QUANTICA | QUARTERLY *Insights*

Crisis liquidity

An analysis on how the COVID-19 crisis has impacted liquidity and trading costs across the most liquid futures markets

#2 – 29 June 2020

The unprecedented surge in volatility across asset classes witnessed during the first quarter in 2020 has been accompanied by an unparalleled change in market liquidity across a variety of financial markets, including cash equity markets and global futures markets. In this note, we quantify and visualize the liquidity dynamics at aggregate asset class and individual market level via different metrics for the period from January to May 2020. Based on a universe of 45 of the most liquid futures contracts traded in the US and Europe, we highlight how the COVID-19 crisis has reshaped the liquidity landscape across equities, bonds, FX and commodities markets. Additionally, we group futures into eight buckets based on their asset class and regional belonging, and we quantify the deterioration in liquidity conditions from end of February onwards for each of these futures' buckets. We also shed some light on the dispersion of each metric within each bucket. Where a corresponding liquid underlying cash market exists, we also provide a comparative analysis of such metrics between the futures and the cash market. Finally, we highlight that a deterioration in liquidity does not necessarily lead to increased trading costs in a strategy implementation context. Analyzing real trading and execution data from our Quantica Managed Futures Program (QMF Program), we show that, while average price market impact across the universe of futures increased during the crisis, the cost of trading one unit of risk actually diminished during the same time period.

Introduction: Quantifying market liquidity

Liquidity is often described as the ability to transact at a reasonable cost across a variety of market conditions. Market liquidity can be measured in many different ways. In this note, we rely on a list of commonly used measures of liquidity[1], as introduced and defined in Table 1:

Liquidity metric	Definition
Daily traded volume	The number of contracts traded over the entire trading day.
Intraday price volatility	The square root of the sum of squared 30-minute returns (log changes in mid-point prices and annualized by square-root of 250).
Average daily bid-offer spread	The average spread between bid and ask at the top level of the order book relative to the average mid-price over each 30-minute interval of the trading day, weighted by the average percent of daily volume traded in each 30-minute interval.
Average daily available bid-offer size	The average number of contracts available on both the bid and the ask at the top level of the order book over each 30-minute interval of the trading day, weighted by the average percent of daily volume traded in each 30-minute interval.

Table 1: Overview and definition of liquidity metrics.

Each of these liquidity metrics are estimated at various sample frequencies based on the intraday trade, bid and ask tick-by-tick history of each individual contract. For any futures contract and any given day we only consider the front month or most actively traded contract for such estimation. Calendar spread trades are excluded for the purpose of this note.

As we aim at highlighting the impact of the recent COVID-19 crisis on the liquidity of the most widely traded futures and cash markets globally, our analysis focuses on the short time period spanning from January 2020 to May 2020. Specifically, we aim at quantifying the average change for each liquidity metric between the low-volatility period from January 1st to February 21st, the high-volatility crisis period from February 24th to March 30th, and the recovery period from April 1st to May 22nd at individual contract and on aggregate asset class and regional level. The dispersion of such metrics within asset classes and regions is also illustrated.

The change in liquidity conditions of the S&P 500 e-mini futures

In order to help contextualize market liquidity dynamics in light of the recent volatility surge observed in early 2020, we illustrate the above metrics for the S&P 500 e-mini futures. With an average daily traded notional amount of more than USD 250 billion, the S&P 500 e-mini futures is the most traded futures contract globally, tracking one of the most widely followed financial gauge, the S&P 500 index.

[1] We deliberately do not include order book depth, another widely used measure of liquidity.

Figure 1 provides an overview of the four liquidity measures between January 1st and May 22nd 2020. Traded volume, bid-offer spread and sizes are normalized with their average value estimated over the calm period from January 1st to February 21st 2020, and are expressed in percentages of this reference average value.

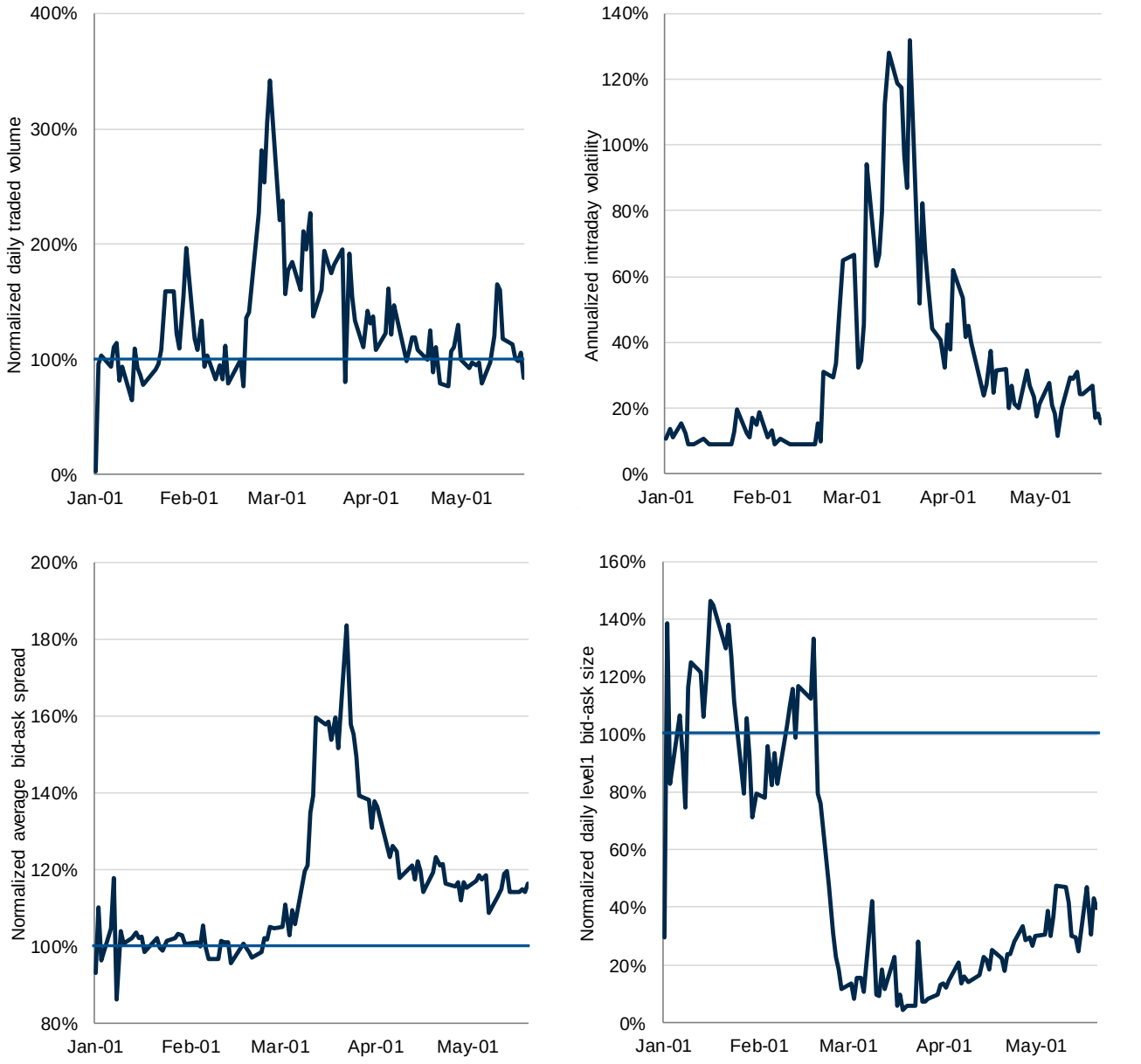

Figure 1: Overview of the four liquidity measures between January 1st and May 22nd 2020 for the S&P 500 e-mini future. Daily traded volume, average bid-ask spread and daily level1 bid-ask size are normalized with their average value estimated over the calm period from January 1st to February 21st 2020, and are expressed in percent of this reference average value.

The spike in volatility (with the intraday metric peaking at above 100% in mid-March) was accompanied by a sharp increase in traded volume, with the number of traded contracts nearly doubling during the first two weeks of the crisis, and a significant increase of bid-ask spreads. Both metrics quickly returned to pre-crisis levels from mid-March onwards. On the other hand, the average available bid-ask size at the top level of the order book sharply declined during the early days of the crisis, to quickly reach only 20% of the typically available levels before the crisis, and unlike the bid-ask spread, it did not recover from these ultra-low levels until May. At the end of April, still only one third of the usual pre-crisis liquidity size was bid or offered at the top of the order book for the S&P 500 e-mini futures.

Given the striking shift in liquidity dynamics for the futures market, it is worth drawing a comparison with the cash market.

Comparing S&P 500 futures versus cash market liquidity

The cash-trading alternative to the S&P 500 e-mini futures is the SPDR S&P 500 ETF Trust (SPY), which is the most liquid ETF globally. It trades an average notional amount of USD 20 billion a day under normal market conditions, notably only about 10% of its futures counterpart. Figure 2 shows the average bid-ask spread and available bid-ask size for the SPY S&P 500 ETF, both normalized with their respective pre-crisis averages, i.e. average bid-ask spread and available size from January 1st to February 21st. The metrics for the e-mini futures, introduced earlier, are included for comparison purposes.

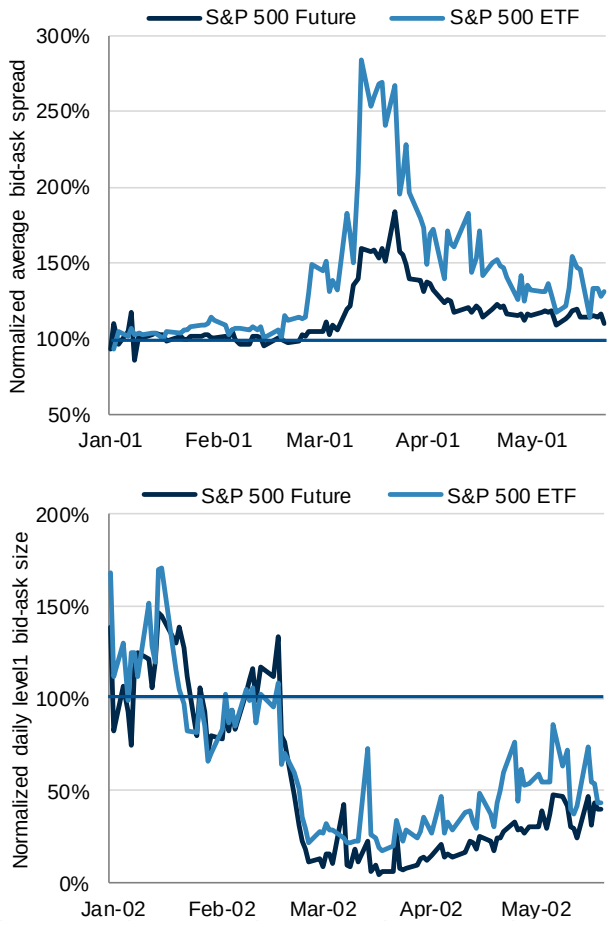

Figure 2: Average bid-ask spread and available bid-ask size for the SPY S&P 500 ETF, normalized with respective pre-crisis averages, i.e. average bid-ask spread and available size, from January 1st to February 21st. The metrics for the S&P 500 e-mini futures are added for comparison purposes.

The deterioration in average bid-ask spread throughout March was more meaningful for the S&P 500 ETF than for the e-mini futures, with the average bid-ask spread increasing by 50% to 100% versus average pre-crisis levels for the e-mini futures compared to an increase of 100% to 150% for the ETF, despite a more than five-fold surge in average daily number of contracts traded over the same period. Similarly, liquidity deterioration was most visible when looking at the available top-of-the-book sizes. These dropped similarly by approximately 80% and had not yet recovered to pre-crisis levels at the end of May. Overall, we conclude that liquidity in the futures markets held up slightly better than in the respective cash markets.

Illustrating liquidity dynamics for equity index, government bond, FX and commodity futures

In order to generalize this analysis across a broader range of markets, we introduce a universe of 45 of the most liquid futures contracts across equities, bonds, FX and commodities markets in the US and Europe. These futures all form an integral part of Quantica's actively traded investment universe.

For the sake of readability, we will focus on analyzing changes in liquidity conditions at an aggregate level. We group the universe into eight distinct buckets of similar futures contracts based on asset class and regional belonging, as outlined in Table 2.

#	Bucket name	# contracts	List of future contracts	Equivalent cash market
1	Equities US	4	ES, NQ, DM, RTY	SPY
2	Equities Europe	7	VG, GX, CF, Z, SM, EO, QC	
3	Bonds US	5	TY, TU, FV, US, WN	TLT
4	Bonds Europe	7	RX, DU, OE, G, UB, IK, OAT	
5	FX G7	6	EC, BP, SF1, CD, JY, AD	
6	Commodities – Energies	5	CL, CO, HO, XB, QS	USO
7	Commodities – Metals	4	GC, HG, SI, PL	GLD
8	Commodities – Agriculturals	7	C, W, S, LC, LH, SB, KC	

Table 2: Overview of different futures buckets, grouped by asset class and regional belonging.

Before looking further into aggregate liquidity metrics across buckets, we provide, with Figure 3, an overview of the relative change in average number of contracts traded per day during the peak of the COVID-19 crisis versus the beginning of the year until February 21st.

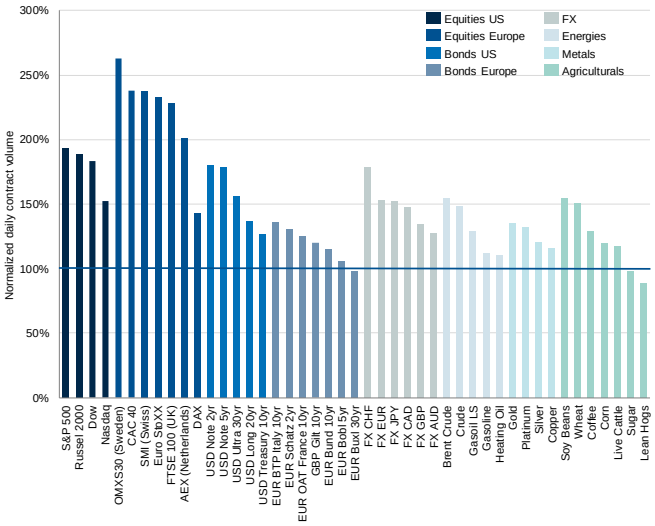

Figure 3: Average daily traded number of contracts in March divided by the average daily traded number of contracts for the period January 1st - February 21st for each of the 45 futures contracts. Contracts are grouped by bucket (see Table 2), and ranked in descending order of traded volume within each bucket.

The average number of traded contracts during the month of March increased across all markets (with the exception of Lean Hogs, Sugar and the 30yr German Govt Bond) and asset classes. The increase in volume was most significant in European equity futures, where all contracts more than doubled their average daily volume with the exception of the DAX, followed by their US counterparts, the 2yr and 5yr US notes and the CHF FX future. A first and important take-away is that the COVID-19 crisis led to a significant increase in trading activity and liquidity supply across all of the most liquid global futures markets.

Figure 4a depicts a complementary view to Figure 3 and the distribution of traded volume across bucket constituents for each bucket and for each of the three distinct periods under consideration. The data for each contract is again normalized to its average over the calm period spanning from the beginning of the year until February 21st. The increase in volume was significant across all asset classes in March, but reverted back to below pre-crisis volumes in April and May.

Figures 4a-d show the distribution of the four liquidity metrics (traded volume, bid-ask spread, available size, intraday volatility) across constituents for all buckets and each of the three distinct periods under consideration.

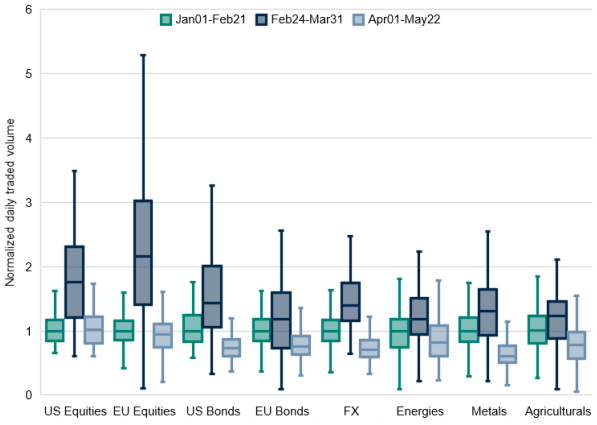

Figure 4a: Distribution of traded volume by bucket for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

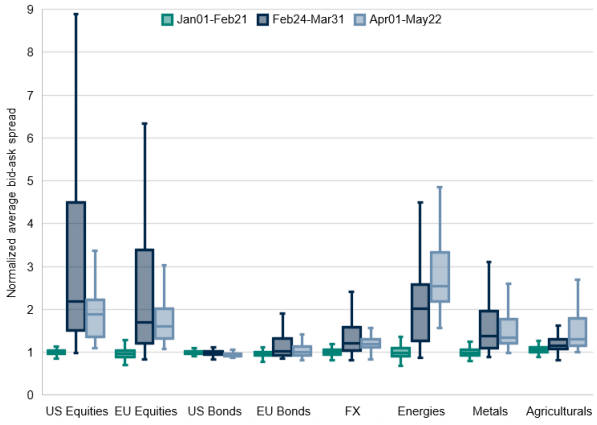

Figure 4b: Average bid-ask spreads by bucket for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

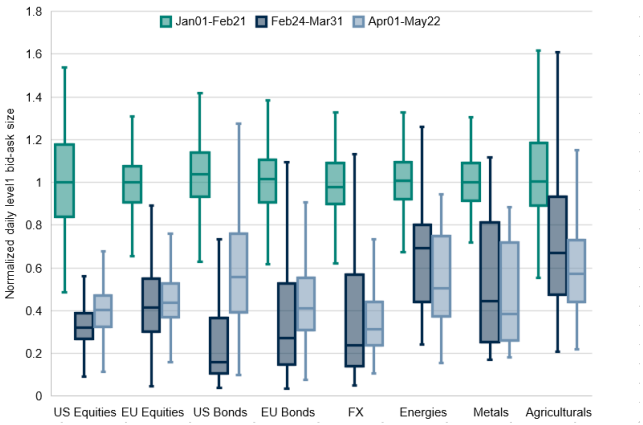

Figure 4c: Average top-of-the-book bid-ask size by bucket for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

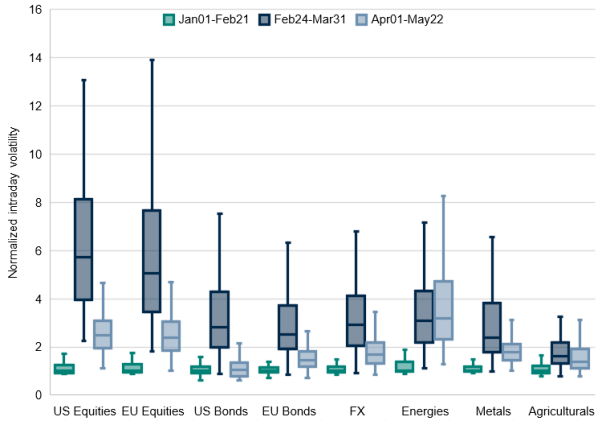

Figure 4d: Intraday volatility by bucket for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

Figures 4b, 4c & 4d confirm our earlier observations made on the example of the S&P 500 e-mini futures and cash markets: average bid-ask spreads increased and top-of-the-book sizes decreased across asset classes and regions. Additionally, the dispersion within an individual bucket can be significant. While the S&P 500 e-mini futures saw an average increase of its bid-ask spread by 50%, its other US equity index counterparts, the Nasdaq, Dow Jones and Russell 2000 futures, saw their bid-ask spreads explode by four to eight times during the same time interval. The European equity bucket was prone to a similar, relatively high dispersion, with the Eurostoxx 50 showing by far the smallest increase in bid-ask spreads compared to all other European index futures[2]. Both increase and dispersion in bid-ask spreads were similarly elevated in the energy markets. However, it is worth putting this into perspective within the massive volatility spike observed within the energy complex during the months of March and April, when intraday volatility peaked at 200% for certain contracts. The only markets that did not see their bid-ask spreads move materially higher were both the European and US bond futures with average bid-offer spreads remaining tight throughout the crisis.

The biggest shift, however, concerns again the average available size offered at the top of the order book. That average available size has dropped consistently and significantly across all buckets and markets by 50% to 80% between January - February and March - May. The drop was most significant across equity and bond futures, while more moderate in some of the commodity markets. Additional analysis shows that, while most US and European bond contracts have recovered up to 80% of pre-crisis levels at the end of May, equities, FX and energy markets remain significantly below pre-crisis top-level liquidity sizes.

Futures versus cash markets

The drop in available quotes at the top of the order book was not restricted to futures markets. Figure 5 provides a comparative overview of four markets (S&P 500, 20-year US Treasury rates, Gold and Crude Oil) for which a highly liquid future contract as well as a highly liquid cash ETF co-exist. As can be seen from this chart, available bid-offer sizes in cash markets followed a very similar pattern to their futures counterparts.

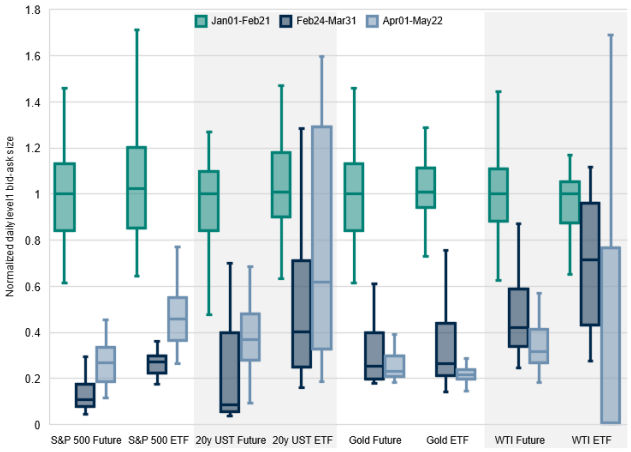

Figure 5: Overview of four key markets comparing normalized average top-of-the-book bid-ask sizes of futures contracts and their respectively comparable cash ETFs for the three distinct periods under consideration.

In summary, both the bid-offer spread and the bid-offer size metric do offer a complementary view on prevailing market liquidity conditions. The significant shift in liquidity conditions outlined above is most relevant to any strategy dealing in these markets, such as Quantica's QMF Program. Beyond the simple observation of liquidity conditions, a key consideration is to understand whether the deterioration of liquidity is actually accompanied with a deterioration of trading costs. Indeed liquidity and trading costs are not necessarily the same concepts, as we further outline below.

Trading costs measured as bid-ask spread per unit of risk

The trading cost associated with an exchange-traded security is a function of the average bid-offer spread and the depth of the order book for that contract: the higher the bid-ask spread and the less contracts bid or offered at the top of the book, the higher the cost for buying or selling such contract.

At the same time, when looking at trading costs, one should also take into account the volatility associated

[2] More specific data is available upon request.

with investing into such contract. By way of illustration, we consider the following two hypothetical contracts:

- One contract displaying an average bid-ask spread of USD 1 and daily volatility of USD 10 / contract
- Another one displaying an average bid-ask spread of USD 2, and daily volatility of USD 40 / contract

For every dollar of volatility exposure, the first contract will cost 10 cents (1 / 10), while the second contract will cost only 5 cents (2 / 40). The second contract appears to be less liquid than the first one (due to an average bid-ask spread that is twice as high). However, in a risk-based investment strategy context, it is less expensive to trade it, as the upside offered by the higher volatility more than offsets the higher bid-ask spread.

Following this rationale, we introduce a "liquidity-to-risk" measure for a security defined as the ratio of its average daily bid-offer spread to its intraday volatility, with bid-ask spread and volatility as shown in Table 1. Figure 6 illustrates the distribution of this liquidity to risk measure for each of the eight buckets before and during the COVID-19 crisis.

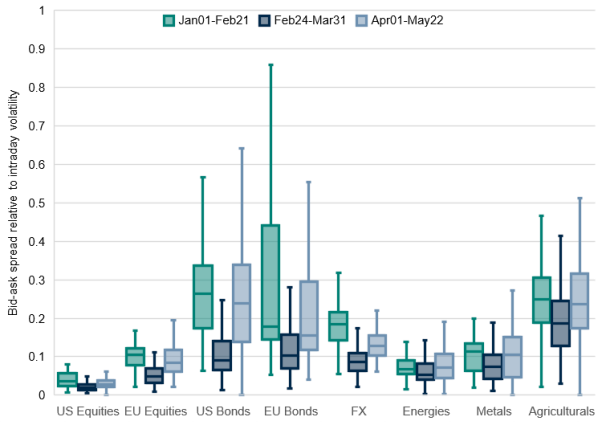

Figure 6: Average bid-ask spread normalized by volatility across all buckets and for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

Figure 6 shows that – at least from a normalized bid-ask spread perspective – the deterioration in liquidity across all buckets in March was over-compensated by the increase in volatility observed over the same period. In other words, while the cost of trading increased, the additional costs were more than offset by the additional investment opportunities that came along with significantly higher volatility. From a risk-based investment approach, trading cost to execute a certain amount of Value at Risk into a portfolio actually decreased during the COVID-19 crisis. One might conclude that liquidity actually increased during the crisis from a risk-based trading cost viewpoint.

Similarly, with volatility coming back off its peak during April and May, the bid-ask spread-to-risk metric increased back to levels that were comparable to the levels observed before the crisis broke out.

Trading costs measured as bid-offer size by risk

The same reasoning can be applied to the available bid-offer size. We argue that a lower quoted bid-offer size is not necessarily an indication of increased trading costs. Like with spreads, quoted bid-offer sizes should be evaluated in relation to intraday volatility levels. Indeed, a market maker's position sizing should be more or less proportional to the prevailing intraday market risk. As volatility moves higher, market makers will likely adjust their positions by reducing quoted sizes, in order to remain within their risk constraints.

We show the product of the bid-offer size by intraday volatility across all buckets and for the same three time periods as below in Figure 7. For the equity and energy buckets, this metric notably increased during March, meaning that the amount of available risk to trade per quoted contract increased. Like the spread-to-volatility metric, the size-by-volatility metric for US and European futures has reverted on average back to pre-crisis levels at the end of May. While equity bid-offer sizes remain far below their pre-crisis levels, because of the still elevated equity market volatility, the cost to trade a certain amount of equity risk has not deteriorated this year. It actually improved during the crisis. In the energy complex, available quote sizes still give access to a greater amount of traded risk compared to before the crisis.

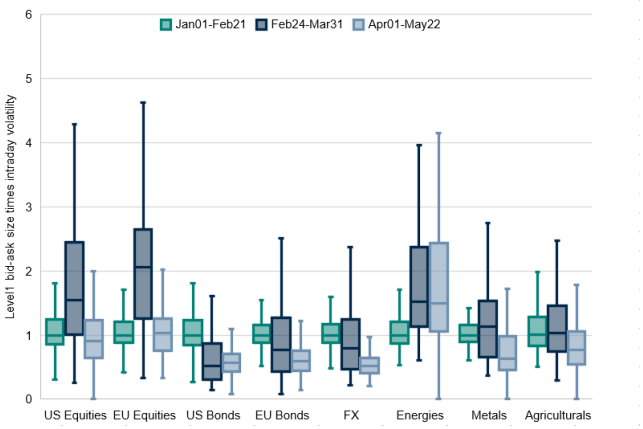

Figure 7: Average bid-ask size times intraday volatility across all buckets and for each of the three distinct periods under consideration; data for each contract is normalized to pre-crisis averages from January 1st to February 21st.

Figure 7 also highlights that, from the perspective of this size-by-risk metric, bond markets remain a notable exception amongst the various buckets: Trading costs were largely higher between March and May compared to the period between January and February. This

means that, unlike for most other futures markets, the amount of tradable risk available at the top of the order book has decreased for most bond futures between the end of February and May.

Trading costs measured as market impact or realized arrival slippage

We conclude this note by presenting an empirical way of quantifying trading costs. Unlike the top-of-the-book bid-offer spread and sizes, which are estimated from publicly available market data, market impact – or the difference between the signal or arrival price of an order and its average executed price – can only be inferred from actual trading activity on such markets. To measure empirical market impact requires a relatively large number of actual orders, which makes a 'real-time' daily estimate close to impossible. In order to get a view on how market impact evolved throughout the crisis, we analyze Quantica's proprietary trade execution database and the more than 2'000 trades actually executed between January 1st and May 22nd 2020.

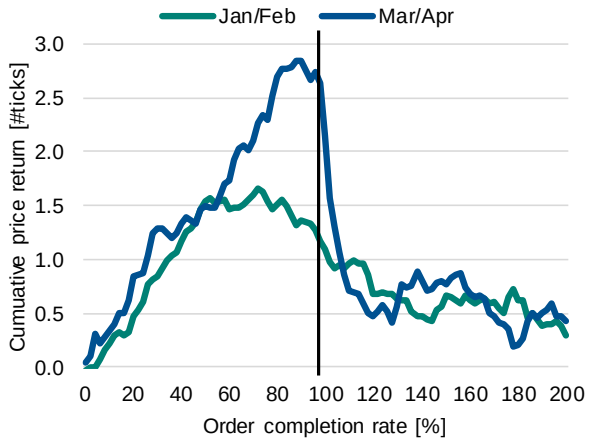

Figure 8: Average signed cumulative price return expressed in number of ticks across all buy and sell orders from the entry time of an order until the full completion of such order (0% - 100%) and for an additional period equal to the duration of completing the order (100% - 200%). Two periods are shown: 1 January 1st - February 21st 2020 and February 24th - May 22nd 2020.
Source: Quantica/Bloomberg.

We are interested in measuring the average cumulative price return per contract expressed in number of ticks across all buy and sell orders (across all 45 futures contracts previously introduced) from the entry time of an order until the full completion of such order (0% - 100%) and for an additional period equal to the duration of completing the order (100% - 200%). Figure 8 provides such analysis for the period from January 1st to February 21st, and for the period from February 24th to May 22nd. More granular analyses by buckets and participation rates are beyond the scope of this note.

Given the reduced order book depth identified previously across all asset classes, the average market impact per contract measured during the crisis months has been materially higher (approximately twice as high) compared to the pre-crisis average impact of 1 tick. However, this number needs to be put into context of a much higher volatility environment. The risk exposure gained from buying or selling one lot of such security is materially higher compared to before the COVID-19 crisis.

Interestingly, the typical post-trade mean-reversion following the completion of an order was not materially different between both time periods considered.

Finally, it is worth putting these numbers into perspective. By converting the impact of each individual order into dollars (thus accounting for the size of each order) and aggregating the dollar impact of all orders for March 2020, we obtain an implied drag on the QMF Program's portfolio performance amounting to a modest 6bps for the full month! This figure seems surprisingly low, notably for a month that saw one of the most significant portfolio rebalancing as a result of one of the biggest market turmoil experienced since the inception of the strategy in 2005. The trading volume during the crisis period was increased by a factor of 2.5 compared to the low volatility period up to February 21st. These figures impressively confirm our general findings that the global futures markets provided significant 'crisis liquidity'. Trend-following CTAs focusing on the most liquid futures markets, such as Quantica, were able to effectively implement their systematic strategies even during this extremely stressed crisis period.

Conclusion

The COVID-19 crisis has led to seismic shifts in liquidity conditions across futures and cash markets, asset classes and regions. The massive volatility spike in March 2020 led to a sharp deterioration in liquidity, best captured by sizeable declines of up to 80% in the average available number of contracts bid or offered at the top of the order book of a number of the most widely traded futures markets globally. Nonetheless, despite this significant drop in order book depth and the increase in bid-offer spreads, the average market impact incurred by a strategy trading a universe of 45 of the most liquid futures in the US and in Europe only increased by a factor of 2. This is to be put into perspective with the decrease in cost of trading one unit of risk for most futures markets over the same time-interval due to the heightened volatility.

Trend-following CTA strategies focusing on a broadly diversified universe composed of the most liquid futures contracts across major asset classes offer the advantage of liquidity, capacity and transparency to investors. Such attributes are valuable in times of increased market stress and volatility. We showed that futures markets offered sufficient and substantial liquidity, even in those times of extreme stress and heightened volatility, to absorb the additional portfolio turnover without incurring significantly higher market impact costs.

Since 2003, Quantica Capital's mission has been to design and implement the best possible systematic trend-following investment products in highly liquid, global markets.

To the benefit of our investors and all our stakeholders.

Disclaimer

Contact us

Quantica Capital AG
Freier Platz 10
8200 Schaffhausen
Switzerland

T +41 44 556 69 00
F +41 44 556 69 01
info@quantica-capital.com