FFSI*, and references therein). Different ETFs use different block sizes and different spacing. For example, it is not unusual to see 25,000 and 50,000 blocks a half-penny apart in the more liquid FNZ ETF. Sometimes these are masked by other orders or recent executions; they disappear outside RTH.

Can you see the Osborne Effect exhibited in the PPH and USF order books (or others)?

Price Impact (Market Impact)

The CLOB has limited depth. For example, looking at the PPH order book, the total visible depth on offer is $6,200 + 5,000 + 305 + 9,308 + \dots + 16,615 + 20,413 = 249,045$ shares, at ever increasing prices. There is likely to be some limited additional depth beyond this. If you submit a naive market order to buy 249,045 shares, say, then you will consume all the visible depth, and you will pay an average price of \$1.750445 per share (i.e., total cost of \$435,940 divided by count of shares). Unlike a simple order to buy 1,000 shares, that could have been executed at \$1.65 per share, you end up pushing prices against you and paying an extra 10 cents per share. See the other worked examples below.

² As an aside, if you click “Share Transactions” (about 20 items down the LHS menu on the NZX order book page), you can see the creation/redemption transactions in the ETFs (see discussion of ETF creation/redemption in Chapter 4 and particularly in Figure 4.2 on p. 471 of *FFSI*).

What if you want to buy 10,250,000 shares of PPH? There are two problems. First, there is not enough depth in the book to satisfy your order. Second, even if there were enough depth, you would likely push prices very much against yourself, perhaps doubling the price you pay on a per share basis. This pushing of prices against you is called **price impact** or **market impact**. If you could buy 10,250,000 shares of PPH through the CLOB, what happens if you then wish to sell your position? If you push the trade through the CLOB, you would likely end up receiving an average price that is only half the price you see as the best bid; another example of price impact.

If a liquidity-motivated trade in a liquid stock eats depth in the CLOB we expect the consumed limit orders to be replaced like-for-like relatively quickly. If, however, an information-based trade eats depth in the CLOB, it might not be replaced, or might be only briefly replaced.

In response to price impact creating T-costs, privately negotiated “**off-market trades**” evolved (see pp. 235–236, 546 of *FFSI*). As of 2021, roughly half (by dollars) of all NZX order flow goes through the order book. The other half is executed off market. The off-market trades use the CLOB for **price discovery**. That is, off-market traders look to the CLOB for the prices. So, the CLOB trades are **price making** (or **price-setting**) trades, but the off-market trades are **price taking** trades.

For example, you can see in the “Last 10 Trades” columns at the RHS of the screen grab that a trade for 10,250,000 shares of PPH was just executed at \$1.65. It is reported as NOT being a price setting (i.e., a price making) trade, because this is an off-market trade and price discovery already took place in the limit order book. That big order did not go through the CLOB.

Some off-market trades are for as little as a single share (e.g., in USF at 1:59:22). These are portfolio managers (PMs) tidying up positions. The PMs do not pay regular brokerage commissions for this (otherwise such a small trade would be prohibitively expensive).

Dark Markets

See p. 235 of *FFSI* for a discussion of NZX Dark. See also p. 240 for further discussion of dark markets.

Example Questions in Order of increasing Complexity

In each case, you should ask yourself: Is the order immediately marketable? Will the trader get a full, or only a partial fill? At what price(s) will the order be executed? What does the order book look like after the execution? We will use the AIR order book here.³ **Each scenario is assumed independent of each other scenario.**

1. Simple Market Order: You submit a **market order to buy 1,000 shares of AIR**. Yes, this order is immediately marketable. One trader is offering 6,363 shares of AIR for sale at \$1.59 per share. Your order is immediately filled at \$1.59 per share. The new top line of the book is **21,525, 1, \$1.58, \$1.59, 1, 5,363**.
2. Simple Market Order to buy with Price Impact: You submit a **market order to buy 10,000 shares of AIR**. Yes, this order is immediately marketable. One trader is offering 6,363 shares of AIR for sale at \$1.590 per share and another is offering 3,838 shares of AIR for sale at

³ Note, however, that the time stamp shows that the AIR book was sampled outside of RTH. Let us, however, treat it as though it were a live order book. Often times, however, outside of RTH prices are not “firm” (i.e., not tradeable) and the CLOB is crossed (i.e., ask < bid) or presents with an unrealistically wide spread.

\$1.595 per share. Your order is immediately filled with 6,363 shares at \$1.590 per share and the remaining 3,637 shares at \$1.595 per share. The new top line of the book is **21,525, 1, \$1.58, \$1.59, 1, 201**. Your order experienced price impact because you walked up the limit order book pushing prices against yourself.

3. Simple Market Order: You submit a **market order to sell 10,000 shares of AIR**. Yes, this order is immediately marketable. One trader is bidding 21,525 shares of AIR at \$1.58. Your order is immediately filled at \$1.58 per share. The new top line of the book is **11,525, 1, \$1.58, \$1.59, 1, 6,363**. The trader who was making a market on the bid side of the book was bidding for 21,525 shares, so, unlike the example of the market order to buy 10,000 shares, that depth is big enough that this order experiences no price impact.
4. Simple Limit Order: You submit a **limit order to buy 1,000 shares of AIR with a limit price of \$1.585**. No, this order is not immediately marketable. No trader is offering any shares of AIR for sale at \$1.585 per share or better. Your order rests in the CLOB at \$1.585 per share. The new top line of the book is **1,000, 1, \$1.585, \$1.590, 1, 6,363**. In this case, you are making a market at the bid, and the bid-ask spread has narrowed from one penny to one-half penny. This is an improvement in liquidity. Note that although AIA is priced about \$0.50, it has a half-penny price step because it is on the permanent exceptions list, presumably because of its liquidity.
5. Simple Limit Order: You submit a **limit order to buy 30,000 shares of AIR with a limit price of \$1.580**. No, this order is not immediately marketable. No trader is offering any shares of AIR for sale at \$1.580 per share or better. Your order rests in the CLOB at \$1.580 per share. The new top line of the book is **51,525, 2, \$1.580, \$1.590, 1, 6,363**. In this case, you are making a market at the bid, but you are standing in line behind the trader who bid 21,525 shares. The bid-ask spread has not changed, but your order increased the depth at the best bid. This is an improvement in liquidity for this stock.
6. Simple Marketable Limit Order: You submit a **limit order to buy 1,000 shares of AIR with a limit price of \$1.59**. Yes, this order is immediately marketable. One trader is offering 6,363 shares of AIR for sale at \$1.59 per share. Your order is immediately filled at \$1.59 per share. The new top line of the book is **21,525, 1, \$1.58, \$1.59, 1, 5,363**. The outcome is the same as the case of the limit order to buy 1,000 shares. This is a case of a **marketable limit order**.
7. Simple Market Order to Sell with Price Impact: You submit a **market order to sell 30,000 shares of AIR**. Yes, this order is immediately marketable. Traders are bidding for your shares in sufficient depth for you to get an immediate fill. You walk up the limit order book, pushing prices against yourself, selling 21,525 shares at \$1.580, 5,258 shares at \$1.575, and the remaining 3,217 at \$1.570. The new top line of the book is **146,012, X, \$1.57, \$1.59, 1, 6,363**, where the **X** indicates that I do not know how many traders' orders were consumed by my 3,217 request out of the 149,229 that were bid. Note that each limit order that was executed was executed at its limit price: \$1.580, 1.575, and \$1.570, respectively.
8. Slightly more subtle case. Marketable Limit Order to Sell with Price Impact: You submit a **limit order to sell 30,000 shares of AIR at a limit price of \$1.57**. Yes, this order is immediately marketable. Traders are bidding for my shares in sufficient depth for me to get an immediate fill at this price or better. You walk up the limit order book, pushing prices against yourself, selling 21,525 shares at \$1.580, 5,258 shares at \$1.575, and the remaining 3,217 at \$1.570 per share. The new top line of the book is **146,012, X, \$1.57, \$1.59, 1, 6,363**, where the **X** indicates that I do not know how many traders' orders were consumed by my

3,217 request out of the 149,229 that were bid. Note that each resting limit order in the book was executed at its limit price: \$1.580, 1.575, and \$1.570, respectively, but **your aggressing limit order was not executed at its limit price.**⁴

The subtlety is that the NZX order book rules could have been set up differently. Remember that **a limit order says execute my order at this price or better**. If my 30,000 shares had, for example, been filled at my limit price of \$1.57, then the traders with the passive resting limit orders to buy at \$1.580, \$1.575, and \$1.570 would have been happy (because they would have paid their limit price or better to buy the shares). Indeed, the traders bidding at \$1.580 and \$1.575 would have been very happy, because they would have gotten a price improvement. This is not, however, how the NZX operates. The NZX confirmed to me that in this scenario, it is the aggressing limit order that gets price improvement when there is price impact, and the execution prices are the same as in the case of the market order to sell 30,000 shares. If you do not see the subtlety, then reread this example.

9. Another slightly more complex case. Limit Order to Sell with only a Partial Fill: You submit a **limit order to sell 30,000 shares of AIR at a limit price of \$1.58**. Ask yourself, is my order marketable? That is, are there traders bidding for my stock at this price or better? Well, in this case, one trader is bidding 21,525 shares at \$1.58. So, I will get a **partial fill** for 21,525 shares at \$1.58, but no other trader is bidding for your shares at a price of \$1.58 or better per share. So, the balance of your unfilled order will go into the book as a resting limit order. The new first line of the order book will be **5,258, 1, \$1.575, \$1.580, 1, 8,475**. Now you are making a market on the offer side of the book, and the bid-ask spread has narrowed from one penny to one-half penny. The **quotes have dropped** from \$1.58-\$1.59 to \$1.575-\$1.580. That is, your sell order has pushed the quotes down. This is an example of supply causing prices to drop.
10. The next level of complexity is to ask students what happens after multiple orders are submitted to the CLOB in succession. For example, Q224 and Q225 in the Q&A Book ask simple questions about successive orders.
11. The next level of complexity is to ask about a non-marketable market order. If you go to <https://www.nzx.com/markets/NZSX> and rank the stocks by market cap, and look at the stocks from the bottom of that list upwards, you will soon find a security with **no depth on one side** (or maybe even **no depth on either side**) of the CLOB. If you submit a market order to buy 1,000 shares when there are no limit orders to sell in the book, then your order is not marketable. Your broker has two options. First, **cancel** your order. Second, call you to ask whether you want to **convert your market order to buy into a limit order to buy**, and if so, at what limit price. Then your non-marketable order can rest in the limit order book until an incoming market order to sell or limit order to sell can be crossed (or partially crossed) with your order.
12. (This material is usually left for the FINC310 Fixed Income course or a higher-level investments course.) Note that NZX fixed income, rights, various notes, and equity options also trade using the NZX CLOB. In the case of bonds, however, the CLOB is quoted in terms of **percentage annualized YTM**. So, unlike stocks, the **quoted ask is lower than the quoted**

⁴ Limit orders passively sitting in the book are said to be **resting** there. Incoming limit orders are **aggressing** orders. See p. 216 of *FFSI*.

bid during live trading, if both exist. You will recall that a higher YTM gives a lower bond price. So, this is *not* a crossed order book; see the WBC010 CLOB for an example. In this case, you can see the coupon rate (4.6950% per annum), it pays quarterly coupons (which was reported here <https://www.nzx.com/instruments/WBC010> but is no longer visible), and the face value on offer is \$100,000.

You can find an Excel sheet at the *FFSI* web site that shows you how to price NZX Debt Market (NZDX) bonds using accrued interest when needed and an ex-coupon period when needed <http://wwwFOUNDATIONSforSCIENTIFICINVESTING.com/Pricing-NZDX-Bonds-Using-Excel-Revised.xlsx> (you may need to actively choose to “keep” the download when prompted by Google Chrome). If you are rusty on accrued interest, there is a working paper on SSRN.com that goes through the basics of accrued interest, full/dirty/invoice prices and flat/clean prices (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4796042).

Further Practice Questions for Students

There are 25 NZX CLOB questions in the Q&A Book accompanying *FFSI*.