

# High Frequency Trading Behaviours: Data Challenges

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# Challenge

‘One good general rule is that it's harder than you think it is to figure out what's market manipulation and what isn't.

Trading a lot, cancelling a lot of orders, putting in orders or doing trades on both sides of the market, trading a lot right before a close or fixing -- all of those things could be signs of nefarious manipulation, or just normal risk management.

No single event or pattern proves manipulation. You often need to look for subtle clues to figure out whether a trade is actually manipulative.’

— Matt Levine, Bloomberg, Oct 2014

The problem is that looking for subtle clues, and putting together pieces of evidence, needs to be done using large trading data sets where the 4 Vs of Big Data (volume, velocity, variety, veracity) apply.

# Talk Overview

This talk is mostly an explanation of why high frequency trading system and FX market surveillance may be a suitable problem area in need of Big Data Analytics solutions.

It provides *brief* explanations of:

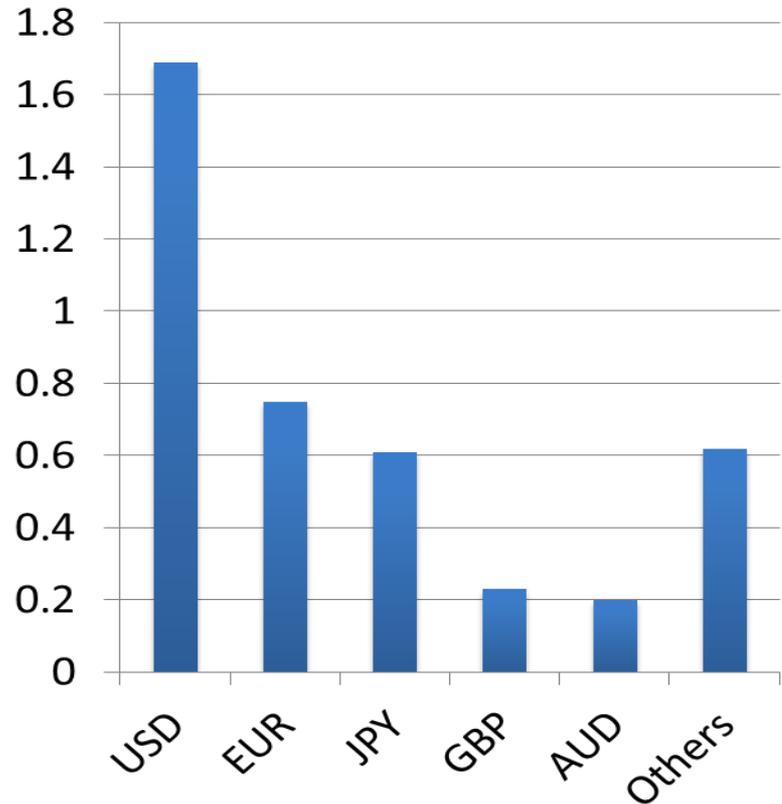
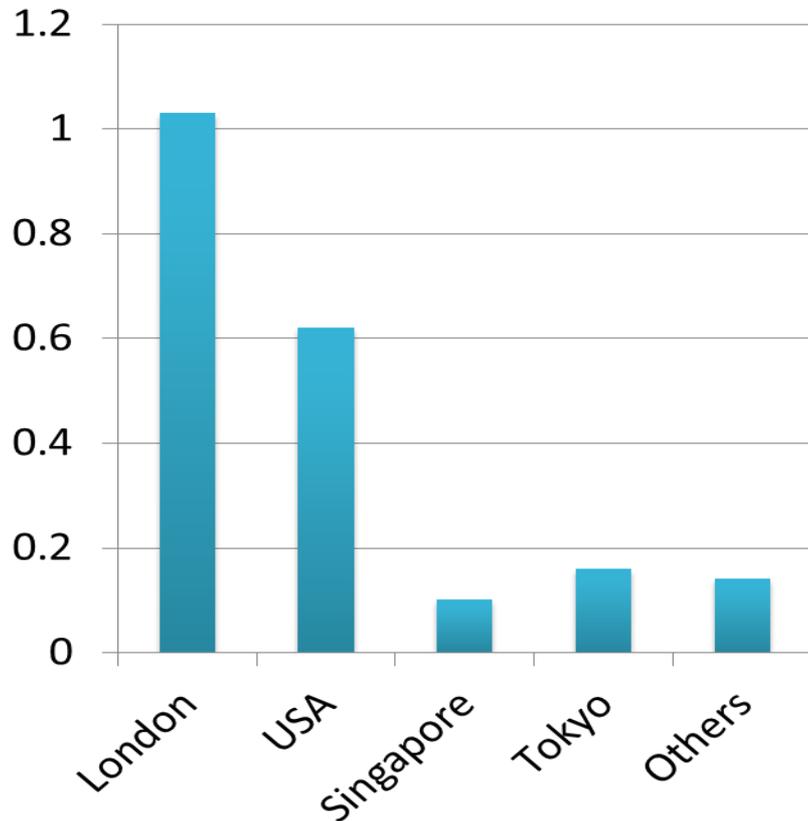
- spot FX market
- spot FX high frequency trading
- current regulation
- coming regulation
- bad behaviours and their indicators
- market surveillance problems and challenges
- possible big data solutions

The content herein is the responsibility of the presenter.

# Turnover of FX Spot Transactions

(BIS Triennial Central Bank Survey April 2013)

## Daily averages, in trillions of US dollars



## Percentage traded electronically

2001 : 20%

2013 : 66%

2015 : >75%

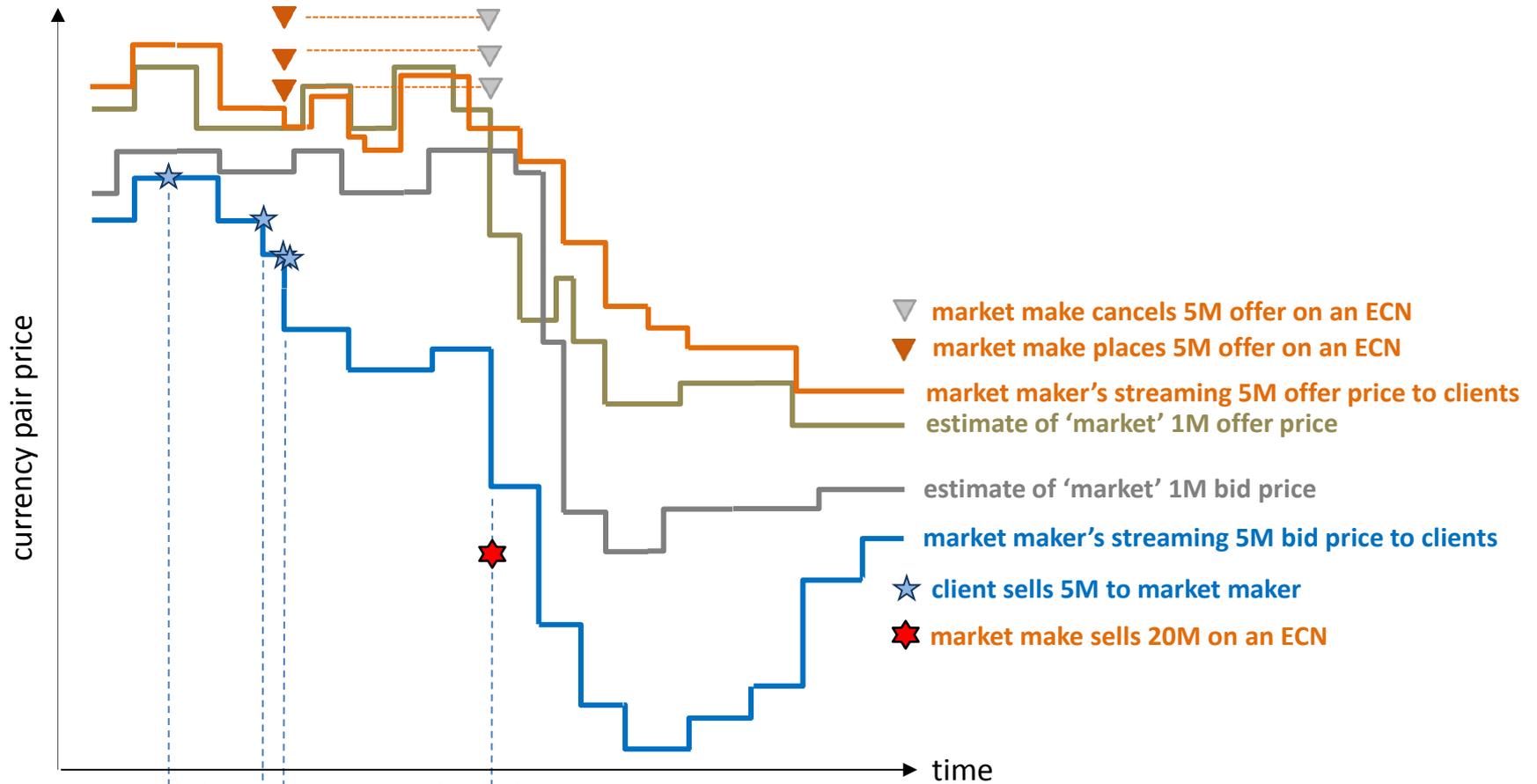
# High Frequency FX Spot Trading

- HFT is algorithmic, systematic trading
- Pricing, risk management, and execution decisions are typically made in under 1ms
- Proprietary HFT desks try to make profit by acquiring positions they predict will be profitable based on price movement forecasts
- Market making HFT desks try to make profit by quoting bids and offers to clients and collecting the spread
- HFT desks estimate bid and offer prices, manage currency positions that result from trading, and try to execute desired position changes optimally
- Some HFT desks engage in a combination of proprietary trading and market making

# Electronic Spot FX Markets

- Most spot FX market makers trade 24 hours a day, 5.5 days a week
- The number of currencies traded is typically (well) under 40 (so the maximum number of possible currency pairs is around 780)
- The amount of a currency is not limited
- Market makers trade with clients (corporations, non-market making banks, asset managers, HFT prop firms, etc.), brokers, and other market makers
- Spot FX counterparties trade:
  - on ECNs with a single liquidity pool
  - on ECNs with many customised liquidity pools
  - with each other over APIs
  - over single dealer platforms
- Liquidity pools can be 'lit' (market order book / quote data is visible to participants) or 'dark'
- At a given instant, the price per unit of a currency pair varies depending on the counterparties and the size of trade
- Prices can be firm, or open to rejection ('last look')
- Trades are not necessarily reported to any centralised agencies
- Trade information is not shared with any counterparty not involved in the transaction
- The characteristics of market data and order book data are quite heterogeneous across trading and order matching systems. Price precision, update frequencies, travel times, depth of book, and order types can all vary.
- An HFT desk may collect 20 — 200 GB of data per day.

# Spot FX Market Making



t(i) client sells 5M to market maker

t(j) client sells 5M to market maker

t(k), t(k+δ) client sells 5M to market maker and then another 5M;

market maker skews 5m prices and places 3 offers for 5M on an ECN

t(l) 'market' prices drop;

market maker cancels offers on ECN, sells 20M on an ECN (i.e. hits other traders' bids) 7

# Regulation of Spot FX Electronic Trading: Introduction

- Spot FX is an Over-the-Counter (OTC) market
- Spot FX is not considered an investment product, and is largely unregulated *at the moment*
- There are many ways more adaptable, more clever, better connected, more experienced, faster HFT desks can take advantage of less fortunate counterparties
- On some ECNs, a spot FX trader can refuse any contact with a counterparty (e.g. an HFT desk) they suspect of exploiting them
- Which behaviours benefit the spot FX market overall, which do not benefit it but do not significantly harm it, and which harm it, is currently the subject of much discussion, review, and disagreement
- Sometimes 'taking advantage' crosses the line into market abuse, or at least market disruption
- Sometimes HFT desks release trading systems that accidentally disrupt markets in some circumstances

# Regulation of Spot FX Electronic Trading: Current Voluntary Code

- Market Abuse (old FSA definition) : Manipulating transactions – trading, or placing orders to trade, that gives a false or misleading impression of the supply of, or demand for, one or more investments, raising the price of the investment to an abnormal or artificial level.
- Non-Investment Products Code (published by the Bank of England on November 2011)
  1. Don't stream tradable quotes, or place orders, if you don't intend to trade.
  2. If you do intend to trade, it mustn't be for the purpose of misleading market participants.
  3. Don't let your trading system run amok.

# Regulation of Spot FX Electronic Trading : Coming Soon

- Current EU-wide regulations and directives MAR, MiFID II, and EMIR do not cover electronic spot FX trading but they do cover:
  - best execution for clients, transaction reporting and audit trails, risk controls, high-frequency trading, market making
- The 'Fair and Effective Markets Review' (FEMR) was conducted by the Financial Conduct Authority, the Bank of England, and HM Treasury, and published on 10 June 2015.
- The review:
  - looked at the primary causes of misconduct
  - considered what new regulation and industry initiatives existed to address those causes
  - considered how effective they might be
  - considered what more needed to be done and made 21 recommendations
- FEMR recommends:
- '3b: A new statutory civil and criminal market abuse regime should be created for spot foreign exchange, drawing on, among other things, the work of the international project to draw up a global foreign exchange code.'

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(...but a market maker streaming 50M bids and offers to many clients is hoping not all clients will trade at once, and may take steps to prevent it)
  2. If you do intend to trade, it mustn't be for the purpose of misleading market participants.

(...but you do often want to conceal your intentions from market participants)
  3. Don't let your trading system run amok.

(...but that can be very difficult to ensure through testing, particularly in novel or extreme market situations)

# Concerned Parties

- The end (start?) clients (retail participants, corporations, small banks, central banks, asset managers, hedge funds)
  - they may be concerned about different, potentially conflicting, issues
- HFT proprietary trading desks
- HFT market making desks
- The risk and compliance departments of financial firms with HFT market making desks and particularly those with HFT prop trading desks
- ECNs (e.g. EBS, FXAll, Gain, Hotspot, ParFX, Thomson Reuters, etc.)
  - they increasingly are required to report to regulators, police the trading activity in their trading pools, manage conflicts of interest between participants
- Regulators and watchdogs
- Consultancy & legal firms, risk firms, trading technology firms, data firms
  - there is money to be made helping all the other concerned parties
- Authors
  - See ‘Consultancy & legal firms, etc.’

# Bad Behaviours:

## Market manipulation, disruption, & dodginess

The list is by no means exhaustive, the names and definitions may vary, and these behaviours are certainly not guaranteed to make a profit though they are guaranteed to cause trouble with at least some 'concerned parties' if found out.

- **Front running ('pre-hedging')**
  - E.g. when executing on behalf of client, trading ahead of client trades
  - E.g. when a client requests to trade on a non-firm quote, trying to offload the position prior to accepting or rejecting the trade
- **Flashing / Strobing**
  - Placing and swiftly cancelling similar orders many times to create the appearance of liquidity
- **Layering**
  - A form of spoofing; placing small orders with intention to trade on one side of the order book followed by a series of very large orders on the opposite side book with no intention to trade, where execution of the small orders triggers immediate cancellation of the larger orders; sometimes only called layering if it occurs within the top-of-book spread
- **Phishing**
  - Quoting or placing orders, usually in small size, to uncover orders or intentions of other participants, and then trading to take advantage of the information obtained; this technique is particularly effective on trading platforms where order confirmations are sent immediately, but market data updates are sent afterwards or even at regular, dowsampled intervals
- **Quote stuffing**
  - Placing and cancelling high volumes of quickly to disrupt trading and slow down other market participants
- **Smoking**
  - Offering attractive limit orders (better than current top-of-book) and then quickly amending these orders to worse prices to exploit slower participants' market orders
- **Spoofing**
  - Feigning interest in significant directional trading (by placing bids or offers with the intent to cancel them before they are filled) to cause a particular market reaction
- **Wash trading**
  - E.g. buying large volume on EBS while quickly selling through API channels
- **Flash crashes**
  - Sudden and statistically significant changes in price, often leading to a temporary absence of buyers or sellers, as the result of (hopefully!) unintentional single trading system error(s), the complex interaction of many trading systems in novel and extreme circumstances, or a central bank saying one thing and two days later suddenly doing the opposite

# Market Surveillance : Indicators and Preventative Measures

## Preventative Measures

Many ECNs try to prevent or at least discourage bad behaviour through the rules and structures of their trading systems.

*Examples:*

- **Minimum Quote Life (MQL)** : Quotes must remain tradable for at least a minimum amount of time (e.g. 500ms) to permit most participants the opportunity to trade on them. On some order matching systems this minimum time is enforced technically (i.e. quote cancellations are not applied until after the MQL).
- **Order matching randomisation** (also known as Latency Floor, and Order Batching) : orders arriving with a period (which is itself random in length and random in start time) are kept within one or more batches, and their priority within the batch is randomised. The point is to decrease the advantage that ultra-low latency participants have in terms of trading first. (ParFX, EBS, and Reuters all have versions of this.)

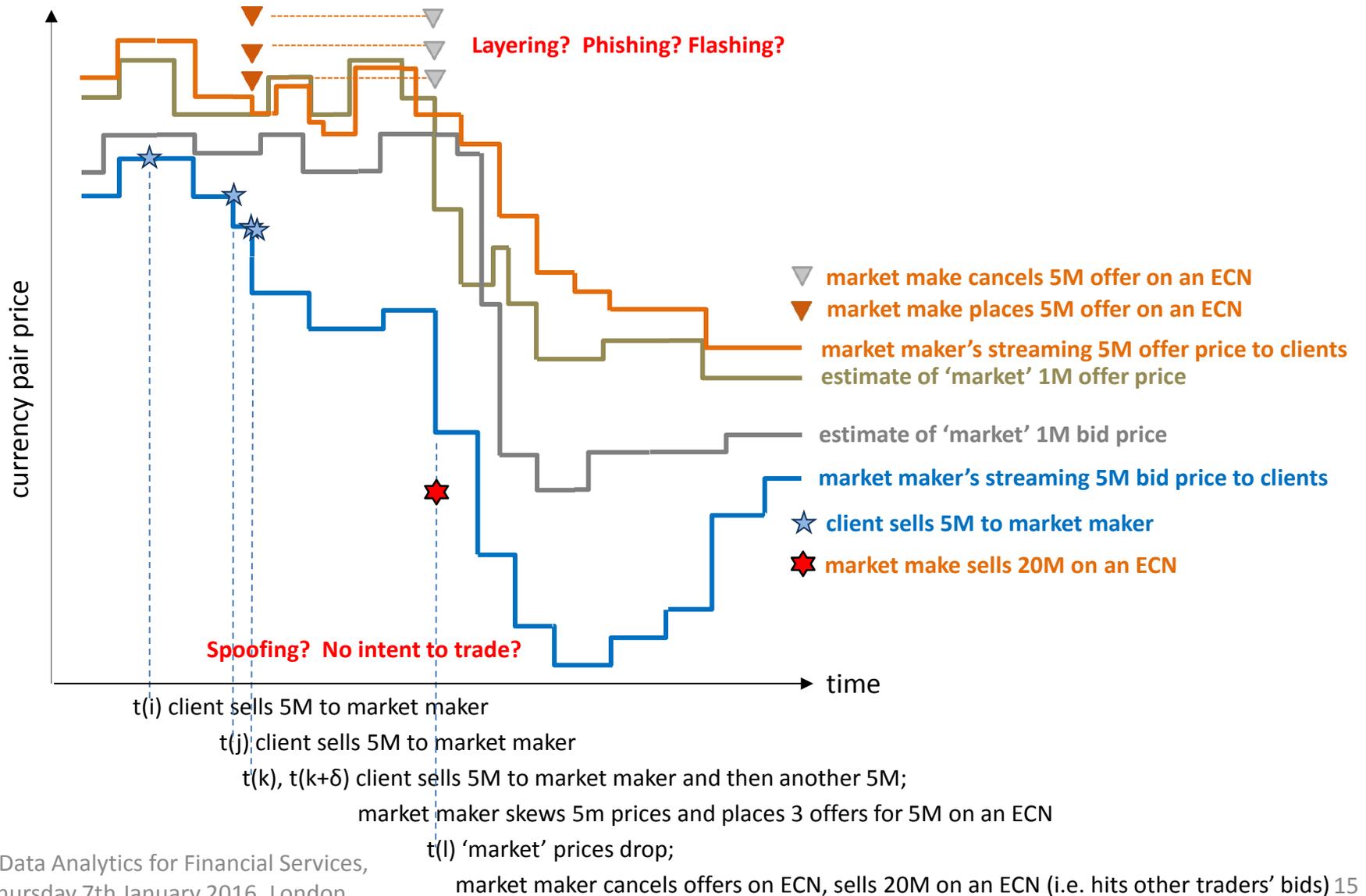
## Indicators

Market surveillance can include capturing and analysing these indicators.

*Examples:*

- **Quote lifetimes** : On some order matching participants' quote lifetime statistics are monitored by those running the system, and participants are warned if they are cancelling quotes too quickly too often.
- **'Last look' holding times** : distribution of delays by market makers when deciding whether to accept or reject a request to trade
- **'Last look' rejection ratios** : Number of trades rejected by a market maker divided by the total number of requests to trade received
- **Minimum fill ratio** (similarly 'order to trade ratio') : Number of orders executed by a participant divided by the number of orders placed.
- **Cancellation rates** : number of orders created and cancelled by a participant within a specified holding time
- **Price fade** : distribution of some or all of a participant's orders being cancelled within a given time after a trade occurring
- **Position reversal to volume traded ratio** : Number of times a participant's net order volume switches from short (long) to long (short) relative to the total volume traded
- **Strategies' names** : Please see 'High-Speed Traders Put a Bit Too Much Gravy on Their Meat' reference on Further Reading slide

# Spot FX Market Making : Being Caught in a Very Large Trade



# Market Surveillance :

## Current Approaches and Problems

Basic metrics and indicators are just a starting point.

Any market surveillance system based only basic metrics and indicators is likely to have too many false positives and too many false negatives to be effective and efficient.

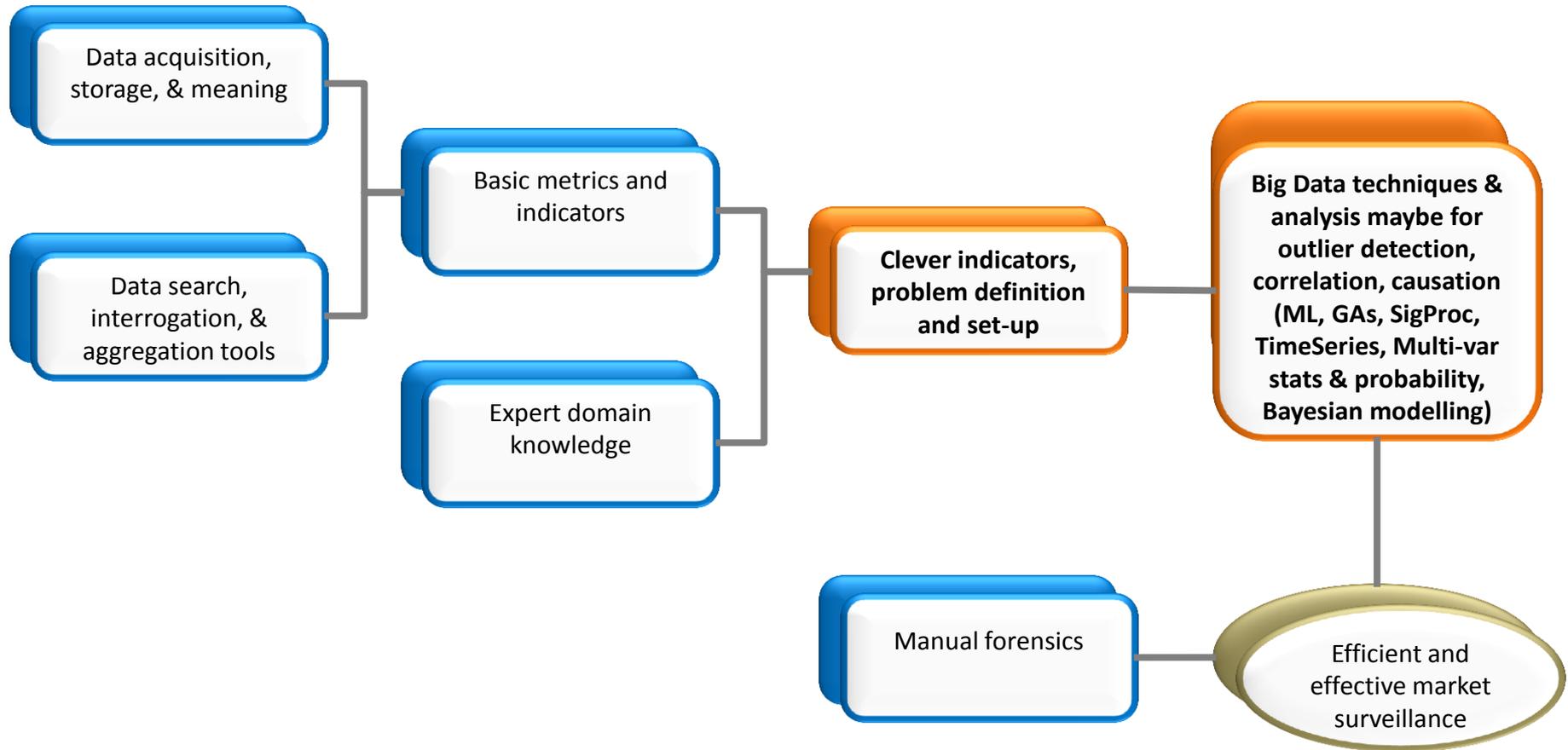
From this starting point to a fully automated, comprehensive market and trading system surveillance is a very big step.

- An HFT desk may struggle to be certain its trading system behaves appropriately. Desk members at least have usually designed, written, and tested the system so know how they want it to work.
- The risk, compliance, and senior management of firms with HFT desks certainly struggle.
- ECNs have an order of magnitude more difficult problem because they need to analyse and understand data across market participants (and trading centres).
- Regulators have an order of magnitude more difficult problem again because they need to look across ECNs, and potentially at data from direct counterparty-to-counterparty dealing via APIs and Single Dealer Platforms.

### Problems

- Usual big data problems: volume of data, rate of data volume growth, semi-structured data
- Some more finance-specific big data problems : time stamp availability, accuracy, and precision
- Skills, experience, motivation, and funding gap: very few teams or organisations currently have all four attributes.

# Market Surveillance : Big Data as the Solution?



# Further Reading

## Regulation

- Non-Investment Products Code
- <http://www.bankofengland.co.uk/markets/Documents/forex/fxjsc/nipscode1111.pdf>
- Fair and Effective Markets Review
- <http://www.bankofengland.co.uk/markets/Pages/fmreview.aspx>

## FX Markets

- Bank for International Settlements (BIS) Triennial Central Bank Survey of FX 2013
- <https://www.bis.org/publ/rpfx13.htm>
- Oliver Wyman Feb 2015 presentation 'FX Market Structure'
- [http://www.afme.eu/uploadedFiles/Events/2015/Market\\_Liquidity/AFME%20Market%20Liquidity%20Conference%202015%20-%20OW%20FX%20Market%20Structural%20Review%20Presentation.pdf](http://www.afme.eu/uploadedFiles/Events/2015/Market_Liquidity/AFME%20Market%20Liquidity%20Conference%202015%20-%20OW%20FX%20Market%20Structural%20Review%20Presentation.pdf)
- BIS paper 'The anatomy of the global FX market through the lens of the 2013 Triennial Survey'
- [http://www.bis.org/publ/qtrpdf/r\\_qt1312e.pdf](http://www.bis.org/publ/qtrpdf/r_qt1312e.pdf)

## High Frequency Trading

- Ed Howorka blog 'A brief history of HFT'
- <http://edhoworka.com/a-brief-history-of-hft/>

## High Frequency Trading and Market Surveillance

- First Derivatives' white paper 'Surveillance Techniques to Effectively Monitor Algo and High Frequency Trading'
- [http://www.firstderivatives.com/downloads/q\\_for\\_Gods\\_April\\_2014\\_Surveillance.pdf](http://www.firstderivatives.com/downloads/q_for_Gods_April_2014_Surveillance.pdf)
- Matt Levine's article 'High-Speed Traders Put a Bit Too Much Gravy on Their Meat'
- <http://www.bloombergvew.com/articles/2014-10-16/high-speed-traders-put-a-bit-too-much-gravy-on-their-meat>
- Matt Levine's article 'Why Do High-Frequency Traders Cancel So Many Orders?'
- <http://www.bloombergvew.com/articles/2015-10-08/why-do-high-frequency-traders-cancel-so-many-orders->

# Non-Investment Products Code

## (published by the Bank of England on November 2011)

### Electronic trading

Interaction with electronic trading venues and how they operate

- 50. No participant should knowingly trade beyond the technical capabilities of an electronic trading venue so that their orders cannot be processed, matched or dealt on. It is important that when an order is placed, there is an intent to deal, and when a quote is propagated, it is done in good faith.

### Pricing

- 51. All prices made on electronic trading venues should be posted with a clear intent to be tradable in accordance with the principles already set out in this Code. Those which are not intended to be tradable should be clearly labelled as indicative prices. Each order should expose the participant placing the order to a potential execution and risk position arising from the resultant trade.
- 52. Manipulation of the prices on an electronic trading venue through price flashing, entering orders without intent to deal or narrowing the top of book in a market in order to create false liquidity or pricing on another venue are not acceptable practices. Price flashing is the distribution of prices or orders to an electronic trading venue for such a short duration of time, or with such a frequency, that there is a minimal (or no) risk of execution. It can give a false impression of the market price or liquidity.
- 53. Participants should also not deliberately place orders that they have no intention of honouring or accepting to be traded on, even just for price discovery, by using a 'last look' mechanism as a control to prevent any possible subsequent trades. Using a 'last look' mechanism is within best practice when showing genuine interest at specific price levels or when providing a support price, in order to mitigate technological anomalies and latencies.
- 54. Subject to credit parameters, it is recommended that all electronic trading venues have controls in place to ensure that all participants have the opportunity to deal on a price. These should be set out in the venue rules and adherence to them should be enforced by trading venue operators, ideally by technological means. (Examples of these controls include: (a) Minimum Quote Life (MQL) - For those venues which have a time element or time-price element to the matching algorithm, then at a minimum, this should include a defined MQL of sufficient magnitude to permit the majority of participants to have the opportunity to deal on the price. This MQL should apply to all appropriate order types. (b) Introducing fill ratios – defined as the number of orders executed divided by the total number of orders placed – for all order types including 'fill or kill' orders. A 'fill or kill' order is an order placed under the condition that, when there is not an immediate match at the moment the order is received by the electronic trading venue, the order is then immediately cancelled. It is important that venues apply appropriate controls to this order type, to prevent it being used to circumvent the venue's MQL controls.)

### Risk Management obligations for participants

- 55. Participants who trade electronically should test and implement circuit breakers. (Circuit breakers are automated safety mechanisms within electronic trading to mitigate the amount of risk exposure taken when problems develop. These can be problems arising from technological failures, logical problems within the trading model itself, unanticipated behavioural interaction with other participants and algorithms within the electronic trading venue or unexpected or extreme market conditions and price moves.)
- 56. Algorithms which are trading electronically should not do so without adequate human supervision. Such supervision should be performed by individuals with the appropriate skills, training and experience. to mitigate the amount of risk accumulated, and speed with which risk accumulates, when an unexpected error or market condition arises.