LIBOR, Foreign Exchange and the Illusion of Liquidity

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ABSTRACT

The LIBOR and FX controversies revealed that prices and benchmarks related to money and currencies were highly susceptible to manipulative and collusive practices. The reform process since has strived to ensure that market participants and end-users can rely on a fair price determination process. Put differently, the emphasis has been on the price-aspects of LIBOR and FX. However, when studying market liquidity, the price always needs to be put into a broader context. This article uses two case studies to illustrate how ignoring other dimensions of market liquidity, such as volume and speed, can result in misleading assessments of the state of the market. At worst, it can lead to, and perhaps even sustain, an illusion of liquidity. This is of particular relevance for OTC markets, which ultimately depend on human relationships and trust.

Keywords: LIBOR, foreign exchange, high-frequency trading, liquidity, regulation

INTRODUCTION

Prior to the discovery of manipulative and collusive practices related to LIBOR (London Interbank Offered Rate) and in foreign exchange (FX) markets, most observers viewed these benchmarks and markets as well-functioning. Why question the robustness of a benchmark underpinning derivatives contracts amounting to hundreds of trillions of U.S. dollars, or, in the case of FX, a market with a daily turnover of more than $5 trillion?[1] Such perceptions, however, turned out to be misplaced. Instead, a widespread culture of misconduct was discovered, which resulted in a number of regulatory settlements, lawsuits and criminal proceedings.

An array of changes has been introduced since – ranging from stricter regulation to enhanced compliance procedures within banks. In short, the 'scandals' acted as triggers to inject markets and benchmarks related to money and currencies with greater professionalism. After all, market participants and end-users ought to be able to expect a fair and robust process in the generation of prices and benchmarks.

Put differently, the emphasis in this process has to make *prices* in FX markets less prone to abuse. The same logic has been applied to LIBOR and other benchmarks, in the way they are used as *prices*. However, although the price-element of a market is essential, it is far from everything. Crucially, when studying the liquidity of a market, prices have to be put into a broader context. Recent anecdotal evidence from trading floors illustrates this. A comment from a money market trader that "LIBOR is just a made-up number" does not suggest that the benchmark continues to be manipulated. It does, however, seriously question the underlying liquidity of the market, which LIBOR is supposed to reflect. A remark by an FX spot trader that "the market moves as soon as you *try* to deal" should not be understood as if someone has shared confidential information that could result in front-running of limit orders. Instead, it suggests that the rise of algorithmic trading has transformed the way human traders assess market liquidity.

This article uses two case studies to illustrate why it is necessary to go beyond the standard focus on price and price-based liquidity.

THE FIXATION ON PRICE-BASED LIQUIDITY

There are many definitions of market liquidity. However, the most widely known is probably that by Kyle (1985), who approaches market liquidity from three dimensions[2]:

- *Price* (how much does it cost to turn around a position over a short period of time?)
- *Volume* (how much can be bought and sold without moving the price?)
- *Speed* (how long does it take for the price to recover after a "shock"?).

In a liquid market, therefore, transactions costs are low even for relatively large quantities. What is more, market-moving transactions are less likely to have a lasting impact on the price.

Of these, the price-dimension, typically proxied by the bid-ask spread, is the by far most popular measurement of market liquidity.[3] This is logical. In standard Economics and Finance theory, price rather than quantity (let alone speed or time) tends to be the key focal point when studying markets and voluntary exchange. Data availability is also important. In most financial markets, there is an abundance of tradable or indicative price quotes. Detailed and frequent information regarding actual transactions or limit order volume, however, is much more difficult to obtain. This is particularly true in over-the-counter (OTC) markets, such as FX, money or derivatives markets linked to these. Consequently, end-users and other observers often have to rely on indicative price quotes rather than firm and transparent submissions on exchanges and electronic trading platforms. These then form the basis for creating a proxy for market liquidity.

Financial benchmarks like LIBOR or the WM/Reuters 4 p.m. fix are also treated as 'prices', although they are not assets that can be bought or sold. The Financial Services Act 2012 defines a benchmark as an 'index, rate or price that is determined from time to time by reference to the state of the market […]'.[4] Here, too, the emphasis lies on the price-like element of financial benchmarks. The state of the market and the relevant time are necessary ingredients but remain secondary to the

index, rate or price that is being generated. For instance, the LIBOR fixing mechanism is a process whereby banks are asked to submit rates according to the following criteria: 'At what rate could you borrow funds, where you to do so by asking for and then accepting interbank offers in a reasonable market size just prior to 11 am?' [5] The individual LIBOR submissions are subjectively chosen and not necessarily interest rates at which transactions have taken place. Nonetheless, the LIBOR question highlights that the price (i.e. the interest rate) is the critical aspect. It is neither the volume ('reasonable market size') nor the time when this price is determined ('just prior to 11 am'). The emphasis on the price is similar for EURIBOR (Euro Interbank Offered Rate), TIBOR (Tokyo Interbank Offered Rate) and other money market benchmarks.

The LIBOR investigations, and the subsequent regularly reform process did not result in a change of the definition of LIBOR. Instead, strict regulation and supervision were introduced to ensure the benchmark, as a *price*, became less susceptible to manipulation. This is not surprising. After all, central to the controversy was the impact LIBOR 'prices' had on other prices, such as LIBOR-indexed derivatives, bonds, corporate loans etc.

In 2014, more than a handful of global banks were fined for their manipulative and collusive practices in FX markets.[6] A significant portion (but by no means all) of the misconduct related to the world's most widely used FX benchmark: the WM/Reuters 4 p.m. fix. In contrast to LIBOR, the WM/Reuters 4 p.m. fix is based on actual trading by market participants just before and after the time of fixing (the 'fixing window').[7] A rule change in February 2015 involved a widening of the fixing window from one minute to five minutes. In addition, a broader range of price sources is now used to generate the benchmark. Designed to act as a snapshot of the state of the market at a specific time of the day, subsequent reforms to the benchmark generation process have followed a similar logic to that of LIBOR. The focus has been on ensuring that the price outcome is fair, robust and professionally determined. Whether the market – in its broader sense – is liquid or not has received considerably less attention.

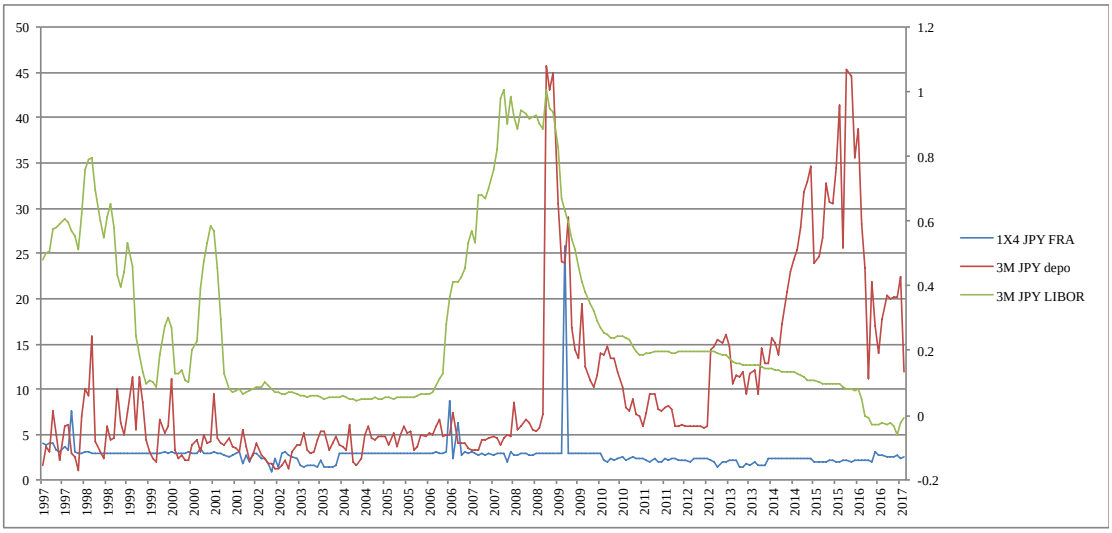
Prices are, of course, crucial, and so are price-based measures of liquidity. However, as market makers know, all three forms of market liquidity are important – and they are often inseparable. Therefore, disregarding the aspects of volume and speed can result in misleading assessments of the actual liquidity in the market. At worst, it can lead to, and perhaps even sustain, an *illusion* of liquidity. This may have implications for the generation of benchmarks, which, in turn, affect other prices across the financial sector and other parts of the economy. To illustrate this process, let us study two examples drawn from LIBOR and FX, respectively.

THE ILLUSION OF LIBOR LIQUIDITY

At the outset, it is very challenging for end-users of LIBOR to assess whether the underlying market – that for unsecured term lending to banks – is liquid or not. In contrast to, say, stock purchases, bank transactions are not transparent in the sense that the activity of market participants can be scrutinised on a daily basis. Furthermore, due to the significant amount of credit risk involved in unsecured transactions, money market trading is less suitable for electronic trading platforms. As a consequence, the most readily observable liquidity indicator for the underlying market remains the indicative bid-ask spread for interbank deposits quoted on Reuters or Bloomberg screens. Although indicative prices often deviate from actual prices, the reputational damage resulting from consistently updating off-market quotes should make them serve as sufficient approximations.[8] In the long run, a tight spread indicates that the market is competitive, whereas a wide spread suggests that the market is relatively illiquid.

The 3-month Japanese yen LIBOR serves as a good example. The benchmark has been remarkably low and stable (ranging from approximately 0% to 1%) for almost a whole generation as a result of the low inflation environment that has existed since the Japanese banking crisis in the 1990s.

Figure 1: 3-month JPY LIBOR (RHS, %) and indicative bid-ask spreads (LHS, basis points) 09.01.1997–16.02.2017



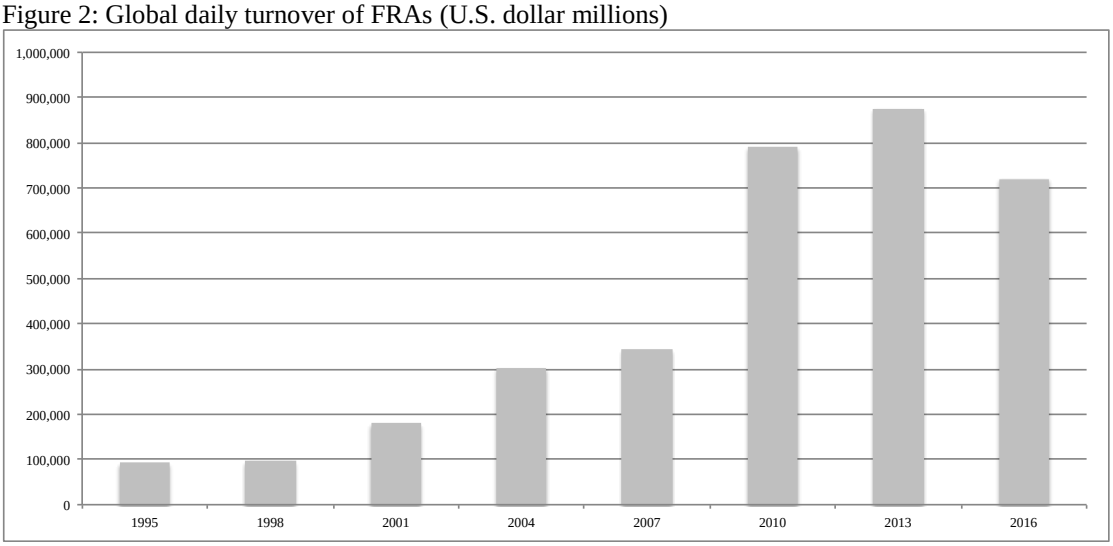
Sources: Bloomberg, Federal Reserve Bank of St. Louis and author's calculations. Notes: monthly 20-day moving averages. Deposits = average of Tokyo, London and New York close.

Figure 1 shows indicative 3-month bid-ask spreads in the Japanese yen market from 1997 to 2017.[9] Studying interbank deposits, we can see that the bid-ask spread gradually narrowed after the Japanese banking crisis and stayed at around five basis points until 2007. The financial crisis of 2007-08 then resulted in a sharp increase of the spread, consistent with the freeze in the money markets for major currencies. Following extraordinary liquidity injections by the central banks across the world, including the Bank of Japan, the spread narrowed but has nonetheless remained considerably more volatile than during the pre-crisis period. The development is therefore consistent with the view that the bid-ask spread tightened as money markets recovered after the Japanese banking crisis and became increasingly sophisticated and competitive – but then ballooned as interbank lending "died" in 2007.

However, the derivatives market referencing the benchmark has hardly been affected by the liquidity swings of the underlying term money market. As can be seen, the bid-ask spread of 1X4 spot forward rate agreements (FRAs) in Japanese yen, which reference the 3-month LIBOR in 1 months time, has remained tight and stable throughout almost the entire period. Indeed, the derivatives market can function perfectly well without a liquid underlying market. This observation is supported by

the reported global turnover in LIBOR-indexed FRAs, which soared in popularity during the crisis even though money markets had frozen (see Figure 2).

Figure 2: Global daily turnover of FRAs (U.S. dollar millions)



Source: Bank for International Settlements. Note: April every year.

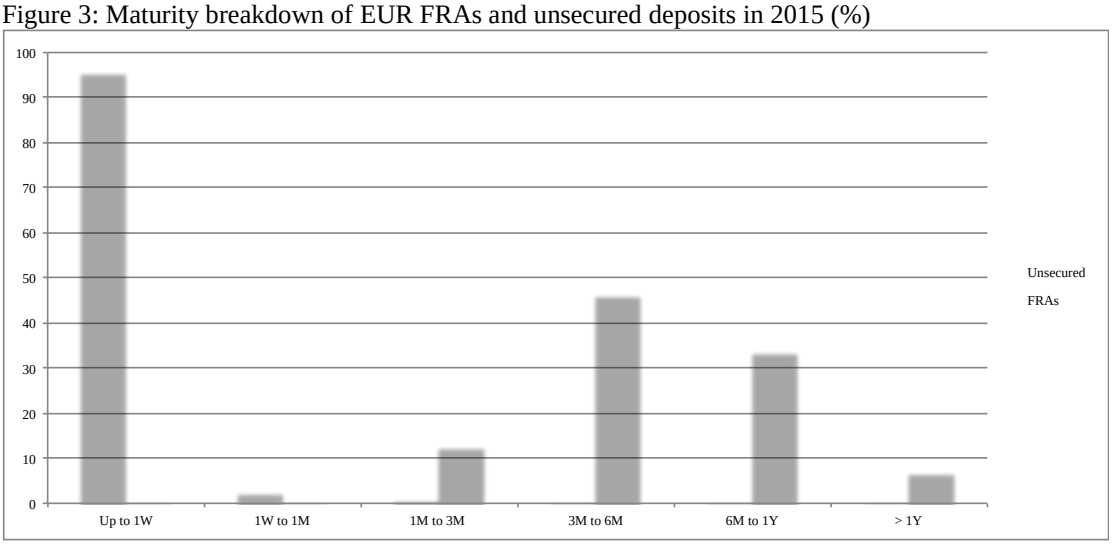
The main reason for the increase in volume from 2007 was, of course, the uncertainty of the development of LIBOR following the credit crunch. After all, a FRA is a derivative instrument, which is designed to hedge against and speculate on a change in *LIBOR* in the near future – and not necessarily on a change in the *underlying* market underpinning LIBOR.

However, the textbook description of a FRA is that of a derivative instrument tailor-made to speculate on short-term interest rates in the future and to provide a hedge against a *genuine* unsecured borrowing or lending need. Therefore, it would be logical to think that the derivatives market would suffer as a result of a less liquid term money market. It did not, and the example illustrates how the vast volumes traded in LIBOR-indexed derivatives also sustained an illusion that the underlying market was sufficiently active.

Importantly, the market for unsecured borrowing and lending between banks did not disappear with the advent of the financial crisis. Very large quantities continued to be traded daily in all major currencies, and continue to do so. Problematically for the generation of reliable IBOR-benchmarks, however, this trading activity is almost exclusively conducted in ultra-short-term maturities. For instance, Figure 3 shows a

maturity breakdown of FRAs and unsecured deposits in the euro money market in 2015, using data collected by the European Central Bank (ECB).

Figure 3: Maturity breakdown of EUR FRAs and unsecured deposits in 2015 (%)



Sources: European Central Bank and author's calculations.

As can be seen, more than 95% of the trading takes place in maturities up to 1 week. Hardly any turnover is reported for maturities such as three months and six months, which is supposed to be the underlying market for the two most widely used EURIBOR fixings. A similar pattern can be observed in the unsecured money markets for other currencies, whether they form the basis for LIBOR, TIBOR, STIBOR, NIBOR or other equivalent benchmarks.

Give the scale of the LIBOR controversy it is logical that the initial reforms addressed the benchmark's susceptibility to manipulation, rather than issues in the underlying money market.[10] Some LIBOR-maturities were abolished from the fixing mechanism. Also, a selection of medium-sized currencies, which had limited trading activity in London, but also their own domestic money market benchmarks, were removed (such as the Swedish krona and the Canadian dollar). For the remaining currencies and maturities, provisions were then made that enabled panel banks to submit LIBOR-rates based upon their expert judgement when the market was deemed illiquid. Whereas these changes made LIBOR more reliable for users of LIBOR-indexed derivatives, they had little, if any, impact on the market, which it was supposed to reflect. Regardless whether a financial benchmark is based upon transactions or estimates where deals ought to take place, the liquidity of the underlying market is essential for it to be sustained in the long-run. This includes the actual volume traded

in the relevant maturities. In July 2017, Andrew Bailey, Chief Executive of the Financial Conduct Authority (FCA) announced that LIBOR, in its current form, would disappear in 2021. The key message from the regulator was that it had found that 'the underlying market that LIBOR seeks to measure – the market for unsecured term lending to banks – is no longer sufficiently active.'[11] A crucial benchmark, which is "just a made-up number", cannot survive. In the end, it was the lack of this liquidity, rather than the LIBOR scandal, which came to determine the destiny of the benchmark.

THE ILLUSION OF FX LIQUIDITY

The 'LIBOR scandal' was quickly followed by the 'FX scandal' when after a Bloomberg article with the headline 'Traders Said to Rig Currency Rates to Profit Off Clients' was released in June 2013.[12] In the story, an academic is quoted saying that 'I'm sceptical of the ability of traders to manipulate the major currencies in a meaningful way given the massive size of this market […] Governments themselves often have a difficult time moving foreign-exchange markets through their interventions.' This view of the FX market, as tremendously competitive as evidenced by vast volumes traded at tight interbank bid-ask spreads, broadly captured the perception at the time.

However, transcripts released by regulators later revealed that banks were able to exercise their significant market power to influence the fixing. For instance, according to the FCA, HSBC accounted for 51% of the turnover in the GBP/USD FX spot market during the fixing window on one of the relevant days.[13] This shows how the liquidity of the FX market (even for the major currency pairs) depends on which lens is used. Most cases in the FX scandal concerned major currency pairs traded in enormous volumes at tight bid-ask spreads. However, one or just a few banks had the ability to move the market at will and when needed. Seen from the perspective of the speed-dimension of liquidity, they could deliberately create a "shock" in the market. Although the price often recovered quickly, the activity during the 60 seconds, which formed the crucial fixing window, was sufficient to obtain a favourable benchmark fixing - to the detriment of the clients.

To illustrate how important all three dimensions are (price, volume and speed) let us use an example. Table 1 shows an overview of a dataset from the USD/JPY FX spot market on the Electronic Broking System (EBS) from 21:00:00 GMT on 8 September 2010 to 20:59:59 GMT on 13 September 2010.[14] USD/JPY is the second-most widely traded currency pair in the global FX spot market, and EBS is the most popular electronic trading platform for market making banks. [15]

Table 1: Overview of USD/JPY FX spot limit orders on EBS 8–13 September 2010

Limit order submissions	787,213
Total limit order amount	$1,020,022,000,000
Bid-ask spread (mean/median)	0.0134% / 0.0119%
Highest mid price	84.50
Lowest mid price	83.49
Market depth (mean / median)	$17.15 million / $14.00 million

Sources: EBS and author's calculations.

The minimum amount allowed on EBS is $1 million, and the dataset contains 787,213 USD/JPY limit order submissions during just three days. To put this into perspective, this corresponds to approximately three new orders of at least $1 million per *second*. The average bid-ask spread is exceptionally tight – not much more than 0.01% (or roughly 1 pip using FX terminology). Furthermore, the USD/JPY FX spot market also appears to be liquid regarding one of the standard measures of market depth. The average aggregated volume of limit orders submitted at the current best bid-ask spread is $17.15 million. In sum, this market looks large and liquid, which is not surprising given that it involves one of the major currency pairs in the FX spot market.

However, a closer inspection illustrates how the vast limit order volume can strengthen the *impression* that the market is liquid.

Table 2: Transactions, market orders and amounts

Transactions (executed amount)	$4,546,000,000
Transactions (number of executed trades)	3,719
Minimum limit order size	$1,000,000
Maximum limit order size	$250,000,000
Proportion of small limit orders ($1 Mio)	85.41%

Sources: EBS and author's calculations.

Two observations are notable from Table 2.

First, despite the exceptionally tight bid-ask spread, the volume traded at either side is surprisingly low. The actual turnover amounts to around $4.5 billion, which is minuscule compared to the total liquidity provided (over $1 trillion). Likewise, the number of executed trades (3,719) is just a fraction of the number of limit orders submitted (787,213).

Second, although some huge limit orders (the largest is $250 million) were submitted during the period, the vast majority (85.41%) of the limit orders were for precisely $1 million. This observation is consistent with other markets populated with algorithmic (including high-frequency) traders, which tend to contain a high proportion of limit orders compared to market orders, as well as a 'race-to-the-bottom' when it comes to the order size.[16] As is well known from stock markets, such a race-to-the-bottom also involves competition in terms of speed. Machines can provide liquidity much faster than humans on electronic trading platforms. Importantly, however, machines can also *withdraw* liquidity much quicker than humans.

Here, it is useful to refer to Harold Demsetz' seminal article 'The Costs of Transacting' from 1968, where the author characterises the bid-ask spread as 'the mark-up that is paid for predictable immediacy' and as the cost of transacting 'without delay'.[17] Immediately means right now. However, in terms of execution, humans might interpret this differently from algorithms. Suppose the total limit order book contains $20 million buy orders and $15 million sell orders at a particular moment in time. A trader then inputs a limit buy or sell order to the platform. The question is: how do other traders react to this new piece of information – and how fast? Is liquidity added, withdrawn or does it remain unchanged? This is important, as it is the liquidity *immediately* that ultimately matters. Using the time stamp of each limit order submission and cancellation, we can quantify if, when and by how much liquidity is added to or withdrawn from the other side of the order book following each new limit order submission. Essentially, we can see how the market reacts when a trader (human or otherwise) shows an interest to buy or sell.

Table 3: Change in limit order volume

Time window (seconds)	0.1	0.2	0.5	1	5	10	60
Change in limit buy order volume ($mio)	0.100	-0.102	-0.893	-0.971	-0.736	-0.545	0.508
Change in limit sell order volume ($mio)	0.124	-0.095	-0.931	-0.997	-0.667	-0.478	-0.140

Sources: EBS and author's calculations.

The FX spot market is a famously fast-paced market, and a minute is considered a relatively long time among market makers. As can be seen from Table 3, a new limit order is, on average, immediately countered with an additional liquidity provision of approximately $0.1 million from the opposite side of the order book. 'Immediately' or 'without delay' is, in this case, defined as within 100 milliseconds. When the pros and cons of high-frequency trading are discussed, the speed-based advantage of machines over human is often raised. It takes around 300–400 milliseconds for a human being to blink, according to estimates by psychologists.[18] Algorithmic traders can execute trades considerably faster than that. When studying the results from the USD/JPY FX spot dataset, we can see that the limit order book has already shrunk somewhat after 200 milliseconds. Then, when human traders reasonably have had the chance to respond to the new information, the market liquidity has already deteriorated. After one second, the volume-based liquidity proxy has already decreased by approximately $1 million. Put differently, from the perspective of a human trader, "the market moves as soon as you *try* to deal".

CONCLUDING DISCUSSION

The LIBOR and FX controversies were, of course, different in several respects. LIBOR involved a money market benchmark, which is not based on actual transactions. The latter concerned a broader range of behavioural issues in the FX market and, with regards to the WM/Reuters 4 p.m. fix, actual buying and selling of currencies. However, it is the historical similarities, rather than the differences, outside the realm of misconduct that stand out: the opaqueness, the lack of regulation, the physical proximity of both activities on the banks' trading floors and so on. Perhaps most importantly, they have shared the same traditions related to the liquidity provision, which has been upheld through voluntary market-making arrangements between banks. Often, this has been with the endorsement of the ACI (the Financial Markets Association), the trade organisation for dealers in the FX and money market.

The ACI sees such liquidity provision agreements as "logical" and that they "play an important role in providing support and liquidity."[19]

Based upon informal conventions, such agreements have tended to include considerations of all three dimensions of liquidity. Although increasingly less common, market conventions regarding standard bid-ask spreads (price-based liquidity) and standard amounts (volume-based liquidity) have been passed down from generation to generation in the foreign exchange and money markets. [20] There is no regulatory requirement preventing a market maker from quoting an unreasonably wide two-way price, nor a market taker from requesting a quote in an abnormally large amount. However, it would be seen as unprofessional. To some degree, the same can said about the speed-dimension of liquidity provision. According to the 2009-version of the ACI Model Code "[…], a dealer has to assume that a price given to a voice/traditional broker is good only for a short length of time, typically a matter of seconds."[21] This highlights how the speed-based boundaries of humans can influence trading etiquette. A convention regarding how to measure 'immediacy', or how long a quoted price at any moment in time is deemed to be valid, shapes expectations of market liquidity in the future.

Problematically, such liquidity provision also encourages human communication among competitors. This, coupled with the history of market-making banks simultaneously acting as principals and agents (as well as benchmark submitters and users), generates an array of potential anti-trust issues and conflicts of interests. The LIBOR and FX controversies laid these bare, and the latest reforms have addressed associated issues – most lately via the new EU Benchmark Regulation (BMR) and the new voluntary FX Global Code.[22] Electronic, rather than human, order execution has increasingly been promoted, too, in part to circumvent potential issues related to conflicts of interest and the sharing of information among human traders, brokers and salespeople.

So what lessons, if any, can be learned by paying attention to illusions of liquidity concerning LIBOR and FX?

First, the transition away from LIBOR (and other equivalent benchmarks) is likely to be considerably more difficult than originally thought. Paradoxically, the LIBOR-indexed derivatives market has become too large compared to the underlying money market to enable a smooth amendment of benchmark used. However, the challenge lies not only in finding a suitable and robust alternative reference rate. It also needs to be underpinned by a market with consistent liquidity provision by market participants.

Second, recent financial crises and 'flash crashes' provide evidence of how the stability of the global financial system has become highly susceptible to sudden changes in, and ultra-fast transmission of shared perceptions of risk (BIS, 2017). A recent example is the Pound Flash Crash in October 2016, which showed how market liquidity might evaporate suddenly and without any macroeconomic causes.[23] Within less than half an hour, the GBP/USD FX spot rate dropped by around 9% and, according to researchers at the FCA, the bid-ask spread saw a 60-fold increase.[24] The FX market is international by definition and lacks circuit breakers. Liquidity withdrawal *en masse*, regardless of whether it is human or algorithmic, can pose systemic risks and therefore have severe consequences for societies at large.

To ensure fair and effective financial markets going forward, and to be able to withstand and prevent future shocks, a multi-dimensional approach to the concept of market liquidity is required. This is particularly important for OTC markets and financial benchmarks linked to these, which ultimately depend on human relationships and trust.

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