Who benefits from colocation?

Written by Björn Hagströmer, Professor of Finance at Stockholm Business School, Stockholm University

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Fibre-optic cables, microwave networks and now quantum computing – the arms race for trading speed is intertwined with cutting-edge information technology. Observing this development, exchanges quickly identified a product, that despite being strikingly low-tech, no serious contender in the speed race could refuse. The service, known as *colocation*, rests on the idea that a shorter cable yields a faster connection. Allowing trading firms to move their machines into their data centres, exchanges can tap into a larger share of trading firms' budgets, but what are the implications for market quality? This short paper reviews academic evidence on the market quality effects of colocation.

All major exchanges now offer trading firms the opportunity to rent server space in their data centres. The service includes basic features such as server cages, electricity, maintenance, and safety installations, but the real treat is fast access to the exchange's matching engine. By placing their machines as close to the exchange as possible, the trading firms can ensure that they are the first to access and react to information generated in the trading system.

In an academic study, which I co-authored with Jonathan Brogaard (University of Utah), Lars Nordén (Stockholm University), and Ryan Riordan (Queens University), we show that an upgrade to the colocation service at Nasdaq Nordic led to improved market liquidity. The difference between the best buy and sell prices, the bid-ask spread, was reduced by 2%. At the same time, the volumes available to trade at those prices increased by 8%. The trading volume required to change the price by 0.5%, in either direction, increased by the same magnitude. In short, the accessible liquidity improved significantly, for small as well as large participants.

How can the causality of such a result be verified? After all, liquidity fluctuates for many other reasons than changes in the market structure, most prominently due to changes in market volatility. In natural sciences, the causal effect of an event can be identified by the use of controlled experiments. In medicine, for example, the effect of a new treatment is identified by benchmarking the results to those of a control group, where the patients are given a sugar pill.

Researchers of financial markets typically do not have the luxury of controlled experiments, but in the case of the Nasdaq Nordic colocation upgrade, a natural control group was available. Nasdaq Nordic also operates a derivatives market, which happened to be unaffected by the change in colocation services. Absent the colocation upgrade, equity index futures traded in the derivatives market should be subject to the same liquidity and volatility fluctuations as the underlying stocks traded in the equity market. We find that the liquidity improvements in the equity market are not mirrored in the placebo group, the index futures market. Based on this, it can be concluded that the liquidity effects observed in the equity market are due to the speed upgrade.

The liquidity result presented above holds on average, but what is the effect for investors who do not pay up for the premium connections? Buy-side investors frequently voice concerns that ever-faster financial markets tilt the playing field to the disadvantage of slow investors. Given the secrecy of trading data, questions regarding such redistribution are often left to speculation.

In this case, however, Nasdaq Nordic lifted the veil of secrecy. For the purpose of our study, the exchange allowed us to analyse the order book activities of each individual trading firm. In addition,

we were granted access to the list of trading entities that subscribed to the fastest colocation service. These unique data allowed us to analyse the underlying economics of the liquidity improvement.

The data reveal that the trading entities that subscribe to the fastest colocation service are those who tend to offer liquidity at the best bid and ask prices, and that actively manage their inventory to minimise their exposure to portfolio risk. These characteristics fit the description of modern market makers, whereas they are inconsistent with the predatory strategies often associated with fast algorithmic trading.

The finding that the colocation upgrade primarily benefits the market making firms is also consistent with the market quality result. If the colocation service facilitates liquidity provision, the firms can afford to quote tighter bid-ask spreads and to commit to trade larger volumes.

If market makers continuously post tighter bid-ask spreads, the benefit should also trickle down to slower investors. Indeed, we find that the cost of trading fell for the participants who did not pay for colocation. The magnitude of the effect was on par with the market average.

So does all this mean that buy-side investors can lean back and relax as proprietary trading firms continue their trading speed race? Not quite. It is important to note that different technologies have diverging impacts. For example, the first microwave links between New York and Chicago (which were up to 30% faster than the straight fibreoptic cable described in Michael Lewis' bestselling book *Flash Boys*), offered a small set of trading firms exclusive access to its signal. An academic study by Andriy Shkilko (Wilfried Laurier University) and Konstantin Sokolov (University of Memphis) shows that this type of speed advantage was detrimental to market quality.

To understand the diverging results, one needs to study the competition among fast traders. In modern markets, the bid-ask spread is under constant attack. Ultrafast market makers monitor order flow closely and update their prices instantly when sentiment changes. They are challenged by arbitrageurs, who specialise in spotting price differences between trading venues and closely related instruments. Whenever they manage to profit from such differences, the market makers lose money. The relative speed between the market makers and the arbitrageurs determine how often that happens.

The colocation upgrade at Nasdaq Nordic was adopted by market makers, who then became better able to compete with the arbitrageurs. They could then quote tighter bid-ask spreads. The microwave network, in contrast, was utilised primarily by arbitrageurs. It gave them a head start in the race to trade on price differences between equities and ETFs in New York and equity index futures in Chicago, which resulted in that market makers had to widen their spreads to cover their losses.

Another difference between the two types of speed improvements is how widely they are offered. Colocation services are available to everyone who is willing to pay the subscription fee. In the case of Nasdaq Nordic, 12 trading firms signed up. The microwave networks discussed above were initially accessed by only a small set of firms, as the bandwidth was highly limited. When microwave-transmitted signals were later made available to a broader clientele, the negative effects on liquidity were reversed, according to the study by Shkilko and Sokolov.

In conclusion, the effects of trading speed on market quality depends on the nature of the innovation. If it can be widely adopted and is made attractive to market makers, it is also likely to improve the liquidity accessible to buy-side investors.