Humans: Are we that predictable?

We are often asked at QB if algorithms are always better than humans. It might surprise the reader that we don't see this as an "us" *vs* "them". In fact, it is precisely through combining the experience and perspectives of human traders and researchers with the discipline of algorithmic methods that one truly pushes the boundaries of performance.

That said there are characteristics in how humans trade compared to algo's that are quite evident in the market data. Perhaps the most striking is that humans prefer to size their trades to "round lots:" trades at sizes such as 10 or 50 rather than 14 or 167. In this paper we examine this effect and note that whilst QB endeavours to learn from experienced human traders it is also important to be wary of introducing patterns in ones order sizing.

A histogram of trade sizes (Figure 1) shows a dramatic excess of volume in round lot trades. We expect that these round lots involve either greater control by human traders than the typical trade, or involve a different class of algorithmic trading. The round lots may also be driven by internal "fat-finger" risk checks and also preset quantity buttons conveniently located in traders execution management systems ("EMS").

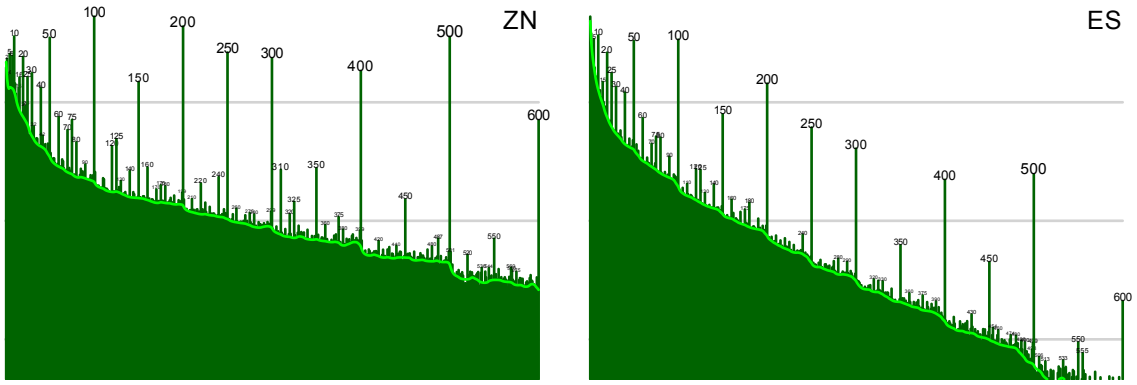

Figure 1: Excess volume is traded in round-numbered sizes. Green bars show total volume at each trade size for 10-year Treasury note futures (ZN) and S&P E-mini futures (ES). Data shown compiles all electronic volume for the year of 2015. The light green lines mark our estimate of the background trade volume at each size. The vertical axis is log-scaled, with horizontal grey lines marking multiples of 10. Many other futures markets show a similar clustering, and the clustering appears to be stable across time.

What do we learn from this?

In Figure 2, we examine the price impact of trades of different sizes. We identify the size and direction of aggressive trades[1] from market data, and for each trade we then measure the subsequent change in the midpoint of the best bid and offer over the next thirty seconds. We adjust for the side of the trade, then average together changes due to trades of the same size. Figure 2 shows that round lot trades clearly have less impact on the market.

We consider two ready hypotheses for the decreased market impact of round lot trades. Our measurement of impact does not take into account the correlations between trades as seen in sequences of orders in the same direction. The first explanation could therefore be that round lot trades are less correlated with subsequent order flow than non-round lot

[1] Orders that cross the spread to take liquidity

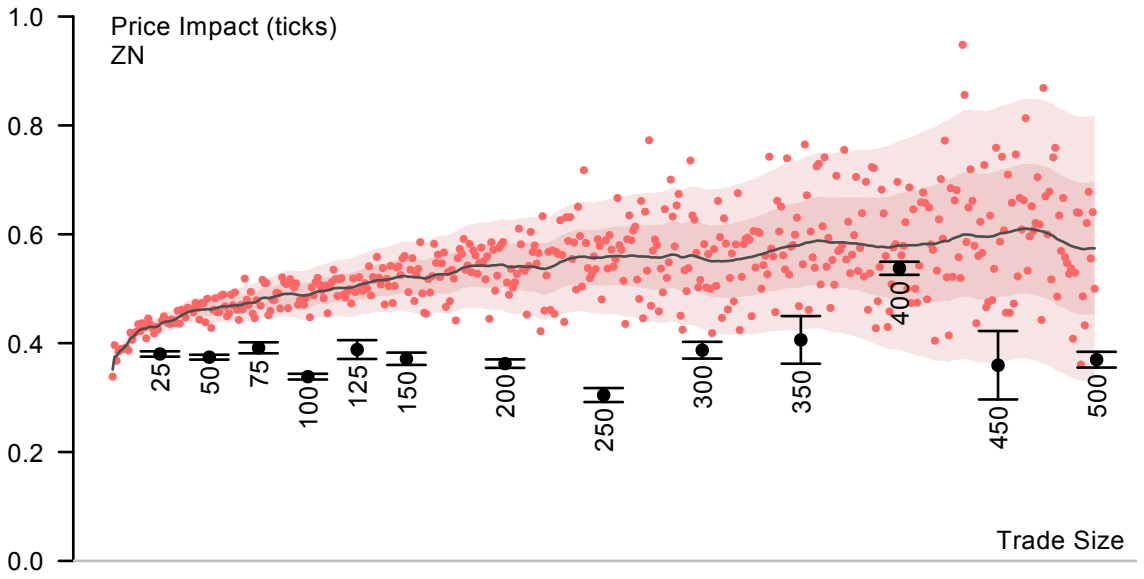

Figure 2: Round lot trades show dramatically lower market impact. Red dots show average 30-second price change following trades of each size. Round numbered sizes are highlighted in black and shown with the standard error of their mean. Shaded bands show regions within 1 and 2 standard deviations of the moving average of the non-round data. The motivation for this report is to explain the effect shown in this figure.

trades are. The second explanation could be that round lot trades are simply timed to enter more liquid markets than are other trades. Either or both of these effects could result in the decreased market impact of round lot trades.

We examine the trade-correlation hypothesis above by measuring the average signed volume in the thirty seconds following trades of different sizes, shown in Figure 3. Round lot trades do not have lower correlations with future order flow than other trades, so this hypothesis does not explain the impact effect.

What's going on?

We investigate the liquidity hypothesis by examining the average opposing depth met by trades of different sizes (Figure 4). Round lot trades do go into deeper markets than non-round lot trades, making this a viable explanation for the lower impact of round lot trades.

As a more direct test of this hypothesis, we can revisit the analysis from Figure 2, but restrict ourselves to trades that enter markets with a fixed range of depths. In Figure 5 we show the impact of trades that meet liquidity between 300 and 500 lots, and we find that the impact effect is dramatically reduced, if not eliminated. This indicates that variability in the opposing depth was indeed a driving force in the differential impact of round lot trades.

This leaves us with the question of whether traders issuing round lot trades are reacting differently to changes in short-term liquidity, or simply trading at times of day when the markets are more liquid. In Figure 6 we compare liquidity at the time of the trade with the time-weighted average liquidity in the 30 seconds on either side. Round lot trades tend to enter at times of temporarily high liquidity compared with other trades. Interestingly, liquidity is lower immediately before trades of all sizes than at nearby times.

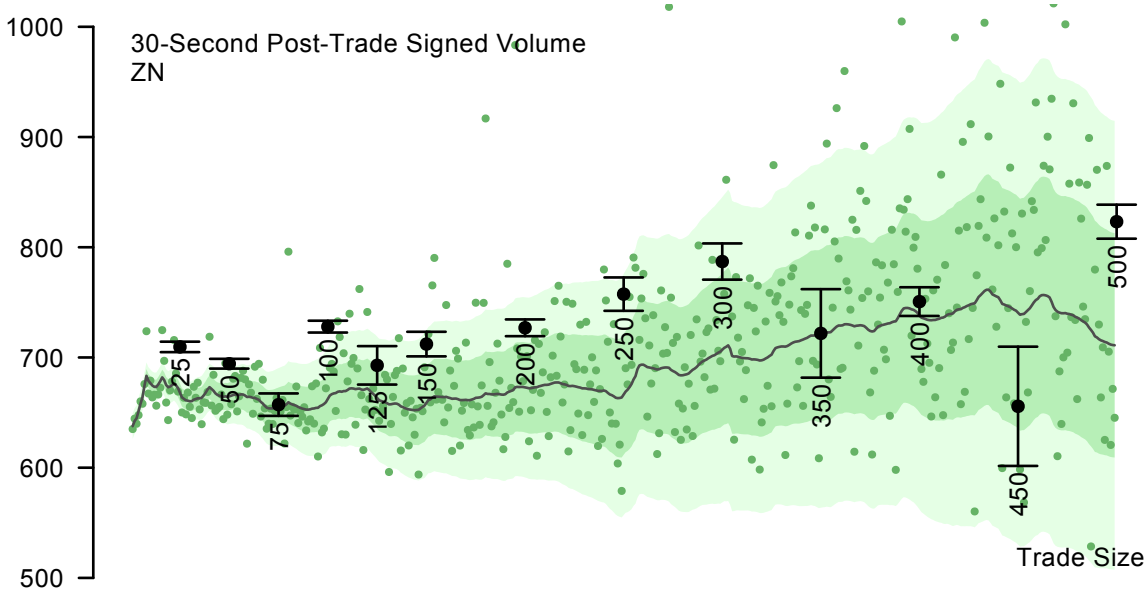

Figure 3: Round lot trades *do not* have lower correlation with future order-flow. Dots show average signed volume in the 30 seconds following trades of different sizes. Round lot trades are followed by *more* volume in the same direction than non-round lot trades, but the effect is not dramatic.

One explanation might be that that a drop in liquidity could actually trigger an algo or human trader to react, and therefore realise trading at lower liquidity level as the drop precipitates the action. Whilst this is evident across both round and odd lot trades the feature particular to round lot trades is trading around more liquid times. This could be due to round lot trades being more prevalent after the inside of the order book has been cleared out, thus trading against the often greater size at the level behind the inside, that is, *greater liquidity but at worse price.*

Conclusions

- Across several futures markets, we find trade-size clustering in round lot sizes.
- Round lot trades appear to have smaller market impact than non-round lot trades.
- This lower impact appears to be because traders issuing round lot trades choose their times of execution differently than non-round lot traders:
  - The liquidity at the point of trading is typically less than that just before or after.
  - Round lot trades tend to occur at times of greater liquidity.
  - This greater liquidity may be at the expense of price.

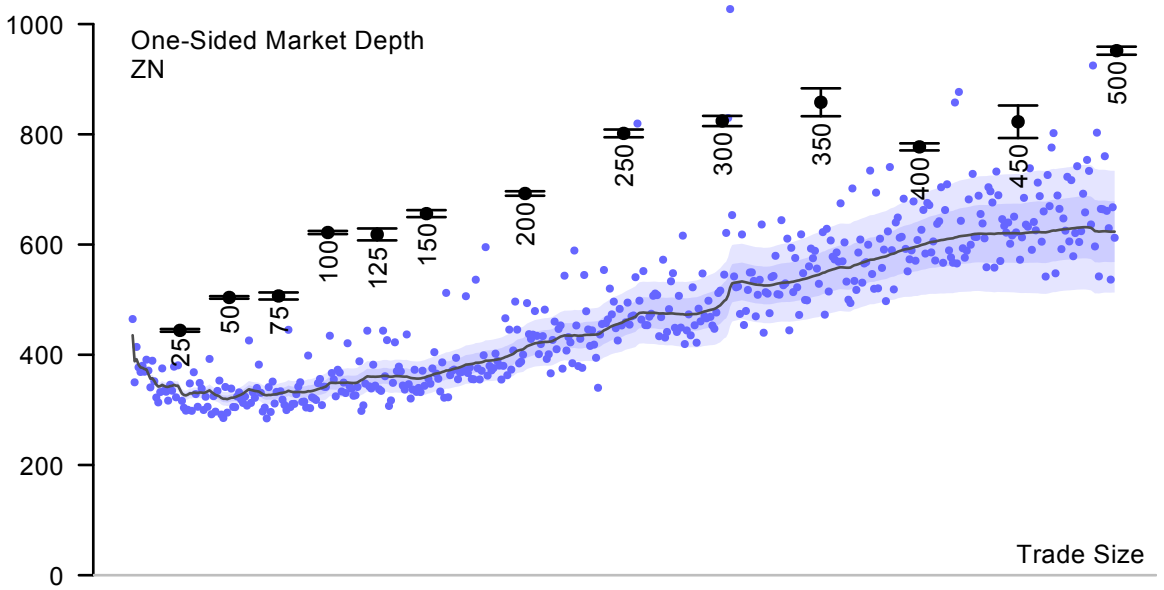

Figure 4: Round lot trades are entered into dramatically deeper markets. Dots show average opposing market depth at trade times within the 30 seconds following trades of different sizes. The higher liquidity that meets round lot trades is a viable explanation of the effect in Figure 2.

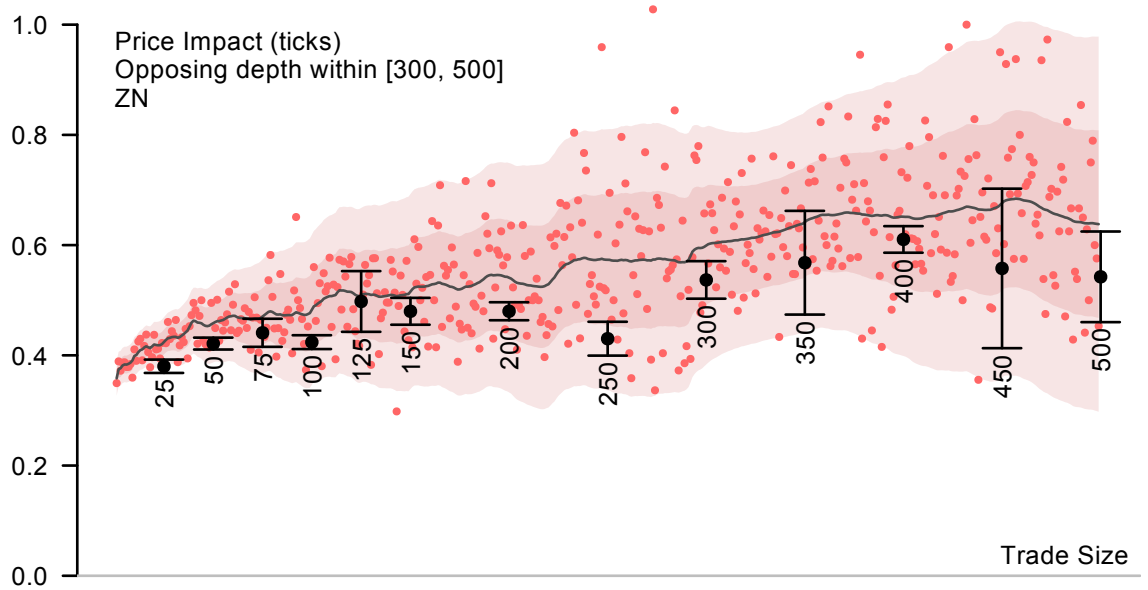

Figure 5: Restricting the range of liquidities we consider greatly reduces the effect of trade roundness on market impact. Dots show the average 30-second price change following trades of different sizes where the depth opposing the trade is between 300 and 500 lots.

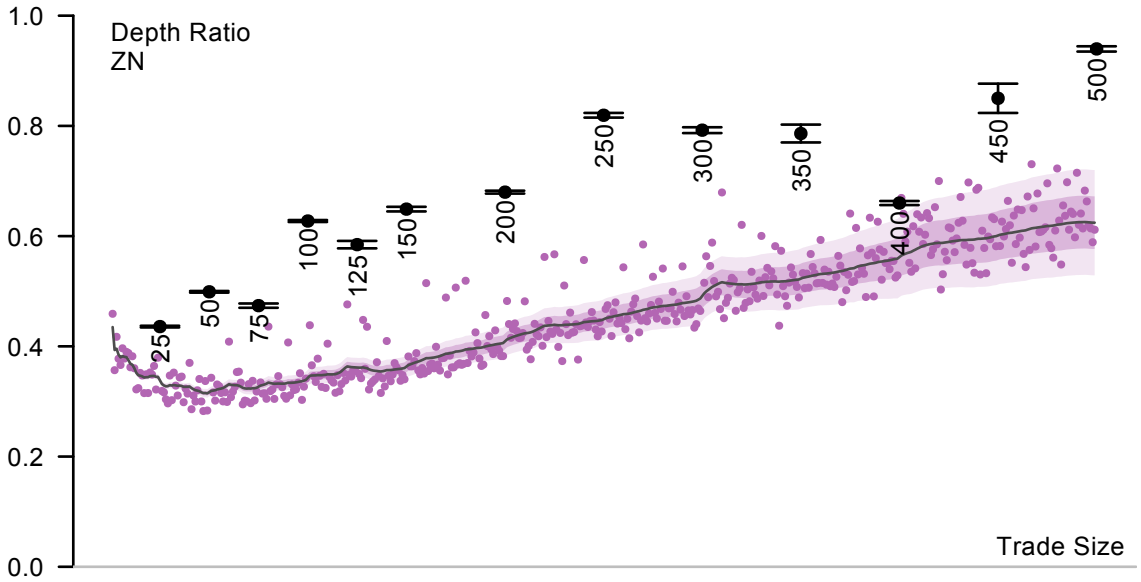

Figure 6: Round lot trades are either more likely to be entered into markets that are only transiently deep, or less likely to be entered into markets that are transiently shallow. Dots show the average ratio between opposing depth at the time of a trade, and the time-weighted average opposing depth for the 1-minute bin centered on the trade. Interestingly, average ratios are less than 1 for all sizes, meaning that the average trade is entered at times of temporarily low liquidity. This may be due to traders acting on quote-imbalance signals, traders following other trades, *etc.*, but it does not affect the conclusion that traders issuing round sizes are reacting differently to liquidity than other traders.