BANK OF ENGLAND

Speech

Run Lola run! The good, the bad and the ugly of FX market fragmentation – and what to do about it

Speech given by

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Introduction

I wonder if anyone remembers 'Run Lola Run' – a somewhat 'experimental' German film from the late 1990s? In it, the lead character runs the streets of Berlin, racing against the clock to save her hapless boyfriend Manni from a ganglord, whose money Manni has left on a train. The big idea of the film is that Lola's race is shown in three alternative realities. In the first, she secures some replacement money, but is tragically shot in a police standoff. In the second, she gets the money a different way, and repays the ganglord – but Manni gets run over by an ambulance Lola has distracted. And, in the third, Lola and Manni both secure their own money, leaving them quids in after the repayment, and living happily ever after.

What on earth does all this have to do with the FX market? I certainly draw no comparison to the handling of ill-gotten gains. But Lola's travails vividly illustrate how, in a complex world, you can get very different outcomes – good, bad or ugly – from an otherwise identical situation. And that's a powerful metaphor for today's FX markets.

The complexity in FX markets lies not in the products themselves, which for the most part are relatively simple. It lies in the structures that have evolved to deliver them, driven by extraordinary technological innovation. For those with the right access and understanding, the multiple sources of liquidity, trading venues and execution algorithms available in FX markets offer enormous choice, competition and functionality. That's the 'good'.

But finding your way around such complexity isn't a cakewalk. Knowledge is power – and even quite sophisticated investors need their wits about them to benefit from everything the market has to offer. Complexity also poses new challenges to system-wide stability and functioning. And, sadly, it can give rise to new ways to behave inappropriately. When any of these go wrong, that gives you the 'bad' – sometimes even the 'ugly'.

But my message today is a call to arms, not a cry for despair. As Lola found, actions matter – and even modest ones can have big effects. Working collectively, there is huge scope for the buyside to improve the value they get as individual firms and strengthen the market as a whole. Today, I want to discuss three specific ways to do that. First, by demanding clearer and more informative disclosures on the services you get from liquidity providers and platforms – including hold times, timestamps and reject codes. Second, by seeking out more effective, robust and independent analytical, aggregation and execution tools. And, third, by signing up to the FX Global Code – where buyside representation remains far too thin.

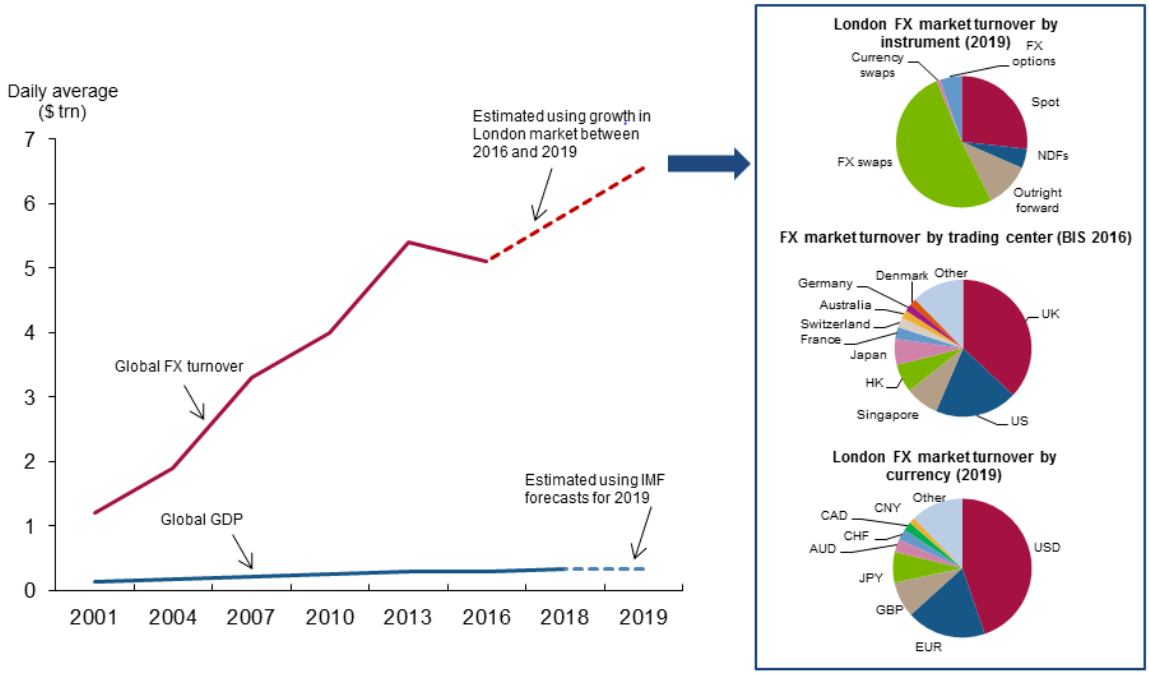
Through these and other actions, it's time for the buyside to recognise, and use, its influence in the FX market to the full. Because you collectively control trillions of dollars of assets – and when you have that sort of buying power, to quote a rather different Lola from Sarah Vaughan's 1950s song, 'whatever Lola wants, Lola gets'.

The macro-behaviour of FX markets: a scorecard

Central banks like the Bank of England care a lot about FX markets. They determine the relative prices of our national currencies. They help transmit monetary policy, and hence also reflect market expectations. And they underpin international trade and asset markets, and hence economic and financial stability. To do all this well, we need FX markets to be **efficient**, **resilient** and **fair**. How do today's markets score?

An informationally **efficient** market is one in which prices reflect all relevant information, in a timely way. FX markets are typically thought to come as close as any to meeting that test. The latest data from the Bank for International Settlements showed that $5 trillion of FX products were traded daily in 2016 – and the London market, the largest single centre, has grown by a third since then. That suggests that global FX turnover may now be more than 20 times the equivalent measure of global economic output, across an exceptionally wide range of products, participants and financial centres (Chart 1). For analysts, investors and policymakers, movements in floating FX rates provide a fast and comprehensive synthesis of market perceptions of economic news. And a huge empirical literature finds little evidence that excess returns are systematically predictable: a formal definition of 'efficiency'. Even a harsh examiner would score FX markets 'very good' on this heading.

Chart 1: The global FX market at a glance



Sources: London Foreign Exchange Joint Standing Committee April 2019 survey, Bank for International Settlements triennial surveys, Bloomberg LP, International Monetary Fund and Bank calculations.

A **resilient** market is one in which markets continue to function in good times and bad, ensuring that prices give a consistently accurate signal about the balance of demand and supply. Again, the experience here is positive. FX markets have rarely 'closed'. For example, during the financial crisis, foreign exchange markets continued to function relatively well following the bankruptcy of Lehman Brothers – despite being under extraordinary pressures.[1] Although there were signs of dislocation, the market did not seize up as others did, aided perhaps in part by that multipolar structure seen in Chart 1. More recently, focus has turned to the increased incidence of so-called 'flash episodes', in which prices move suddenly and sharply, often without any obvious fundamental driver. The jury is out on how seriously these events highlight weaknesses in market resilience. So far, the price effects, in FX and elsewhere, have tended to unwind in minutes (Table 1), with few consequences for financial stability. That's encouraging. But liquidity has sometimes taken longer to rebound than prices – and global authorities, including the Bank of England's Financial Policy Committee, are on the alert for signs of more sizeable contagion.[2] Overall therefore, I'd score FX market resilience as 'good, but with some things to keep an eye on'.

Table 1: Key flash episodes over the past decade

Year	Asset class	Markets	Price move	Duration (minutes)*
2010	Equities	S & P 500	-6%	5
2011	FX	USD/JPY	-4%	4
2014	Bonds	US Treasuries	+37bps	5
2015	FX	EUR/CHF	-41%	20
2015	FX	NZD/JPY	-10%	10
2015	FX	USD/EUR	-2%	4
2016	FX	ZAR/USD	-9%	15
2016	FX	GBP/USD	-9%	1
2017	Bond futures	French OAT	-11bps	1
2018	FX	ZAR/USD	-9%	1
2019	FX	USD/JPY	-4%	4
2019	FX	TRY/JPY	-10%	7

Sources: Bank for International Settlements, Bank Underground, Bloomberg Finance L.P., Cielinska,O, Joseph,A, Shreyas,U, Tanner,J and Vasios,M (2017), 'Gauging market dynamics using trade repository data: the case of the Swiss franc de-pegging', *Bank of England Financial Stability Paper No. 41,* Financial Times, International Monetary Fund, MarketFactory, Inc., Nanex, Reserve Bank of Australia, Securities and Exchange Commission and Bank calculations.

*Approximate time space in which price moves from prevailing price to a new low (or high) price.

Finally, a **fair** market is one with open access, in which clients feel they can trade safely and on the basis of merit, with counterparties who hold to clear standards of market practice and integrity. And here, clearly, FX markets have had ground to make up over the past decade. Standards in some parts of the market fell

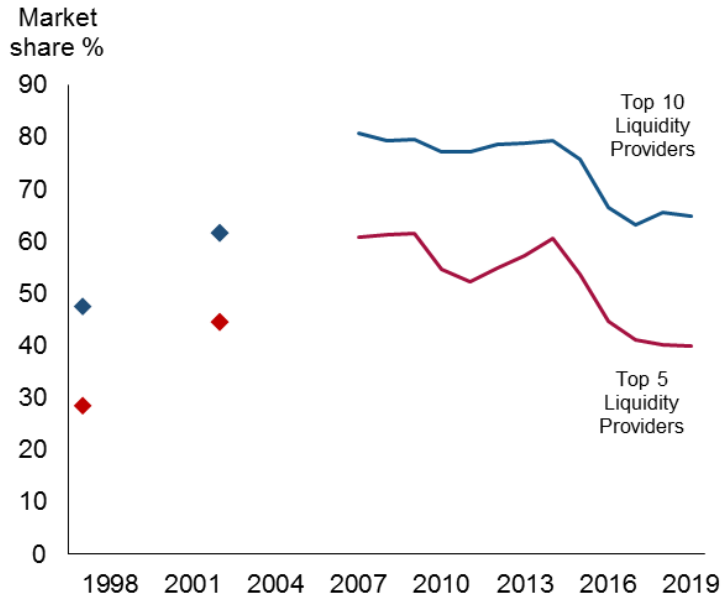
[1] See Section 5.2 of https://www.bis.org/publ/cgfs37.pdf.
[2] See the July 2019 Financial Stability Report, at https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-report/2019/july-2019.pdf.

unacceptably short in the years running up to, and following, the financial crisis – and that led to a concerted push to turn the corner with agreement of the FX Global Code. The overall takeup numbers are impressive: as of 9 September, there were 956 public commitments to the Code on the Global Index.[3] And the Code has driven some beneficial changes in market practice – eg on information sharing. But it will take time to see whether it has led to a persistent step-up in behaviour. So, while it may be an 'A for effort' on fairness, it's also a 'must show consistent improvement'.

Technology and FX market fragmentation

In many ways, though, the most profound change in FX markets has been happening elsewhere, in response to hard economics and technological innovation. As a relatively standardised, high volume product, spot FX had embraced widespread electronic trading well before the financial crisis. In the early days, that led to a concentration of liquidity provision amongst the largest incumbent banks, eager to grow volumes and able to afford the expensive high-speed equipment required. More recently, however, some of those firms have exited or downscaled as the scope to deliver returns from traditional business models has fallen. And a number of non-bank providers have emerged, focused less on providing balance sheet capacity to the market, and more on exploiting new technology. Taken together, this has driven a renewed dispersion of market share (Chart 2). In 2009, the number one provider in Euromoney's annual FX survey saw nearly ten times the flows of the number ten firm. Today that ratio is just two.

Chart 2: Falling concentration amongst liquidity providers

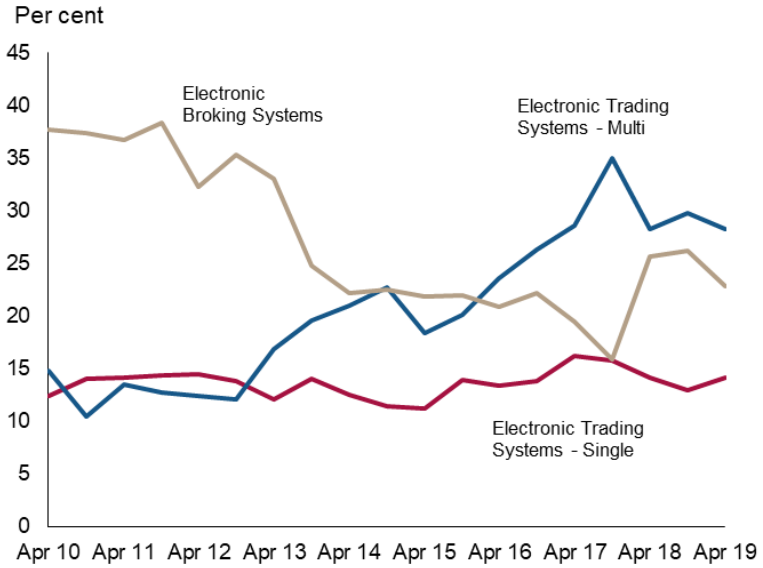


Source: Euromoney FX surveys.

[3] https://www.globalfxc.org/global_index.htm, adjusting for duplicate entries reported to more than one national index.

There's been an even bigger revolution in trading platforms, as the share of trading routed through liquidity providers' single dealer offerings and the traditionally dominant primary venues has fallen, and business has increasingly migrated towards multi-dealer platforms, which allow users to put multiple chosen providers into competition on a single site (Chart 3).

Chart 3: Platform use as a share of spot FX turnover in the London market[4]

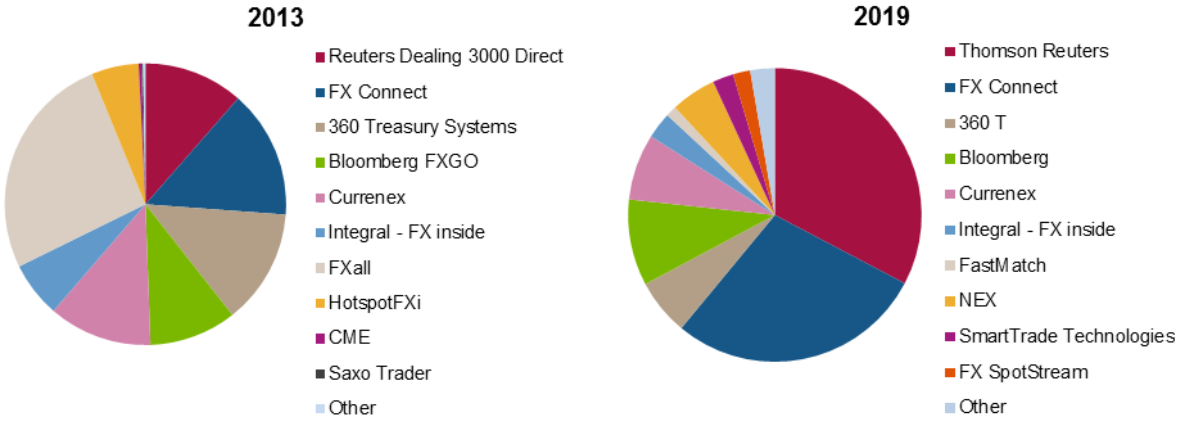


Source: London Foreign Exchange Joint Standing Committee surveys and Bank of England calculations.

Competition both on and between platforms has generated an extraordinary array of FX execution choices for market participants to choose between. Whether to seek opportunities to net offsetting trades with others before transacting in the market. Whether to trade by voice or electronically. Whether to prioritise speed or diversity of execution. Whether to use algorithmic or trade-by-trade price selection – on firm or indicative prices; with wider or narrower groups of counterparties; in full view ('lit') or anonymously ('dark'); or with more or less sophisticated 'Transaction Cost Analysis' (TCA) tools. Shifting patterns of demand for different bundles of these services, coupled with aggressive price and non-price incentives, have driven dramatic swings in market share between platforms (Chart 4).

[4] Electronic Broking Systems line measures trades executed via automated matching systems for dealers. Electronic Trading Systems lines measure trades executed (predominantly by or for customers) via single-dealer proprietary platforms or a multi-dealer systems.

Chart 4: Multi-dealer FX platforms – buyside market share



Source: Euromoney FX surveys.

Some implications of fragmentation: the good, the bad and the ugly

Is fragmentation here for good? Some suspect it will eventually hit the buffers, as the declining marginal benefits of ever-greater product diversity, and the growing cost of navigating it, become more evident. But others argue that it could accelerate further, as technology costs continue to fall, helping market users seek out more obscure venues where they might have an edge.[5]

Whatever happens, for today's market participants, fragmentation is a fact. And that means – just like Lola – they can experience a markedly broad range of outcomes. That has important implications for all three of the characteristics – informational efficiency, resilience and fairness – I talked about a moment ago. Central banks are watching those issues closely.[6] But today I want to focus on the effectiveness of the FX market in delivering the services needed by its users – using three storylines of my own.

Our first fictional FX market user has never had it so good. With the resources and knowledge to connect to dozens of competing platforms and liquidity providers, analyse rich data sets in real time to work out the best way to deal, and using an array of algorithms (perhaps even arranged in an 'algorithm wheel') to execute at speed with minimal price impact, she gets an exceptional service from FX markets. I say 'she' quite deliberately here too – because, as I discussed back in June in a different speech,[7] technological innovation means embracing diversity – of people, ideas, and working practices – is no longer a choice, it's a business necessity. For heavily-traded currency pairs, our hypothetical FX trader is getting bid/ask spreads that are a fraction of a basis point for a $1m trade, rising to a few basis points for a large trade. And she's taking

[5] See for instance https://www.bis.org/publ/mktc10.htm and https://www.marketfactory.com/whitepaper-why-does-fragmentation-continue-to-increase-increasing-entropy-in-currency-markets/
[6] See for instance my predecessor's speech on fast markets at https://www.bankofengland.co.uk/-/media/boe/files/speech/2017/keeping-up-with-fast-markets; or the recent ECB paper https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2300~68bda93b78.en.pdf.
[7] https://www.bankofengland.co.uk/-/media/boe/files/speech/2019/why-diverse-markets-need-diverse-talent-speech-by-andrew-hauser

advantage of the changes in the market brought about by the Code: accessing so-called 'Global Code pools', and increasingly firm, or near-firm, pricing.[8]

Many of you here today will recognise aspects of this experience. But many won't – and the reason for that is clear. Navigating complexity requires understanding, data, connectivity and computing power – and that can be a challenging combination. To give an extreme example: one of the large non-bank liquidity providers is said to have access to 42 petabytes of data storage.[9] That's more than 4,000 times what's needed to hold the entire Library of Congress and would cost around $10m a year from Amazon Web Services, at their most basic standard rate. If you need that sort of kit to scale the mountain, many will struggle to get to base camp.

Of course that's an extreme comparison. So let's sketch a second storyline: that of a large to mid-tier buyside firm, for whom FX is an important, but by no means dominant part of its overall business. The firm has access to a pool of liquidity providers, and will compare pre-trade price quotes, perhaps making use of proprietary TCA tools from those providing liquidity. It might execute some trades electronically. But it has bigger costs to worry about than FX trade execution alone – including the broader bundle of services it needs across asset classes. And it is conscious that larger FX trades involve material risk, including as a result of market dynamics it doesn't necessarily understand. So it will also work to maintain broader relationships with liquidity providers – and will tend to revert to voice trading with a trusted counterparty for larger orders, or at times of heightened volatility. It may not always have complete clarity on the basis on which such trades are executed (internalised vs externally traded, principal vs agent) or rejected. And it recognises that, in seeking quotes, it may be leaking information about its position. But broadly speaking it is content with the service it receives on FX, and feels it has bigger fish to fry elsewhere.

In many ways, it is hard to label this case 'bad'. The firm is trying to inform itself about market trends. But it recognises that FX is a professional market, whose complexities it needs assistance to navigate. It knows it may not always be getting the finest price, or the perfect service – but feels that the cost/benefit case for investing in a lot of extra data or understanding is not in its favour. At the same time, however, this situation is sub-optimal in terms of market-wide functioning: pricing may be inefficient, perhaps materially so, and other elements of the service offering fall short of best practice. Collective, market-wide action to improve competition and standards would benefit this firm and many others – raising all ships. But the firm itself feels powerless to drive that change by itself. It's that missed opportunity that is 'bad', or perhaps better put, 'sad'.

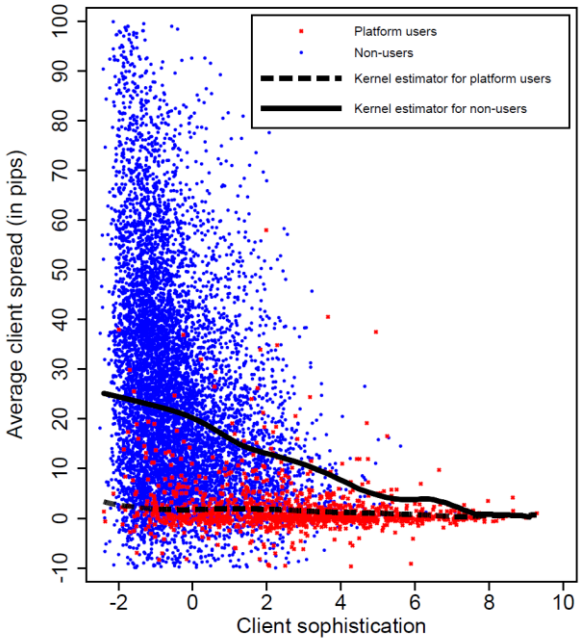
The third and final stylised storyline is definitely 'ugly'. It involves a large and regular buyside user of FX markets which chooses to operate through a single relationship bank, which also provides custodian services. It places all of its FX business with the bank to work through over an extended period. It has no

[8] See for instance https://newsroom.nex.com/news/04092018/nex-markets-experiences-a-reduction-in-hold-times-and-reject-rates-as-a-result-of-the-fx-code-of-conduct, which shows that, for one of the platforms in Chart 4, hold times have fallen from 93 to 37 milliseconds since introduction of the Code, with 97% of trades with the top 10 liquidity providers now being filled at the original quote price.
[9] https://codeforces.com/blog/entry/65002

connections to other venues, does no material TCA, and receives no specific timestamping on its trades. Although it believes it makes no economic sense to vary its FX practices, in fact its trades are of a size, regularity and complexity that it would pay the client materially to shop around.

Clearly these are deliberately exaggerated descriptions, and can't be used by themselves to quantify the potential gains from changes in individual or collective behaviour. But one academic attempt to do just that, for a specific segment of the market, is shown in Chart 5. The range of observed spreads for transacting in euro/dollar FX forwards was found to be strikingly wide (ranging from 2 'pips'[10] for the 25th percentile to 52.6 pips for the 90th percentile) – and strongly inversely correlated with a measure of client sophistication. On average, the unsophisticated – and over half the sample trade with only one bank – appeared to pay a much higher spread than their sophisticated peers. That premium could be all but eliminated if they instead traded on a multi-dealer platform: a rent estimated by the authors to be worth over €600mn.

Chart 5: Relationship between spreads on EUR/USD FX forwards and client sophistication



Source: 'Discriminatory pricing of Over-The-Counter derivatives' by Harold Hau, Peter Hoffmann, Sam Langfield and Yannick Timmer, December 2017[11]

These results should be interpreted with some care. Higher spreads for less sophisticated clients may be capturing more than execution costs alone (FX forwards involve a credit element, for example). And tighter observed spreads for those using platforms and those with greater sophistication may underestimate true effective spreads if prices regularly move against them, through information leakage or otherwise. Spreads

[10] A 'pip' is the smallest amount by which any given exchange rate can change. The euro/dollar exchange rate is conventionally quoted to four decimal places, so a pip is 0.0001. At the current exchange rate that is approximately equal to one basis point, allowing comparison to spreads in other markets.

[11] http://www.haraldhau.com/wp-content/uploads/FX_PriceDiscrimination_in_FX_OTC_markets.pdf. The chart is based on 548, 298 trades in vanilla forward in EUR/USD involving 10,087 clients and 204 dealers between April 1, 2016 and March 31, 2017, as reported on the DTCC, REGIS and UnaVista trade repositories.

can also be too low as well as too high. Business won at zero or negative spreads – eg to build market share – cannot be sustained in the long run, unless compensated by more remunerative returns elsewhere. Persistently compressed earnings have in the past been one factor cited as a trigger for misconduct.

But these results do give some sense of the potential gains that might be available from improved understanding of FX markets, and effective use of execution technologies.

How to navigate a fragmented market: disclosures, TCA and the Global Code

How can the buyside make practical progress in this area? I want to highlight three main areas for action: demanding better disclosures; seeking more effective technology; and adopting the Global Code.

Effective disclosures are a necessary precondition for ensuring good service. As the UK's Fair and Effective Markets Review argued in 2015[12], you can't evaluate an FX transaction if you (or your agent) don't know when it was executed (timestamping), why some trades were rejected and others not (reject codes), whether your counterparty was acting as principal or agent, how long your request to trade was held before a decision was made (hold time), or what was happening during that hold period. Good disclosures should not be documents written by lawyers for lawyers, aimed solely at limiting liability. They should be clear and practical tools to inform trader-to-trader contact.

The FX Global Code[13] stresses the importance of clear and effective disclosures in many of its high level principles. And in February this year, the Global FX Committee (GFXC) published supplementary guidance on the key characteristics that good disclosures should have, covering: content, accessibility, clarity and review frequency.[14] At the Bank of England, we take disclosures from our own wide range of trading counterparties very seriously. We recently reviewed these documents to ensure firms were following through on their commitments under the Code. Most covered the topic headings we would expect to see, and the best scored well across a broad range of criteria. But few had been reviewed since the GFXC's guidance came out. And in general we found significant room for improvement, in particular on clarity and accessibility. A recent review of public disclosures by *Risk* magazine[15] came to similar conclusions.

In the Bank's case, we will be engaging bilaterally with relevant counterparties over the coming months, asking questions and seeking greater clarity. I'd strongly encourage others users of FX markets to do something similar. Work together too. It is good to see the UK's Investment Association, for example, pushing for the standardisation of reject codes. But given the amount at stake, the buyside ought to be exerting more concerted pressure for better disclosures across the board. The GFXC's upcoming three-yearly review of the Code provides an ideal opportunity to look again at the scope for stronger

[12] See Box 4 in https://www.bankofengland.co.uk/-/media/boe/files/report/2015/fair-and-effective-markets-review-final-report
[13] https://www.globalfxc.org/docs/fx_global.pdf
[14] https://www.globalfxc.org/docs/the_role_of_disclosure_and_transparency.pdf
[15] https://www.risk.net/derivatives/6888556/how-the-top-50-liquidity-providers-tackle-forex-last-look

market-wide standards, including on anonymous platforms. Please make sure your local FX Committee hears your views as this work progresses.

A second response to the challenges of greater fragmentation comes from **seeking more effective, robust and independent aggregation, analytical and execution tools** – using technology to beat technology at its own game. This isn't a free lunch: but putting liquidity providers into competition through robust aggregation and execution tools makes good business sense. Of course, you need to be alert to the potential for services offering lower spreads to claw back that gain through greater price slippage. To evaluate that, you need an effective TCA tool that goes beyond measuring just the observed spread to include market impact, price variation, hold times and fill ratios, and can give you guidance pre-trade, as well as post-trade analysis.

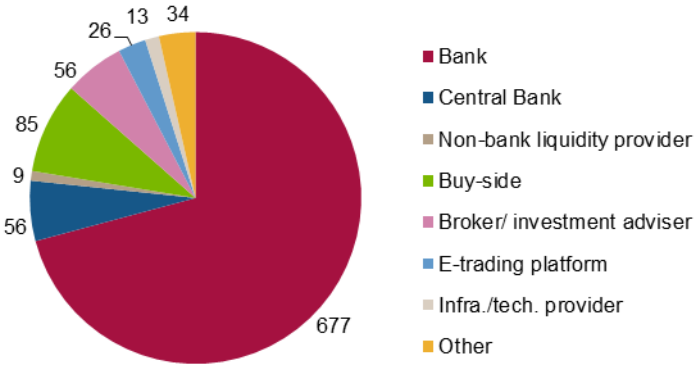
TCA is already well established in equity markets, reflecting amongst other things the European regulatory obligation to show best execution under MIFID II. But FX poses different challenges. There is no MIFID obligation for most spot FX business. And effective data are harder to come by, given the lack of market-wide pre- or post-trade transparency. TCA data sourced exclusively from one liquidity provider are unlikely to provide an objective evaluation. Platforms typically only give access to their post-trade data to active users. And very large shares of FX turnover are internalised by the large liquidity providers. So it's hardly surprising that less than two-thirds of European FX desks use any form of TCA[16] – and only a fraction of this (according to our market intelligence) involves picking trading strategies, using genuinely independent data.

It remains to be seen whether independent third-party TCA providers can develop business models in FX that are both sustainable economically but also robust enough in terms of their quality and breadth of data inputs to drive widespread adoption. Establishing common standards for effective TCA, and sharing post-trade data anonymously, are areas where the buyside can usefully collaborate. But this discussion does reveal a catch-22 – which is that participants on both sides of the market typically want two inconsistent things: (a) they'd like everyone else's information in a publicly-visible price so they can trade in full knowledge of their positions, but (b) they want to keep their own information out of that same price, to avoid driving it against them. One response to this, which TCA may itself recommend, is to take trades 'dark'. But that risks undermining the robustness of that TCA (by reducing the quality of the market data on which TCA assessments are based), and may also harm the efficiency and resilience of the market, if it increases market fragmentation. I can't help feeling that a highly fragmented world in which everyone pays up individually to secure information privately through TCA tools and market data that they could have publicly under a market-wide public disclosure standard seems deeply suboptimal and costly. Such a standard is clearly not feasible to impose by edict in a global market – but it is worth reflecting on whether current developments are heading in the right direction.

[16] *State of Transaction Cost Analysis 2019*, quoted in https://www.fixglobal.com/home/mifid-ii-boosts-tca/.

Underpinning many of my remarks today is a sense that the buyside has so much to gain, and to offer, from a more active collective participation in FX markets. And that is where we need more of you **sign up to the Global Code**. I mentioned earlier that there were over 950 public commitments to the Code on the Global Index. But only 85 of those are from the buyside – and only a handful more represent platform, infrastructure or technology operators (Chart 6). The GFXC has recognised some of the practical challenges faced by smaller firms when signing up to the Code, and has prepared new material to help ease this process.[17] But we need more of the largest firms too: 17 of the largest 30 global asset managers are still not signed up (Table 2). That's $22 trillion of investors' funds without a voice in the use and development of the Code.

Chart 6: Public commitments to the FX Global Code[18]



Source: Global Index of public registers as of 9 September.

Signing up to the Foreign Exchange Global Code should be high on the agenda for the CEO of every major asset management firm. It deepens trust: between you and your clients, your counterparties and your regulators. It strengthens corporate governance: providing a ready-made blueprint for best practice within your firm. That is especially true for UK firms, which will fall under the Senior Managers Regime from the end of 2019. Behaviour that is in line with the Code will tend to indicate a person subject to the Regime is meeting their obligation to observe 'proper standards of market conduct.' And the Code empowers your trading teams to demand the best from others in the market, even – or perhaps especially – when FX is not your core business. All of that means a stronger foreign exchange market. But it also means better returns for your investors – so it's good for the bottom line.

[17] https://www.globalfxc.org/education.htm?m=71%7C433
[18] 'Buy-side' category includes: Asset managers, Corporate treasury departments, Pension funds, Insurance companies, Quasi-sovereign or supranational institutions, and Sovereign wealth funds.

Conclusions

Let me conclude.

In many ways, the FX market is in great shape. It's informationally efficient, resilient, and a cauldron of technological innovation. That technology is bringing many new benefits: wider access, cheaper prices, better services. But we need to ensure those benefits are widely shared if the market is to work effectively. I've set out three ways for the buyside, working together, to play its part in that project: demanding better disclosures; seeking robust and independent analytical and execution tools; and signing up to the Global Code. Do that successfully, and we can turn the 'bad' to 'good' – and do away with the 'ugly' altogether. And Lola's run can finally come to an end.

Table 2: Statements of Commitment to the FX Global Code by 30 largest asset managers

	Firm	Assets Under Management ($billions)	SoC on public register, or have otherwise informed the Bank of England
1	Blackrock	6,060	✓
2	Vanguard Asset Management	4,663	
3	State Street Global Advisors	2,641	✓
4	Fidelity Investments	2,284	
5	BNY Mellon Investment Management	1,808	
6	Capital Group	1,715	
7	J.P. Morgan Asset Management	1,677	✓
8	PIMCO	1,667	
9	Amundi	1,626	✓
10	Prudential Financial	1,323	
11	Legal & General Investment Management	1,263	✓
12	Goldman Sachs Asset Management	1,224	✓
13	Wellington Management International	1,026	
14	Natixis Investment Managers	947	✓
15	T. Rowe Price	941	
16	Nuveen	923	
17	Northern Trust Asset Management	913	✓
18	Invesco	890	
19	AXA Investment Managers	850	
20	DWS (Deutsche Asset Management)	800	✓
21	Affiliated Managers Group	794	
22	UBS Asset Management	756	✓
23	Insight Investment	751	✓
24	Sumitomo Mitsui Trust Bank	748	✓
25	Aberdeen Standard Investments	739	
26	Legg Mason	733	
27	Franklin Templeton Investments	716	
28	BNP Paribas Asset Management France	649	
29	Mitsubishi UFJ Trust and Banking	611	✓
30	Allianz Global Investors	568	

Source: Firm AUM rankings from IPE's 'Top 400 Asset Managers 2018', https://www.ipe.com/Uploads/k/x/x/Top-400-Ranking.pdf. GFXC signup data from the GFXC global index of public registers, https://www.globalfxc.org/global_index.htm.