Electronic Trading in fixed income institutional markets

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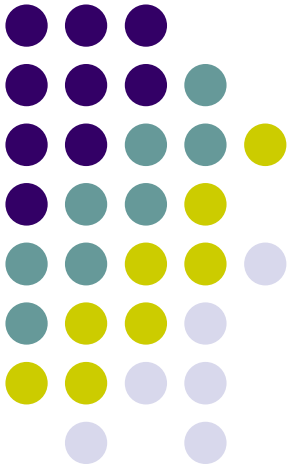

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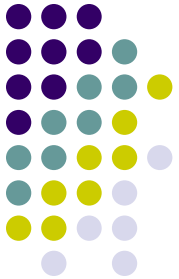
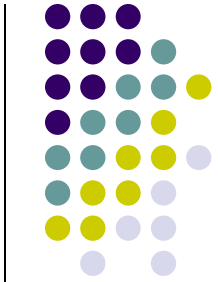
Abstract



The presentation gives a high-level overview of electronic trading in fixed income markets. We will cover the financial products that are traded electronically, with particular focus on the bilateral Over-The-Counter markets which receive less public notice and attention compared to Exchange markets. We will also touch on the typical use cases of why institutional clients would use and trade such products. Finally we dive into two areas *(FX Swaps and Government Bonds)* in more detail to showcase the modelling challenges involved in electronic market making.

What are Fixed Income markets?



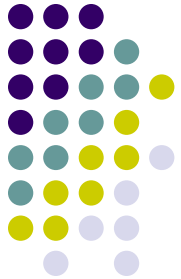
Fixed Income includes areas such as:

- Foreign Exchange (Spot FX, FX forwards and Swaps, FX Options)
- Bonds (Government and Corporate)
- Interest Rate derivatives (Swaps, Futures, Caps, Swaptions,…)
- Credit derivatives (Credit Default Swaps)
- Loans
- Repo

Commodities are often considered as part of Fixes Income

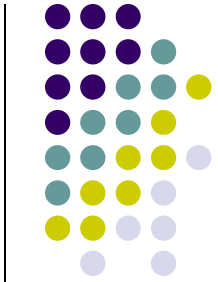
- Precious Metals (Gold, Silver, Platinum)
- Energy (Crude Oil, Natural Gas, refinery products)
- Electricity

What are typical fixed income products?



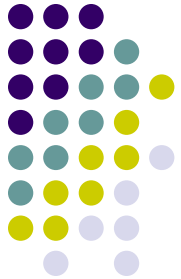
- **Spot FX** is a contract that obliges the counterparties to exchange X amount of currency1 for Y amount of currency2 in two days time (typically)
- An **FX Forward** is similar to Spot FX, but the exchange takes place at an agreed rate in the future, on a date that can be 10 years from now
- An **FX Swap** can be thought of as two FX Forwards, where the buyer exchanges the currency at spot, then exchanges it back to the original currency at some time in the future, paying the rate differential
- An **FX Option** is a contract that gives the buyer the right (but not the obligation) to exchange currency at a predefined rate at some time in the future
- A **Government Bond** is originally issued by a government, and distributed through Primary Dealers via an auction. But if a client wants to sell the bond before it matures, they need to go to market makers to help find a willing buyer
- An **Interest Rate Swap** would allow the buyer to exchange one kind of interest (let's say the prevailing interbank lending rate) for another kind of interest (let's say a fixed rate), with some frequency (every quarter) for some period (10 years)

What does “Over-the-Counter” mean?



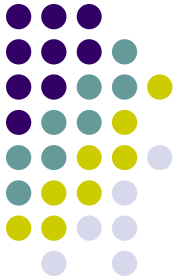
- Products are traded bilaterally between market participants
- Typically there is no central exchange or clearinghouse involved
- Banks and some other financial institutions (“Dealers”) act as **Market Makers** or **Liquidity Providers**: if a client sends a Request For Quote, they are obliged to respond with a buy and sell price (bid/offer), which they are expected to honour
- Market participants know each others’ identity before trading
- One client may see a different price than another
- But if one side goes bankrupt, there is a problem…

What is “Central Limit Orderbook” model?



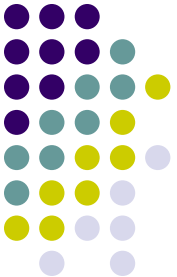
- Exchanges and some OTC inter-dealer venues use this model
- Participants send in their orders anonymously, and exchange matches the order if there is a cross between a buy and a sell
- Participants face a central clearing house, so bankruptcy risk is managed
- Identity of the counterparty is not known at the time of trading, and in some cases not even after the trade.
- Symmetry of information for both market makers and market takers

What are the main differences between OTC and CLOB?



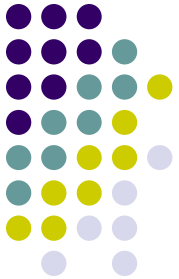
- OTC Products tend to be more custom and idiosyncratic, as opposed to exchange products which are standardized
  - FX Forwards can be traded OTC for any settlement date out to 10 years, whereas FX Futures can only be traded on certain settlement dates (quarterly), and only the first futures are actively traded
  - Government bonds are also pretty unique: a 10Y German bond is not the same as a 10Y bond issued a few months ago: different coupon rate, time to maturity, etc. But there is only one liquid Bund future contract on exchange that is prices based off of the “Cheapest-to-deliver” bond in the delivery basket
- Really large, customized deals are typically negotiated on the OTC market “over voice”

What does it mean to trade “electronically”?



- In the olden days, client would call on the phone to “Request for a Quote”
- Then client would contact using Bloomberg chat or Reuters Terminal
- Banks would start providing a trading application for the client to install on their machine
- Clients would want to compare prices across dealers so Multi-Dealer Platforms emerged
- Dealers would trade between themselves using Inter-Dealer Brokers *(EBS, Reuters, MTS)*

Electronic trading today



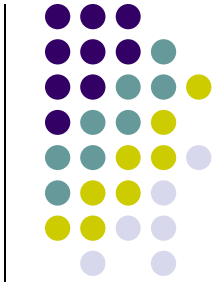
- These days, clients want to completely automate their risk management, so they connect their systems through an API
- Examples:
  - Someone takes out cash from an ATM in a different currency, an automated message gets generated to trade the same amount as an FX Forward with a major dealer
  - A company processes a bill or an order that is due in the future, they trade an FX Forward or FX Swap to lock in their margin
  - A bank issues a new fixed-rate mortgage and it trades an Interest Rate Swap to convert the fixed rate to their prevailing funding rate
  - An Euro-based investment fund invests into Emerging Markets, they automatically trade FX Swaps or FX Options to lock in the FX rate in case clients want to withdraw their investments

Why are these buildings interesting?

Equinix LD4, Slough

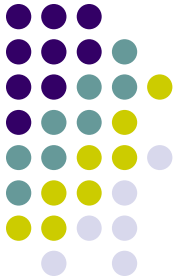
Equinix NY4, Secaucus

Trading venues



- Even though OTC trading is bilateral and decentralized…
- Everything is highly interdependent and correlated!
- There are some products that are liquid, which influence the price of all other products
  - The price of an FX Option is a function of the underlying FX Spot, so every time FX Spot changes, all FX Option prices need to be updated
  - Every time the Bund Futures are traded, we assume all bonds in the same maturity region change their price
- Latency is a major concern, so activity tends to get concentrated in particular physical locations, on particular trading venues

Modelling aspects



What is the best estimate of the price for this product at this point in time?

- The price of everything is linked and correlated to various degrees
- Price of less liquid products need to be derived/interpolated/estimated from more liquid products
- There is no single price at any point in time – due to the bilateral nature and relativistic effects of latency, prices are aggregated from various sources and sent out asynchronously
- Price of liquid products will depend on prices on liquid venues, other correlated products, the dealers' own inventory, observed client trade flow, anticipated economic events, etc.

What bid/offer should be charged for this product?

How should the accumulated inventory impact our pricing?

FX Swap – the forward curve

Name	Bid	Ask
EURUSD ON FWD	-1.2760	2.5910
EURUSD TN FWD	0.5950	0.7270
EURUSD SN FWD	0.6290	0.6950
EURUSD SW FWD	4.5900	4.7100
EURUSD 2W FWD	9.1500	9.5500
EURUSD 3W FWD	13.9100	14.2600
EURUSD 1M FWD	20.8000	21.1000

Sell 1mio EUR vs 0.98010mio USD at Spot

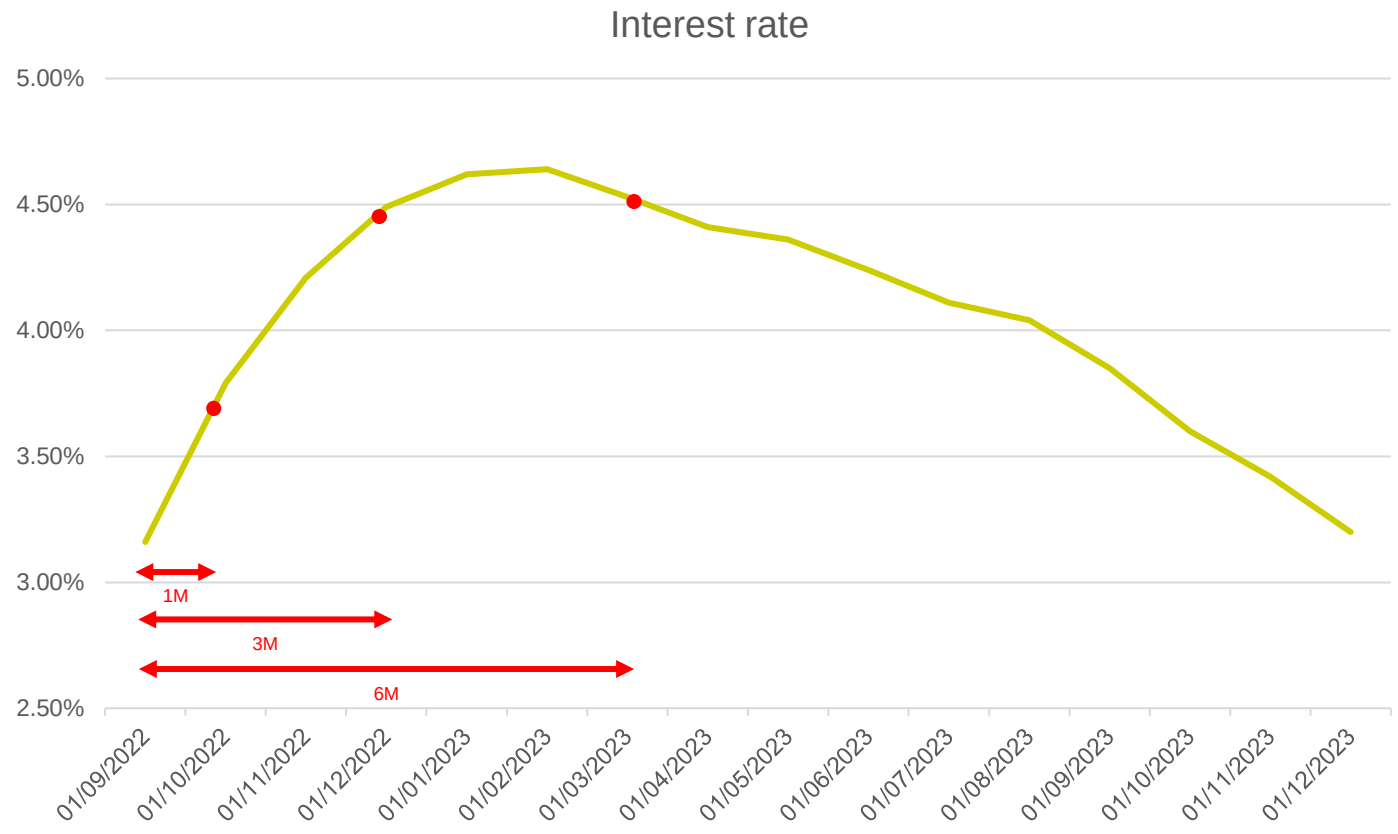
Buy 1mio EUR vs 0.98**22**1mio USD at 1 Month

This 21.1 points difference is caused by the *covered interest rate parity* between the two currencies

- Dealer can synthesize this swap by borrowing USD, and investing the EUR in a deposit

$$(1 + i_{\$}) = \frac{F_t}{S_t}(1 + i_c)$$

FX Swap – the interest rate curve – LIBOR



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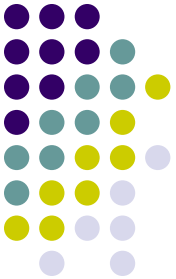
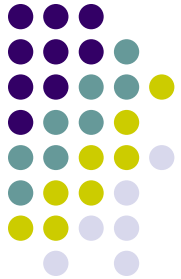
FX Swap – the interest rate curve – LIBOR



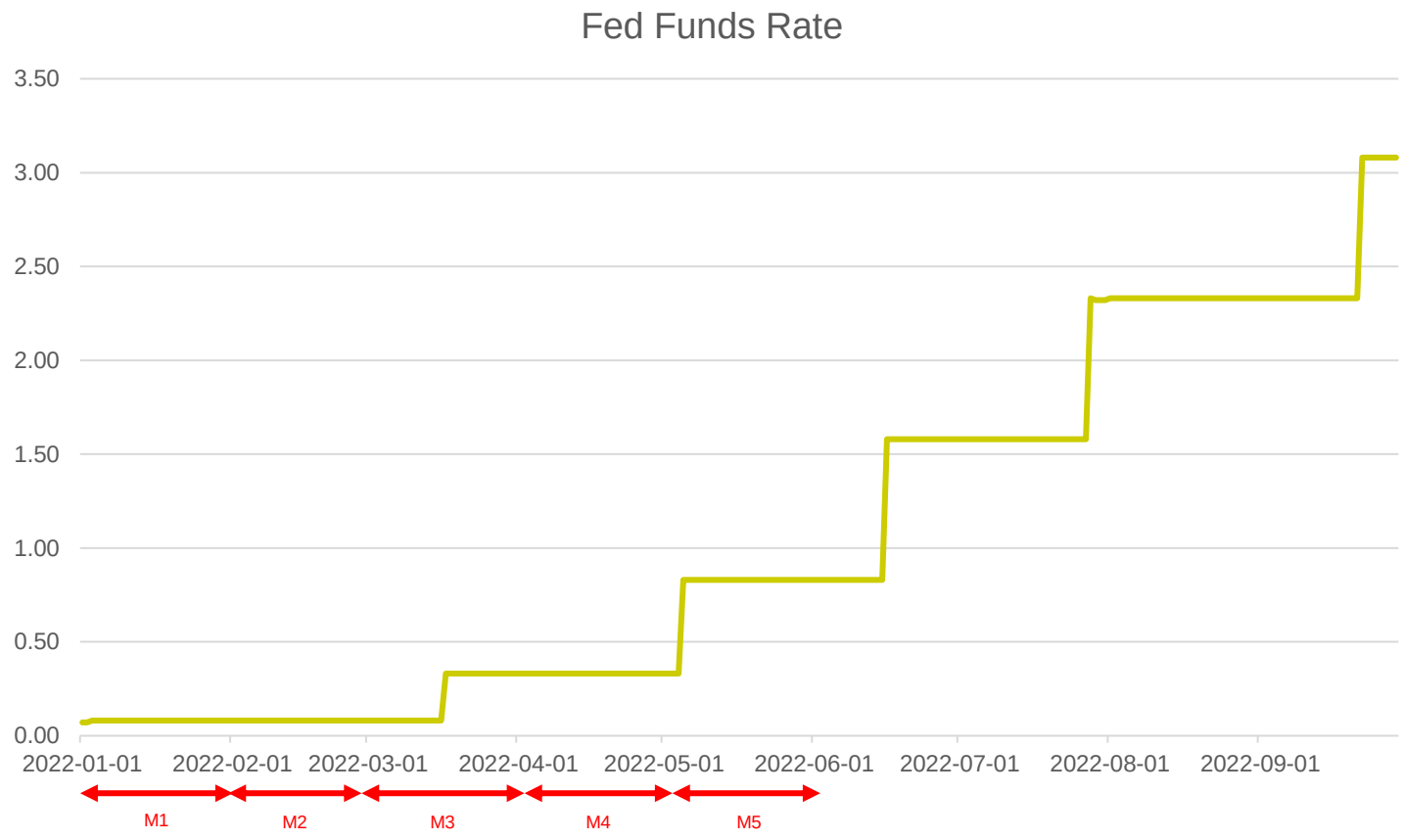
- Before 2007, the London Interbank Offer Rate (LIBOR) represented the rate at which top-tier banks would lend to each other, and it was assumed to be the “risk-free rate” of lending
- It was based on a voluntary survey by a panel of banks
- Interest rates were observable
  - 1-month, 3-month, 6-month LIBOR
  - Liquidly traded 1/2/5/10-year Interest Rate Swaps exchanging Libor versus a fixed rate
- You could *bootstrap* a curve starting from the short dates, and appending each instrument to the curve one by one:
  - “What is the 1Y interest rate that would result in 1Y swap price match what is observed in the market?”
  - Use spline interpolation to make the curve smooth

FX Swap – the interest rate curve – OIS



- The crisis revealed that LIBOR includes a credit risk component
- In 2012 it as revealed that it's prone to manipulation
- To mitigate the credit and manipulation risk, banks started using new benchmarks:
  - Fed Funds rate: the rate at which US banks lend to each other overnight, calculated by the FED from daily transactions.
  - SOFR – Secured Overnight Financing Rate: the rate at which US banks lend to each other using US Treasuries as collateral, calculated by the FED from Repo transactions.
- How is yesterday's interest rate going to help me build a curve of future interest rates?
  - Fed Fund Futures: the average FF rate for a 30-day period, up to two years in advance
  - Overnight Indexed Swap: a liquidly traded swap instrument that exchanges the average benchmark rate over a given period vs a fixed rate

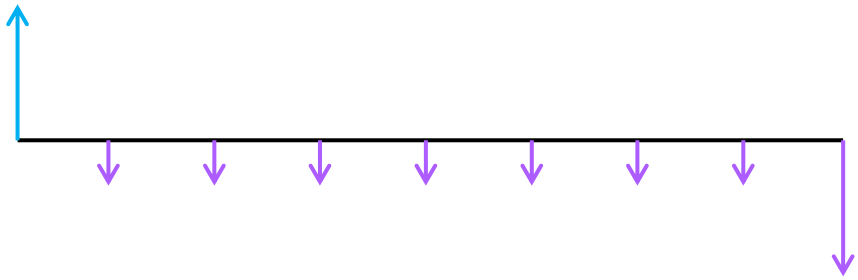
FX Swap – the interest rate curve – OIS



Government Bonds

- Coupon payments are exposed to interest rates up to maturity
- To make them comparable, we convert them to “Zero coupon yield curve”
- The weighted average duration of cash flows is shorter than maturity: a 10-year bond with 7 years remaining maturity can have 5 year duration
- Duration depends on interest rates, so bond price/interest rate relationship is non-linear *(convexity)*

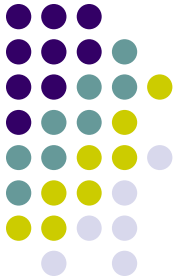
Issuer	Coupon (%)	Maturity	Price
Treasury 0.125% 31/01/2023	0.125	31/01/2023	99.09
Treasury 0.75% 22/07/2023	0.750	22/07/2023	97.65
Treasury 2.25% 07/09/2023	2.250	07/09/2023	98.42
Treasury 0.125% 31/01/2024	0.125	31/01/2024	94.85
Treasury 1% 22/04/2024	1.000	22/04/2024	95.35
Treasury 2.5% 17/07/24	2.500	17/07/2024	365.34
Treasury 2.75% 07/09/2024	2.750	07/09/2024	97.26
Treasury 0.25% 31/01/2025	0.250	31/01/2025	90.50
Treasury 5% 07/03/2025	5.000	07/03/2025	101.14



$$P = \sum_{i=1}^{N} \frac{Notional * Coupon}{(1 + Rate_i)^i} + \frac{Notional}{(1 + Rate_N)^N}$$

$$Macaulay\ Duration = \frac{\sum_{i=1}^{N} t_i\, PV_i}{\sum_{i=1}^{N} PV_i}$$

Government Bonds - Each bond is unique



- Newly issued bonds *("On-The-Runs")* are liquid, but liquidity drops as the bonds mature
  - High/low-coupon bonds have different convexity
  - A newly issued 5-year bond vs a 10-year bond with 5 years remaining maturity is not always comparable
- Activity is concentrated in a few Futures contracts
  - Liquidity premium for bonds in the Future Delivery Basket
  - Cheapest-to-Deliver bond is the most liquid
- Bonds with special contract terms, Green bonds, …

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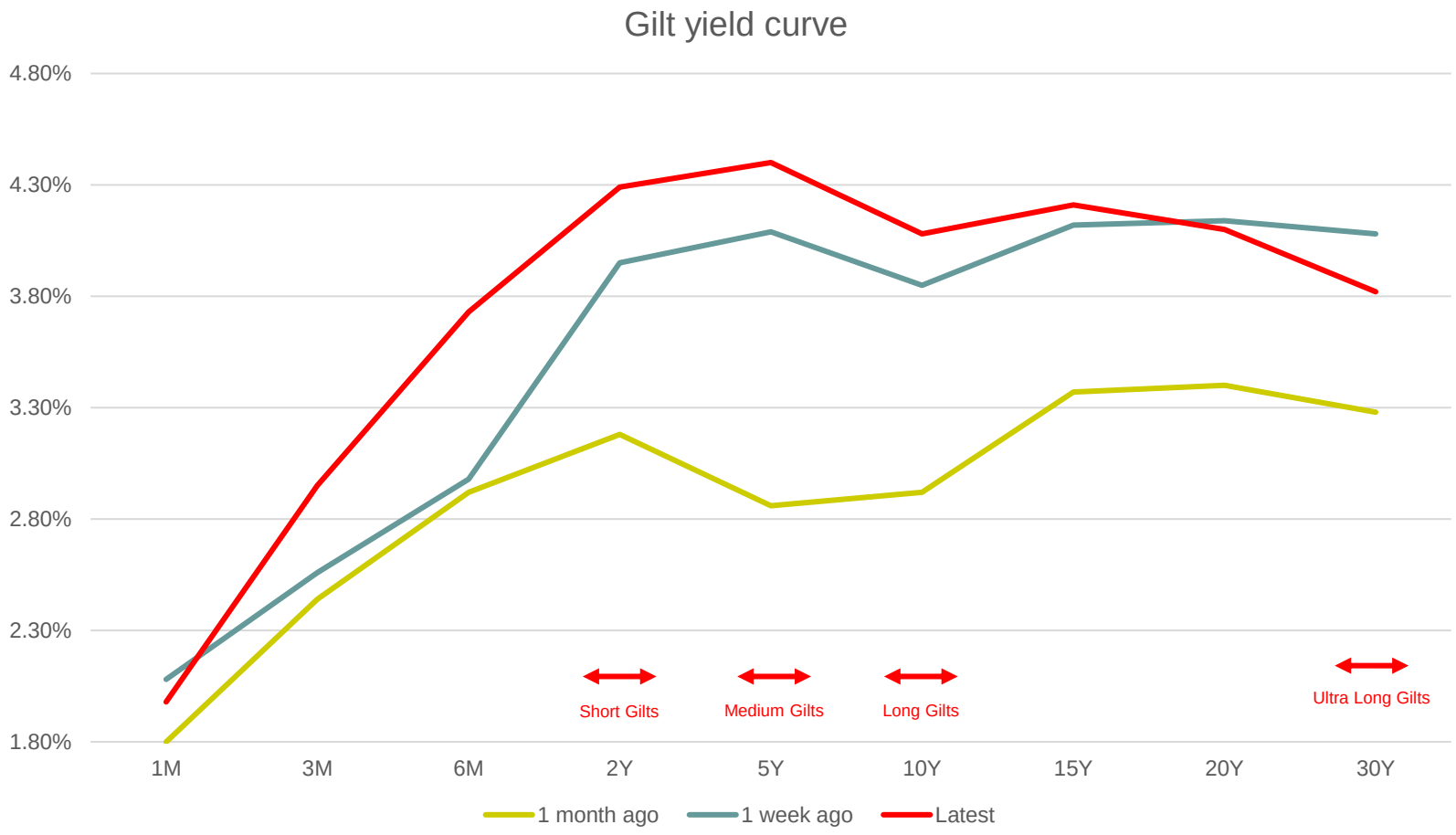
Government Bonds – Bond yield curves



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Q&A

Thank you for your attention!