EUROPEAN CENTRAL BANK

EUROSYSTEM

Statistics Paper Series

Gonzalo Camba-Méndez, Jan Jerzy Darecki,
Andrés Manzanares, Matteo Metra,
Riccardo Vergnano

On the collection of MiFIR transparency data: an application to the ECB eligible marketable assets

No 51

Contents

Abstract

One of the main goals of launching the EU's second Markets in Financial Instruments Directive (MiFID II) and the respective Markets in Financial Instruments Regulation (MiFIR) was to increase the transparency of transactions in financial markets. Prior to MiFID II, transparency requirements in financial markets were limited mostly to equities traded in regulated markets. Following MiFID II, transactions now need to be publicly reported for a broader range of financial assets. Furthermore, disclosures on financial transactions are not restricted to those transactions executed in regulated markets but apply also to those executed over the counter. Importantly, this information should be made available free of charge, ensuring non-discriminatory access, within the 15 minutes following the transaction. The published information should also be machine-readable.

The purpose of this paper is to show how a relatively simple IT tool may be devised that gathers data on market prices and transacted volumes published in compliance with MiFID II. We steer our simple IT tool towards retrieving data on those financial assets that are eligible for use as collateral in Eurosystem credit operations. This includes those assets eligible for outright purchase under the various monetary policy programmes launched by the Eurosystem. In view of the importance of UK financial markets when it comes to trading in Eurosystem eligible marketable assets, our tool also covers transactions and quotes reported by UK trading venues and investment firms in compliance with UK MiFIR. Apart from the merits and potential of our IT tool, this paper documents some of the tool's shortcomings related to processing the posted MiFID II and UK MiFIR raw data. It also covers some of the deficiencies associated with the data.

Increased market transparency contributes to deeper and more integrated financial markets, potentially supporting economic growth. ECB access to these rich financial market data is very important for the conduct of its monetary policy. This is the case not only from the perspective of gathering all information relevant for monitoring financing conditions in euro area financial markets. It is also the case that the availability of pre-trade and post-trade data published in compliance with MiFIR could be a useful day-to-day tool for central bank monetary implementation and risk mitigation. The data collected provide a rich description of the price, liquidity and depth of various types of ECB eligible marketable assets.

JEL: C81, D40, G10

Keywords: MiFID II, financial market prices, ECB eligible assets

1 Executive Summary

This paper shows how a relatively simple IT tool may be devised to gather data on market prices and transacted volumes published in compliance with MiFID II. We steer our simple IT tool towards retrieving data on those financial assets that are eligible for use as collateral in Eurosystem credit operations. This includes those assets eligible for outright purchase under the various monetary policy programmes launched by the Eurosystem. Increased market transparency contributes to deeper and more integrated financial markets, potentially supporting economic growth. ECB access to these rich financial market data is very important for the conduct of its monetary policy, both to monitor financing conditions and to manage financial risks, by obtaining accurate information on the prices at which financial assets are traded.

In view of the importance of UK financial markets when it comes to trading in Eurosystem eligible marketable assets, our tool also covers transactions and quotes reported by UK trading venues and investment firms.

Our data allows us to analyse the depth of the various market segments of ECB eligible marketable assets, revealing that the largest proportion of the transactions on ECB eligible assets relate to sovereign bonds. The transactions in eligible sovereign bonds in May 2024 amounted to €1.6 trillion, representing 17% of the outstanding amount in ECB eligible sovereign bond debt. The depth of other market segments is much less, both in terms of gross volumes traded but also in terms of the share of transactions relating to outstanding amounts. This is always well below 5%. Most of the trading is registered within the EU. The average transaction size of reported transactions in the United Kingdom is larger than in the EU for a significant majority of bond market segments, indicating that UK trading is mainly wholesale. The average size of transactions conducted over-the-counter is larger than the average size of transactions executed in trading venues (e.g. around €1.5 million for transactions on sovereign bonds executed in trading venues versus an average of €3.1 million for such transactions executed over-the-counter). When looking across the various market segments, the data reveals that trading in supranational bonds and ABSs is conducted in large sizes, while transactions in corporate bonds are conducted mainly in small sizes, with 20% of the total number of transactions associated with transactions smaller than €100,000. According to our data for May 2024, fewer transactions on ECB eligible bonds were executed over-the-counter than in trading venues.

The availability of pre-trade price data published according to the MiFIR also provides multiple analytical insights. For example, the share of ISINs for which quotes can be gathered is much larger than the share of ISINs for actual transactions. Interestingly, financial bonds, and to a certain extent also covered bonds, display very limited market activity in terms of transactions but appear relatively well represented in terms of collected quotes.

In the context of the pricing tools operated by the Eurosystem, it is crucial to aim to constantly improve the number and quality of the data inputs that go into the process

of deriving direct market prices and calibration curves. It is also here that MiFIR pre-trade and post-trade data can be put to good use, and this paper presents a concrete illustration of the benefits of expanding on price data sources.

2 Introduction

Promoting the free movement of capital is one of the objectives established by the Treaty of Rome, which was signed in 1957. Ever since then, the EU has launched various regulatory measures in support of this objective. In 2004 the first Markets in Financial Instrument Directive (MiFID) was introduced with the intention, among other things, of allowing investment firms to provide services throughout the EU and establishing transparent and non-discretionary rules for fair trading.[1] These changes facilitated competition between trading venues, thus contributing to ameliorating the fragmentation of EU financial markets (see Foucault, 2013).

The events of the 2007-08 global financial crisis highlighted weaknesses in the functioning of European financial markets. As part of its response to these events, the EU embarked on an ambitious agenda aimed at strengthening the regulatory framework for markets in financial instruments. The second Markets in Financial Instruments Directive (MiFID II) was launched and was soon followed by the corresponding MiFIR.[2] The purpose of MiFID II is to improve the functioning of financial markets in the EU. This would be done by increasing market transparency, protecting investors better and providing a sound harmonised legal framework governing the requirements applicable to the various market players (e.g. investment firms and regulated markets), while ensuring that national supervisory authorities are able to perform their role.

Prior to MiFID II, transparency requirements in financial markets were mostly limited to equities traded in regulated markets. Following MiFID II, since January 2018 brokers/dealers and trading venues have also had to report transactions relating to exchange-traded fund (ETF) certificates, bonds, structure finance products, emission allowances and derivatives. MiFID II regulates both pre-trade transparency (i.e. information on quotes on future financial transactions) and post-trade transparency (i.e. information on past financial transactions and prices).

Post-trade transparency helps investors to form their views on the intrinsic value of a financial asset. By contrast, pre-trade transparency enables investors to better assess the execution costs and risks associated with a trade. Pre-trade transparency also boosts competition between market dealers and, from this perspective, it follows that MiFID II contributes to further reducing fragmentation across EU financial markets. Increased competition between market dealers also has a positive impact on market liquidity (see Boehmer et al., 2005; Foucault, 2013 and Lannoo and

1 The “old” MiFID, or MiFID I as it is sometimes referred to, relates to Directive 2004/39/EC of the European Parliament and of the Council of 21 April 2004 on markets in financial instruments amending Council Directives 85/611/EEC and 93/6/EEC and Directive 2000/12/EC of the European Parliament and of the Council and repealing Council Directive 93/22/EEC (OJ L 145, 30.4.2004, p.1)

2 In this paper, and following standard practice, we will use MiFID II to refer to Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU (recast) (OJ L 173, 12.6.2014, p. 349). Meanwhile we will use MiFIR to refer to Regulation (EU) No 600/2014 of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Regulation (EU) No 648/2012 (OJ L 173, 12.6.2014, p. 84). In this paper, references made to MiFID II, unless linked to specific sections of the directive, should be understood as being references to the pair MiFID II/MiFIR.

Thomadakis, 2019). In turn, improved market liquidity encourages investor participation, lowering the expected return demanded from a financial asset by reducing financing costs for firms in financial markets (see Boehmer et al., 2005). It also facilitates the mobilisation of capital across countries supporting the EU economy and leads to better integration of financial markets. The latter will also improve transmission of the single monetary policy in the euro area (see ECB, 2022).

The purpose of this publication is to describe a tool that can be used to gather data on the market prices and transacted volumes of ECB eligible financial assets. Access to reliable price data for financial instruments is also very important for optimal implementation of monetary policy. This is the case not only from the perspective of evaluating monetary policy stance by gathering all information related to monitoring financing conditions in euro area financial markets. It is also the case that from a pure risk management perspective, obtaining accurate information on the prices at which financial assets are traded is crucial for mitigating risks in both outright purchase programmes and collateralised lending operations. The ECB has a high level of exposure to marketable debt instruments. This derives directly from large asset holdings of marketable debt instruments resulting from the ECB's outright purchase programmes and indirectly from large volumes of collateralised credit granted to credit institutions (given that the bulk of the collateral employed by the banks consists of marketable debt instruments).[3]

The pricing framework guiding purchases for all the ECB's outright purchase programmes relies on available market prices to ascertain fair value. In addition to reflecting on prices before asset purchases, the ECB's risk management area also conducts post-trade checks on transaction prices executed as part of its monetary policy operations (see ECB, 2015).

To mitigate credit, legal and operational risks, Eurosystem credit operations are conducted against adequate collateral. The amount of cash lent against a collateral asset depends on that asset's market value. Frequently updating the latter ensures that (at least prior to a counterparty default) the exposure is covered. Daily pricing allows for daily mark-to-market collateral valuation, triggering margin calls when the value of a counterparty's collateral pool falls below a defined threshold (see Adler et al., 2023). Furthermore, the efficient calibration of valuation haircuts is heavily reliant on good quality market price data.

This note is organised as follows. Section 3 provides a brief overview of the transparency requirements imposed by MiFIR. In view of the relevance of UK financial markets to transactions in EU bonds, we also elaborate on the transparency requirements imposed by UK MiFIR and the implications of a separate (albeit not too dissimilar) transparency regulatory regime in the United Kingdom. Section 4 describes the data sources and database schema for the retrieval of MiFID

[3] The ECB publishes the Eurosystem´s consolidated financial statements on a weekly basis. On the asset side, item 7.1 is linked to "Securities held for monetary policy purposes" and item 5 is linked to "Lending to euro area credit institutions related to monetary policy operations denominated in euro". On 14 July 2023 item 5 and item 7.1 were €610 billion and €4.8 trillion respectively. On 7 October 2022 item 5 and item 7.1 were €2.1 trillion and €4.9 trillion respectively.

transparency data associated with the universe of ECB eligible marketable financial assets, targeting data from EU and UK trading venues as well as over-the-counter transactions executed by EU and UK investment firms. Section 5 elaborates on the technical aspects associated with IT retrieval and database management. Section 6 provides some stylised facts for the financial data that illustrate the rich information that can be extracted from the database and how it can be applied for analytical and central bank policy implementation purposes. Finally, Section 7 concludes and reflects on the future workplan to expand use of this tool.

3 Transparency requirements in respect of bonds under MiFIR

3.1 Trading venues and over-the-counter transactions

All financial instruments admitted to trading on a regulated trading venue are under the scope of MiFID II. These include shares, depositary receipts, ETF certificates, bonds, structured finance products, emission allowances and derivatives. Such financial instruments may have been issued in the EU or beyond, the relevant factor being that they are traded on trading venues regulated by EU national competent authorities. Instruments that are registered for trading in regulated trading venues will also need to comply with certain transparency requirements when these instruments are transacted over-the-counter (i.e. outside a trading venue) by regulated investment firms.

A trading venue should be understood as a regulated market (RM), a multilateral trading facility (MTF) or an organised trading facility (OTF), as defined in MiFID II. All three types of trading venue are multilateral systems, based in the EU, that bring together multiple third-party buying and selling interests in financial instruments and have been authorised by competent authorities to operate as such.

MiFID II defines an RM as a trading venue operated and/or managed by a market operator that is required to perform its tasks under the supervision of a competent national supervisory authority. By contrast, an MTF can be operated by either a market operator or an investment firm and is not subject to the strict supervision applicable to RMs. In both RMs and MTFs trading is conducted according to non-discretionary rules and neither RMs nor MTFs are entitled to engage in own-account trading. By contrast, OTFs may execute orders on a discretionary basis, taking a role in negotiations between market participants, and may trade on an own-account basis. OTFs may operate in bonds, structured finance products, emission allowances or derivatives. They may not, however, operate in equities. Both MTFs and OTFs must be authorised by the competent authorities to operate as trading venues and should thus comply with the conditions stipulated in MiFID II, Title II.

The stricter supervision applicable to RMs is also reflected in the fact that the registration of a security for trading in a regulated market implies the fulfilment of various regulatory disclosure requirements, including the publication of a detailed prospectus approved by the supervisory authority.[4] EU legislation also requires issuers whose securities are traded in regulated markets to ensure that annual financial reports are made public in a timely manner.[5] Furthermore, the current EU

4 See Regulation (EU) 2017/1129 of the European Parliament and of the Council of 14 June 2017 on the prospectus to be published when securities are offered to the public or admitted to trading on a regulated market, and repealing Directive 2003/71/EC (OJ L 168, 30.6.2017, p. 12).

5 See Directive 2004/109/EC of the European Parliament and of the Council of 15 December 2004 on the harmonisation of transparency requirements in relation to information about issuers whose securities are admitted to trading on a regulated market and amending Directive 2001/34/EC (OJ L 390, 31.12.2004, p. 38).

provisions on corporate sustainability reporting establish differentiated reporting requirements for undertakings, depending on whether or not their securities are admitted to trading on a regulated market in the EU.[6] The disclosure of information associated with tradable securities is vital if asymmetries of information between investors and issuers are to be removed, thereby ensuring investor protection. By contrast, a prospectus approved by the supervisor need not necessarily be provided for financial instruments registered for trading in MTFs. Only when an initial public offering is conducted via an MTF does this requirement need to be fulfilled.[7]

3.2 Pre-trade versus post-trade transparency

Titles II to IV of MiFIR impose various pre-trade and post-trade transparency requirements on market operators and investment firms. Pre-trade requirements relate to information on bid and offer prices and the volumes intended for trade at the prices advertised. Post-trade requirements relate to the time of execution, the transaction price of the financial instrument and the transaction volume. In both cases reporting takes place at the level of the instrument, which is uniquely identified by a financial instrument identification code. These transparency requirements relate to the disclosure of market transactions to the public and to the relevant competent supervisory authorities. They extend to the trading of shares, depositary receipts, ETF certificates, bonds, structured finance products, emission allowances and derivatives. We will now focus exclusively on the transparency requirements stipulated for bonds, which are the relevant marketable financial asset class eligible as ECB collateral for credit operations. With regard to pre-trade transparency for bonds, trading venues operating a central limit order book or a periodic auction system must comply with pre-trade transparency requirements. Trading venues operating other trading systems, most notably request-for-quote systems, need not comply with the pre-trade transparency requirements. As indicated in paragraph 7 of the preamble to the recent amendment to MiFIR: “[…] voice-trading systems and request-for-quote systems provide requesters with tailor made quotes which have marginal information value to other market participants”.[8] Meanwhile, investment firms conducting financial transactions over-the-counter are not required to comply with pre-trade reporting requirements.

With regard to post-trade transparency for bonds, all transactions conducted in EU regulated traded venues must comply with the post-trade requirements, whatever type of trading system is adopted by the trading venue. Furthermore, investment firms conducting financial transactions over-the-counter must comply equally with post-trade reporting requirements (see MiFIR, Title III). The information associated with over-the-counter financial transactions executed by investment firms should be

6 See Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting (OJ L 322, 16.12.2022, p.15).

7 See also Regulation (EU) 2017/1129.

8 See Regulation (EU) 2024/791 of the European Parliament and of the Council of 28 February 2024 amending Regulation (EU) No 600/2014 as regards enhancing data transparency, removing obstacles to the emergence of consolidated tapes, optimising the trading obligations and prohibiting receiving payment for order flow (OJ L, 2024/791, 8.3.2024).

made public through an approved publication arrangement (APA) in as close to real-time as is technically possible (see MiFIR, Article 20). An APA, according to its definition in MiFID II, is a "person [sic] authorised under this Directive to provide the service of publishing trade reports on behalf of investment firms". The Directive also mandates that information shall be made public once through a single APA, thus avoiding duplications in the reporting of financial transactions, and that it be offered to the public free of charge.[9]

Market operators and investment firms operating a trading venue are responsible for reporting the pre-trade (quotes) and post-trade (transactions) activities conducted in the trading venue. APAs are responsible for reporting post-trade (transactions) activities conducted over-the-counter by EU investment firms. This information should be made available free of charge, at the most 15 minutes after the transaction and ensuring non-discriminatory access (see MiFIR, Articles 13.1 and 13.2). Both trading venues and APAs should publish data that are machine-readable, meaning that it should be possible for the data to be accessed, read, used and copied by computer software that is free of charge and publicly available. APAs should make instructions available to the public explaining how and where to easily access and use the data, also identifying the electronic format (see Regulatory Technical Standards (RTS) 13 supplementing MiFIR).[10]

It is important to point out that MiFIR, Article 1 stipulates that pre-trade and post-trade transparency requirements do not apply to transactions with the European System of Central Banks (ESCB) when these are conducted as part of the monetary, foreign exchange and financial stability policies of the ESCB. This means that collecting MiFIR data using the tool described in this paper will not grant the general public access to such transactions.

Increased market transparency should attract and encourage investors and should directly address the problem of market fragmentation across the various trading venues in Europe. Transparency facilitates price formation, allowing investment firms to assist their clients more effectively. However, MiFID II also acknowledges that heightened transparency may discourage liquidity providers or market-makers from participating in financial markets. This could be the case if liquidity providers fear that excessive transparency could jeopardise their ability to liquidate large positions. MiFIR therefore contains a number of relaxations of reporting obligations that fully waive the requirement to report in the case of pre-trade reporting (quotes) or that, in the case of post-trade reporting, allow the publication of some or all of the details associated with a transaction to be deferred.

Waivers (pre-trade). The pre-trade reporting requirements (quotes) for bond instruments are waived altogether if the prospective trade is (i) to be conducted in a non-liquid market or (ii) large in scale, see MiFIR, Article 9(1a) and Article 9(1c).

---

9 APAs may charge investment firms (the traders) for the service of posting details of these transactions to the public. However, this should be carried out on a reasonable commercial basis.

10 See Article 14 of Commission Delegated Regulation (EU) 2017/571 of 2 June 2016 supplementing Directive 2014/65/EU of the European Parliament and of the Council with regard to RTS on the authorisation, organisational requirements and the publication of transactions for data reporting services providers (OJ L 87, 31.3.2017, p. 126).

There are RTS that provide the precise definition of what constitutes a liquid market or what constitutes large-in-scale prospective transactions. These RTS will be referred to subsequently as “RTS 2 supplementing MiFIR” or simply as “RTS 2”.[11]

Deferral (post-trade). The conditions under which the reporting of transactions in bond instruments may be delayed for a certain period of time are elaborated in Article11(1a) of MiFIR. These conditions allow publication to be deferred, depending on the category a given bond transaction is assigned to. For our purposes there are five main categories for these bond transactions:

- Category 1: medium-sized transaction conducted in a liquid market;
- Category 2: medium-sized transaction conducted in a market that is NOT liquid;
- Category 3: large-sized transaction conducted in a liquid market;
- Category 4: large-sized transaction conducted in a market that is NOT liquid;
- Category 5: very large-sized transaction in a bond.

Once again, definitions of what constitutes a liquid market or medium-sized/very large-sized transaction conditions are left to RTS 2.

At the time of writing there are certain harmonised criteria that define what constitutes a liquid market. However, time entitlements when delaying publication of transactions as well as the post-trade information published (i.e. deferral regimes) are not completely harmonised across the euro area. This is because MiFIR provides different possibilities which are applied at the discretion of national competent authorities. ESMA (2020a) suggests that the overwhelming majority (over 98%) of non-sovereign bonds benefiting from a deferral regime have a two-day publication delay entitlement. By contrast, a significant majority (around 80%) of sovereign bonds benefiting from a deferral regime afford an entitlement to delay publication by as much as four weeks. In addition, transactions may be reported in aggregated form. For sovereign bonds, the publication of aggregated transactions may imply an aggregation of transactions that might be executed over a one-week period rather than on the same day.

[11] Commission Delegated Regulation (EU) 2017/583 of 14 July 2016 supplementing Regulation (EU) No 600/2014 of the European Parliament and of the Council on markets in financial instruments with regard to regulatory technical standards on transparency requirements for trading venues and investment firms in respect of bonds, structured finance products, emission allowances and derivatives (OJ L 87, 31.3.2017, p. 229). This Regulation sets the RTS on transparency requirements associated with MiFID II/MiFIR for non-equity financial instruments and defines the details associated with financial transactions that should be made available to the public. This regulatory text is called the “RTS 2 supplementing MiFIR” or, simply, “RTS 2”.

3.3 Transparency requirements under UK MiFIR

UK financial markets are very important centres for transactions in euro area assets. Trading in ECB eligible bonds in the United Kingdom, both in trading venues and/or over-the-counter, has always represented a large share of the total market for ECB eligible bonds. From 31 December 2020, following the end of the transition period stipulated in the withdrawal agreement between the EU and the United Kingdom, UK trading venues no longer operate under the regulatory framework of EU trading venues. However, following the transition period, in 2022 the United Kingdom embarked on its Wholesale Markets Review (WMR) in an attempt to improve the functioning of secondary financial markets in the United Kingdom and to take advantage of the new regime following withdrawal from the EU (see HM Treasury, 2022). Subsequently, the UK authorities agreed to retain the MiFID II/MiFIR texts through UK legislation (the Financial Services and Markets Act of 2023), albeit with the introduction of some changes associated with a relatively narrow set of issues identified in the WMR. The remaining issues identified in the WMR will require more substantial changes to the regulation and were left for a later date.

In practical terms this meant that in the aftermath of the United Kingdom's withdrawal from the EU, financial transactions in bonds in the United Kingdom, whether executed in trading venues or over-the counter, were subject to transparency standards that were similar to those in the EU (corresponding in fact to those agreed as part of MiFID II/MiFIR).

Meanwhile, in early 2024 the EU approved new amendments to MiFIR as part of the March 2024 MiFIR Review. The amendments relate to the transparency regime associated with fixed income transactions and, among other issues, stipulate that:

1. pre-trade transparency ceases to apply to systematic internalisers (dealing over-the-counter) and trading venues operating under request-for-quote and voice-trading systems; [12]

2. a new deferral regime for bond transactions should be devised with the aim of harmonising practices across the EU.

Point (2) above will still require time for implementation as it will require substantial amendments to RTS 2, which at the time of writing have not yet been incorporated. However, point (1) has already been enforced in the EU and is a point of departure from the current regime in the United Kingdom. To a degree this means that the pre-trade transparency regime in the United Kingdom is currently both stricter and broader in scope. However, this is likely to change soon. A recent consultation launched by the Financial Conduct Authority (FCA) is putting forward proposals for some amendments to UK regulation regarding the transparency of financial

[12] Before the March 2024 MiFIR review, systematic internalisers had to comply with certain pre-trade reporting requirements associated with over-the-counter activities. According to MiFID II, systematic internalisers are defined as "investment firms which, on an organised, frequent, systematic and substantial basis, deal on own account when executing client orders outside a [trading venue]". The pre-trade information requirements associated with the over-the-counter activities of systematic internalisers had to be made public through the facilities of a regulated market or an APA, or by means of proprietary arrangements. Note that in the previous section the discussion of the scope of MiFIR already reflects the amendments incorporated in March 2024.

transactions, likely reflecting the amendment in point 1 above (see FCA, 2023). It is therefore to be expected that the transparency regimes in the EU and in the United Kingdom will not differ very much in the years to come.

In practical terms, this means that financial transactions executed in UK trading venues or over-the-counter transactions executed by UK investment firms can be retrieved directly from UK trading venues and UK APAs. This also means that transactions in ECB eligible assets can be monitored in both the EU and the United Kingdom. The only problem associated with this is avoiding the risk of double-counting financial transactions, and it should also be borne in mind that for the United Kingdom reported volumes will obviously be denoted in pounds rather than in euro.

In particular, and from the perspective of the EU, the EU's MiFID II/MiFIR regulatory regime stipulates that over-the-counter transactions concluded between EU investment firms and non-EU firms must be reported in the EU through an APA. This also applies to the reporting requirements expected of UK firms when operating over-the-counter for instruments registered in UK trading venues. To the extent that a financial instrument is registered for trading in both EU and UK trading venues, it is expected that an over-the-counter transaction between a UK investment firm and an EU investment firm will be reported in both a UK APA and an EU APA.

With regard to transactions executed in trading venues, the EU regulatory regime is not very specific on whether and if so how transactions of financial instruments (listed in EU trading venues) executed by an EU investment firm in a third-country trading venue are to be reported in the EU. A European Securities and Markets Authority (ESMA) opinion on this matter (see ESMA, 2020b) has stipulated that transactions executed by EU investment firms in a trading venue located outside the EU should also be reported via an APA in the EU, although only when that trading venue is not subject to transparency rules similar to those enforced by the MiFID II/MiFIR framework. As we discuss below, the UK trading venues targeted in our IT tool are all included on this list. Meanwhile, on 1 October 2020 the FCA published a statement indicating that UK investment firms executing financial transactions in trading venues outside the United Kingdom would not be required to publish those transactions through an APA in the United Kingdom.[13]

Overall, this suggests that there will be double-counting in respect of over-the-counter transactions between a UK investment firm and an EU investment firm, but potentially more limited double counting in respect of transactions by an EU investment firm in a UK trading venue and/or transactions by a UK investment firm in an EU trading venue. However, as we show in Box 1 in Section 6.2, there is apparent double counting of financial transactions executed in UK or EU trading venues, suggesting that the recommendations in the ESMA opinion, as well as those issued in the FCA's statement, may not always be adhered to by the competent supervisory authorities and/or investment firms.

[13] See the FCA's statement "MiFID trade reporting and position limit obligations" on I October 2020.

4 Data sources and database schema

4.1 ECB list of eligible marketable assets

The ECB accepts as collateral a broad range of fixed income instruments and publishes a daily list of eligible marketable assets, identifiable by corresponding ISIN, together with some of their characteristics (e.g. type of asset, maturity, issuer name and haircut category assignment).[14] This list of assets numbers around 29,000. This narrows down the records collected by our tool to primarily fixed income instruments (see Section 5 for more details). The eligibility criteria used to assemble this ECB list have been set with a view to avoiding market distortions and the preferential treatment of asset classes, issuers or sectors. At the same time, the ECB's collateral framework aims to restrict collateral to simple and transparent debt instruments. To be eligible as valid collateral for ECB credit operations, debt instruments must either be admitted to trading on an RM (authorised in accordance with MiFID II) or admitted to trading on certain acceptable non-regulated markets (but possibly regulated trading venues such as MTFs or OTFs) that comply with certain principles of safety, transparency and accessibility.[15] Bindseil et al. (2017) provide more details on the desirable properties of a central bank collateral framework. A table showing a list of ECB eligible assets will represent one of the sources of our relational database (see Section 3.4, Chart 1 below).

4.2 Trading venues and APAs

According to ESMA statistics, bonds are mostly traded over-the-counter (see ESMA, 2021, pp. 6). Unlike equities, for which deals are mostly executed via an electronic platform, the telephone is still the primary communication channel in the secondary bond market in Europe. 59% of bond transactions are executed over-the-counter while more than 55% of equity transactions are executed in trading venues. According to ESMA (2021), the volume of bonds traded on EU markets excluding the United Kingdom amounted to €17.9 trillion in 2020, with the figure rising to €61.6 trillion if trading in UK venues is included. In this context, it is important to remember that the United Kingdom (London) has always been a big financial centre for transactions in international euro-denominated and non-euro denominated financial assets. In our paper the focus will be on ECB eligible assets which are primarily euro-denominated – within that scope UK trading volumes do not exceed those of EU markets. However, from our perspective it is nonetheless of the essence to (i) retrieve information on both over-the-counter transactions and transactions executed in trading venues and (ii) collect data associated with bond transactions from both the EU and the United Kingdom.

14 The ECB publishes the list of eligible marketable assets daily on its website.

15 See Article 68 of ECB/2014/60 on the implementation of the Eurosystem monetary policy framework (General Documentation Guideline).

According to MiFIR, the post-trade reporting of bond transactions should be conducted by trading venues or APAs (for over-the-counter transactions or transactions executed on a third-country trading venue), whereas the reporting of pre-trade transactions should be enforced by trading venues applying a central limit order book or a periodic auction trading system. As discussed in Section 3.3, UK MiFIR currently enforces pre-trade reporting requirements that apply to a broader set of trading venues. However, this is likely to change in the years ahead.

Both ESMA and the FCA compile and update registers of authorised RMs, MTFs, OTFs and APAs. This registry list of trading venues and APAs will represent the second main table of our relational database. Once again, for the sake of completeness, in Annex I we reproduce some of the main details associated with our database's Table of Trading Venues. The number of reporting entities in the EU is about 315, split between 15 active APAs and 300 trading venues (128 RMs, 142 MTFs and 30 OTFs). Meanwhile, the number of reporting entities in the United Kingdom is about 133, split between six active APAs and 127 trading venues (14 RMs, 79 MTFs and 34 OTFs).

4.3 Linking trading venues with ECB eligible assets

ESMA has established a registry that discloses the full universe of financial instruments under the scope of MiFIR: the Financial Instruments Reference Data System (FIRDS). Meanwhile, the FCA publishes a similar list of instruments under the scope of UK MiFIR. These unique databases are updated daily and independently by ESMA and the FCA and are available for free download via the internet. The lists also make it possible to link a financial asset, identified by its ISIN, with the trading venues in which this ISIN is registered for trading. These FIRDS lists produced by ESMA and the FCA (although limited to ECB eligible marketable assets) represent the third main source of our relational database and allow us to precisely identify the trading venues in which ECB eligible assets are registered for trading. As will be discussed in more detail in Section 6.1, the number of trading venues in which ECB eligible assets are registered for trading is a very small proportion of the total number of trading venues.

4.4 Transaction records and database schema

The final two tables of our database are assembled with (i) the post-trade records of transactions involving ECB eligible assets collected directly from the individual retrieval points established by the trading venues and the APAs for the benefit of the public, and (ii) the pre-trade posted quotes associated with those assets in those same trading venues and APAs. Unlike the situation for equities (largely traded in trading venues), where posted quotes are firm and carry a strong expectation of commitment, quotes for bonds provided over-the-counter may be only indicative (rather than firm) commitments to trade. Therefore, certain segments of the bond markets remain rather opaque and quotations are less informative of market

conditions and dynamics than they are in the more liquid equity markets. Furthermore, a large share of the transactions in bonds are executed in the over-the-counter market. From this perspective, access to both pre-trade and post-trade data on fixed income instruments would provide a better picture for the purposes of analysing price developments.

Data collection for transactions and quotes represents a more technical challenge in the construction of our database. As explained above, Commission Delegated Regulation (EU) 2017/583 sets the RTS for the details associated with financial transactions (post-trade) and quotes (pre-trade) that should be made available to the public. The information (fields and flags) contained in the trade message varies according to asset class and individual trade scenarios. Following the RTS supplementing MiFIR published by ESMA, certain fields are common across all asset classes for the purposes of post-trade transparency (RTS 1 for equity financial instruments and RTS 2 for non-equity financial instruments), while additional non-equity-specific fields are required for non-equity products (RTS 2). Article 7 and Annexes II and III of RTS 2 provide details on the mandatory fields and format types that should be followed when reporting post-trade transactions. Annex II of RTS 2 also provides a long list of flags that should be reported. These flags are useful in identifying transactions subject to deferral regimes or identifying records adjusting previously reported transactions. So, for instance, some observations may be amendments to previous transactions (e.g. revealing the volume of the transaction that had previously been hidden) or they might indicate the cancellation of previously reported transactions. Article 2 and Annex I of RTS 2 provide the standards that must be followed when reporting pre-trade quotes. Standards for reporting pre-trade quotes are defined in more general terms than those for post-trade reporting.

Chart 1

Schema of MiFIR tool relational database.

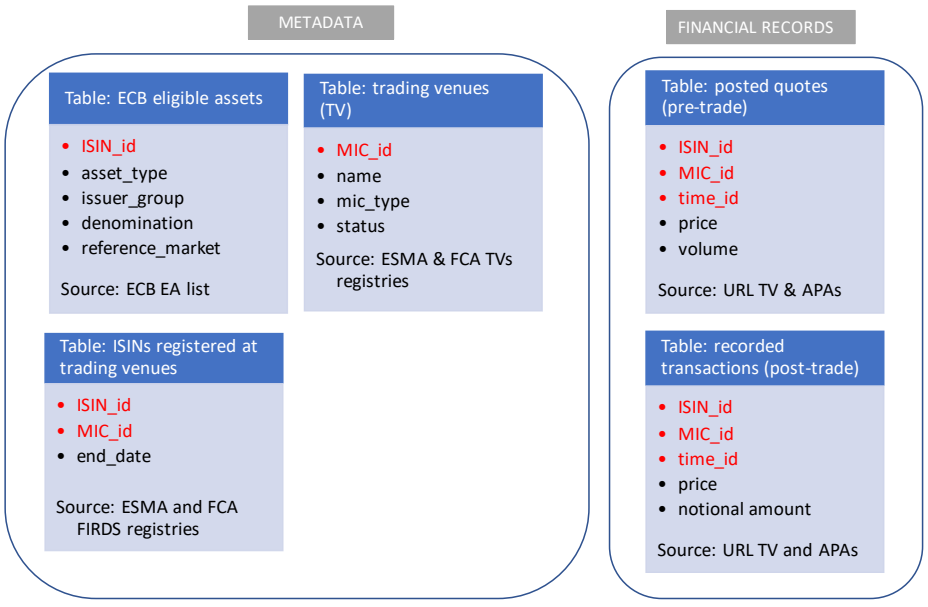


Chart 1 displays a simple schema of our relational database. The ISIN represents the primary key identifier for every individual asset. The Market Identifier Code (MIC) represents the primary key for trading venues or APAs. Finally, the combination of ISIN, MIC and datetime represents the key identifier for each transaction. In Annex I: Tables of field names we reproduce the main details associated with the various tables in our database.

5 IT retrieval and database management

5.1 IT retrieval technicalities for metadata

The data used to compile the three main tables that comprise the metadata for our database are freely available to download from the internet. Retrieval of the data from the internet can be accomplished by employing the cURL free software which has become a standard for transferring data using various network protocols. cURL Provides a library (libcurl) and a command-line tool (curl). Python provides an interface for the libcurl library in its package PycURL.

Examples of the code used to retrieve our data (executable as part of a standard Bash script file) are shown in **Table 1**. The main issues to note are as follows. First, the table of ECB eligible assets is directly downloadable as a well-structured csv file storing the records for a given day. The procedure for automatising the selection of the date and for uploading the records to a database management system are straightforward to implement and have therefore been left undocumented for the purposes of this paper.

Table 1

Command lines for the retrieval of metadata main files.

Table for which data are retrieved	CURL
ECB eligible assets	curl https://www.ecb.europa.eu/paym/coll/assets/html/dla/ea_MID/ea_csv_230613.csv -o $HOME/MIFIR_DATA/ECB_eligible_assets.csv
Trading venues	FIELDS_TVS="authorisationNotificationDate:ae_authorisationNotificationDate,homeMemberState:ae_homeMemberState,competentAuthority:ae_competentAuthority,lastUpdate:ae_lastUpdateStr,authorisationWithdrawalDate:ah_authorisationWithdrawalDate,entityTypeCode:ae_entityTypeCode,MIC:ae_micLeiEsmaId,authorisationEndDate:ac_authorisationEndDate,timestamp,headOfficeAddress:ae_headOfficeAddress,authorisationWithdrawalEndDate:ae_authorisationWithdrawalEndDate,status:ae_status,entityTypeLabel:ae_entityTypeLabel,headOfficeLei:ae_headOfficeLei,lei:ae_lei,entityName:ae_entityName" curl "https://registers.esma.europa.eu/solr/esma_registers_upreg/select?q=ae=%7B!join+from%3Did+to%3D_root_%7Dae_entityTypeCode%3AMIR+ae_entityTypeCode%3AMIT+ae_entityTypeCode%3AMIO+ae_entityTypeCode%3AMIS+ae_entityTypeCode%3AMIP&fq=(type_s%3Aparent)(entity_type%3AaeActivity)(entity_type%3AaeActivityHistory)&fq=(type_s%3Aparent)&rows=1000&wt=csv&indent=true&fl=${FIELDS_TVS}" -o $HOME/MIFIR_DATA/TV.csv
ISINs registered at trading venues	curl "http://firds.esma.europa.eu/firds/FULINS_D_20230603_01of03.zip" -o $DIRDATA/FULINS_D_20230603_01of03.zip unzip $DIRDATA/FULINS_D_20230603_01of03.zip -d $DIRDATA rm $DIRDATA/FULINS_D_20230603_01of03.zip curl "http://firds.esma.europa.eu/firds/FULINS_D_20230603_02of03.zip" -o $DIRDATA/FULINS_D_20230603_02of03.zip unzip $DIRDATA/FULINS_D_20230603_02of03.zip -d $DIRDATA rm $DIRDATA/FULINS_D_20230603_02of03.zip curl "http://firds.esma.europa.eu/firds/FULINS_D_20230603_03of03.zip" -o $DIRDATA/FULINS_D_20230603_03of03.zip unzip $DIRDATA/FULINS_D_20230603_03of03.zip -d $DIRDATA rm $DIRDATA/FULINS_D_20230603_03of03.zip

Notes: These lines of Bash script provide some examples of how to retrieve various metadata. Annex III: Metadata retrieval with Python provides a Python script with details on how to retrieve the full metadata from both ESMA and the FCA.

Second, to retrieve data both ESMA and FCA registers operate using the Apache Solr open-source enterprise search server. This makes it possible to retrieve blocks of data via curl that respond to certain parameters set by the defined queries. The curl executable line we report in **Table 1**retrieves the latest information on registered APAs and trading venues from ESMA – this is aligned with the table structure of our database discussed above.

Third, our table “ISINs registered at trading venues” relies on the data provided by FIRDS. Both ESMA and the FCA provide these data in two main formats: full and delta. Full files contain the full reference data received by ESMA and the FCA before a reference date. Delta files contain all records for which a change has occurred since the generation of the last files. These records are provided for the benefit of managing the extended data in an externally managed database like that described in this paper. Details on how to build a historical database from these records are documented in ESMA (2022). In **Table 1**we also document the curl instructions for retrieving the main large xml compressed files from ESMA that contain the records for the debt securities we need to target to assemble our database. We thus ignore the retrieval of files that record data for other financial instruments (e.g. equities and derivatives).

Finally, in Annex III, the previously described codes are made available in Python, documenting in full the retrieval of data from both ESMA and the FCA.

5.2 IT retrieval technicalities for transactions and quotes

All reporting trading venues and APAs provide post-trade data with a delay of 15 minutes on their respective websites. Although the files are available for free download for a period of 24 hours following upload, there are no standard guidelines for uploading files, with the result that each source follows different rules when it uploads files. Although the process is slightly different for each source, the structure of the code is generally composed of three main parts.

a. The data source description: this includes the list showing the columns reported by the source, the datetime format, the frequency at which the data are reported, the column name for the ISIN, the generic URL of the page on which the data are published, the list of channels (when applicable) and the login data (when applicable).

b. Functions: for each trading venue and APA some specific functions are defined. The most relevant of these are: (i) a function for downloading each file available: this might vary slightly (e.g. some sources need to log in), (ii) a function for opening the files (not all sources have the same format but all of them must be machine readable), and (iii) a function for performing some preliminary data cleaning and for harmonising the column names across the different sources.

c. Main: this is the final source-specific script that, when executed, downloads the files and uploads them to our data management system after filtering out the ISINs that do not belong to the list of eligible assets. In our setting the IT tool operates within a Hadoop system. In particular, the data retrieved via the internet is transformed (once more via Python) into Apache Parquet format. The database management then follows on from the handling of these parquet files using various standard utilities of the Hadoop system (e.g. Hive or Impala).

For the sake of simplicity, **Table 2**shows the URLs employed to download the various source files in the database. It should be noted that the URLs utilised to obtain files

from different sources might follow slightly different structures, particularly regarding the frequency at which files are uploaded by the reporting entities. There are differences in accessing data, such as login procedures or different HTML page formats. In addition, some sources upload files every few minutes (the code is therefore required to iterate over multiple possible URLs containing date combinations) while other sources upload only one file a day at the same URL containing all the transactions of the day (the request is therefore always the same).

Table 2

Command lines for the retrieval of transaction records from trading venues and APAs.

Name parent group	MIC	Type of venue	CURL
Bloomberg	BAPE	APA	https://www.bloombergapa.com/download?key=BAPA-POST-<YYYYMMDD>-<hh:mm>.csv
	BAPA	APA	https://www.bloombergapa.com/download?key=BAPE-POST-<YYYYMMDD>-<hh:mm>.csv
	BMTF	MTF	https://www.data.bloombergmtf.com/download?key=BMTF-RTS2-POST-<YYYYMMDD>-<hh:mm>.csv
	BTFE	MTF	https://www.data.bloombergmtfe.com/download?key=BTFE-RTS2-POST-<YYYYMMDD>-<hh:mm>.csv
BME	BMEA	APA	https://www.bmeregulatoryservices.es/docs/Ficheros/BMEAPA/Post-Trade/<YYYY>-<MM>-<DD>_BMEA_posttrade.json?ANzbLA!!
London Stock Exchange Group	ECEU	APA	https://dmd.lseg.com/dmd/download/posttrade/TEC/AFM/ECEU-post-<YYYY-MM-DD>T<hh_mm>.csv
	ECHO	APA	https://dmd.lseg.com/dmd/download/posttrade/TEC/FCA/ECHO-post-<YYYY-MM-DD>T<hh_mm>.csv
	LNFI	MTF	https://dmd.lseg.com/dmd/download/posttrade/TEC/FCA/ECHO-post-<YYYY-MM-DD>T<hh_mm>.csv
	LIQF	MTF	https://dmd.lseg.com/dmd/download/posttrade/TEC/FCA/ECHO-post-<YYYY-MM-DD>T<hh_mm>.csv
	AFSO	OTF	https://dmd.lseg.com/dmd/download/posttrade/TEC/FCA/ECHO-post-<YYYY-MM-DD>T<hh_mm>.csv
Tradeweb	TWEA	APA	http://<PERSONAL NUMBER>.mifid.io.tradeweb.com/Tradeweb_BV_APA_Post-Trade_TWEA/BV_TWEA_<YYYYMMDD>_<hhmm>.csv
	TREA	APA	http://<PERSONAL NUMBER>.mifid.io.tradeweb.com/Tradeweb_UK_APA_Post-Trade_TREA/UK_TREA_<YYYYMMDD>_<hhmm>.csv
	TREU	MTF	http://<PERSONAL NUMBER>.mifid.io.tradeweb.com/Tradeweb_UK_MTF_Post-Trade_TREU/UK_TREU_<YYYYMMDD>_<hhmm>.csv
	TWEM	MTF	http://<PERSONAL NUMBER>.mifid.io.tradeweb.com/Tradeweb_BV_MTF_Post-Trade_TWEM/BV_TWEM_<YYYYMMDD>_<hhmm>.csv
MTS	SSOB	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/bvs/export/all + /delaytime/type/bvs/export/all
	BVUK	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/bvs/export/all + /delaytime/type/bvs/export/all
	BMTS	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
	MCAD	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
	EBMX	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
	MTSF	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
	FMTS	MTF	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
	MTSC	RM	https://www.mtsmarkets.com/mts-dataportal/deferredtime/type/cmf/export/all + /delaytime/type/cmf/export/all
MarketAxess	TRAX	APA	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/TRAX_APA/<YYYY-MM-DD>.csv
	TRNL	APA	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/TRNL_APA/<YYYY-MM-DD>.csv
	MANL	MTF	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/MANL/<YYYY-MM-DD>.csv
	MAEL	MTF	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/MA_MTF/<YYYY-MM-DD>.csv
	TSAF	OTF	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/TSAF/<YYYY-MM-DD>.csv
	TEUR	OTF	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/TEUR/<YYYY-MM-DD>.csv
	TCDS	OTF	https://<PERSONAL_NUMBER>.cloudfront.net/TRADES/TCDS/<YYYY-MM-DD>.csv
Euronext	ETLX	MTF	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	XMOT	MTF	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	XPAR	RM	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	XBRU	RM	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	XAMS	RM	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	XLIS	RM	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
	MOTX	RM	https://marketdata.euronext.com/data-reporting-service/trades-file/download/Trades_FixedIncome.csv
Deutsche Borse	FRAB	MTF	https://mifid2-apa-data.deutsche-boerse.com/DFRA-posttrade/DFRA-posttrade-<YYYY-MM-DD-HH:mm>
	FRAA	RM	https://mifid2-apa-data.deutsche-boerse.com/DFRA-posttrade/DFRA-posttrade-<YYYY-MM-DD-HH:mm>

Notes: We have chosen to highlight in grey those lines associated with APAs rather than trading venues.

The code runs daily on a server, downloads the files and applies a first round of filtering to the data, excluding those ISINs that do not belong to the list of eligible assets. It then uploads the output to a database. Annex IV: Example of data retrieval with Python from a trading venue shows an example of the Python code used to retrieve data from a certain trading venue. Similar codes are assembled to retrieve data from other trading venues and APAs.

5.3 Overcoming some of the data reporting deficiencies

Data retrieved from APAs and trading venues are extremely raw and need to be carefully cleaned. For example, there are instances where previously published transaction reports are cancelled or amended. This possibility is already contemplated in the RTS 2 supplementing MiFIR, which assign a space for cancellation and amendment flags as part of the reporting records. The APAs and

trading venues thus include a column that clearly states whether the transaction has been amended or cancelled and that can be used to clean and update the data. Unfortunately, in some instances the cleaning procedure is not as straightforward. While in some cases, following consultation with trading venues and APAs, some of the deficiencies can be addressed, very often the only alternative is to completely discard the pre-trade and post-trade reporting records posted. There are currently several critical issues in particular that are difficult to solve. The list below provides an overview of some of the most critical deficiencies and challenges we have encountered when collecting and harmonising the data.

Non-standardised reporting of flags across APAs and trading venues. Our database tool first creates a different table for each pre-trade and post-trade data source, as per **Table 2**. This makes it possible to report source-specific fields and flags. Unfortunately, the flags used by different APAs and trading venues are not harmonised. The RTS 2 supplementing MiFIR clearly define the list of flags that should be reported but are not sufficiently precise on how to implement the list in practice. For example, some may choose to report a Boolean (True/False) type identifier for every individual flag under a field name while others may choose to report the flag identifiers shown in Table 3 of the RTS 2 under the field name “flags”. For example, a cancellation flag is reported as a Boolean (True/False) type under the field name “canc_flag” by some, while it is reported by others as “CANC” within a field that consolidates all transaction flags, separated by commas. To make matters worse, the naming convention for the field names associated with the flags is not harmonised. For example, some report all flags under the field name “mifid_flag” while others choose to separate the flags into two categories, drawing inspiration from the RTS 2.[16] However, the naming convention for flag types is also not standardised, which can lead to confusion. Making good use of these flags, which is key to handling the data, can thus become a complex task. All these problems are compounded significantly by the fact that some sources provide hardly any clear documentation on the fields reported.

Lack of harmonisation in the adopted field names. An example of this is reporting under the heading “pricenotation” or “price_notation”. This renders the process of assembling a tool for downloading the data more cumbersome as time needs to be spent matching records across the various trading venues. Most of the time deciphering the naming convention should be a simple matter, although at times it may not be easy to associate the name assigned to a field with the relevant field or flag described in RTS 2.

Contingent field definitions make it more challenging to interpret data. An example of this is the data reported under the field “NOTIONAL AMOUNT”. RTS 2 specifies that the field should be populated “with the face value, which is the amount repaid at redemption to the investor” for bonds, but also “with the nominal value per unit multiplied by the number of instruments at the time of the transaction” for structured finance products. While there is a good justification for such a reporting

16 In Table 3 of Annex II of the Commission Delegated Regulation (EU) 2017/583 supplementing MiFIR eight of the 22 flags mentioned are referenced as “Supplementary Deferral Flags”.

mechanism, the correct interpretation of the data retrieved is contingent on the availability of additional metadata specifying the subclass of each instrument.

Inconsistencies in the conventions used to report data. An example of this is the data reported under the field "QUANTITY". Some APAs and trading venues adopt very different conventions for reporting quantities. The field "QUANTITY", that according to RTS 2 should report "the number of units of the financial instrument, or the number of derivative contracts in the transaction'', is often multiplied or divided by the price, leading to inconsistencies in the data. Furthermore, some sources consistently report the same number for both the field "QUANTITY" and the field "NOTIONAL AMOUNT". This appears to be misaligned with the RTS 2 guidelines.

Non-separation of post-trade data from other price data. Article 12 of MiFIR clearly highlights the obligation to report post-trade and pre-trade records separately. From this perspective, it is to be expected that the data posted under the banner of "post-trade" will relate exclusively to executed transactions. However, we have encountered an instance where this is not the case. The records collected from one of the trading venues contained artificial or theoretical prices possibly assembled with (or without) the use of information from posted quotes in that trading venue. We learned this via direct exchanges with the trading venue, although the issue is not explicitly mentioned in the documentation disclosing the technical details associated with downloading the data.[17] Similar issues may exist with other sources but there is currently no specific information in this regard.

Lack of harmonisation of pre-trade reporting data. As indicated in Section 4.4, the RTS for reporting pre-trade data are not as precise as they are for post-trade data. To a certain extent this is understandable, as the disparities in the management of the order book across the various trading venues point to a need to report information on posted quotes differently. However, it should be possible to provide a common set of reporting fields across the various trading venues on top of the additional trading venue-specific information.

IT retrieval of the data remains complex at times. Technical access to some of the data retrieval points was also complex in various instances. Access was straightforward in some cases, sufficiently documented in others and altogether indecipherable in still others without conducting further enquiries with the technical experts at the trading venue. For example, some APAs ask the user to log in (for free) in order to download the transaction data, an approach which is obviously more complex than a direct download.

Ambiguities when reporting non-euro prices. According to RTS 2 supplementing MiFIR, if prices are not in euro this should be indicated. However, despite the existence of RTS 2 specifying the field "PRICE CURRENCY" as the currency in which the price is expressed (applicable if the price is expressed as monetary value), it is sometimes evident from the data that this approach has not been followed. This is clear because when some recurring ISINs are examined, comparable prices are observed with and without the currency being specified. Additionally, some sources

[17] On a more positive note, these records can easily be separated from the "true" post-trade MiFID records by discarding records with a value of zero under the "NOTIONAL AMOUNT" field.

of prices in subsequent days for the same ISIN are about the same even when indicating different currencies, suggesting that the transactions may have been reported in euro, even when the currency indicated is different. Additionally, the reported values under “PRICE CURRENCY” do not always follow the required ISO 4217 three-letter currency notation (e.g. “1” or “2” at times used as reported values).

6 The data in the context of the ECB's collateral framework

6.1 Distribution across trading venues

For analytical purposes, we will now classify ECB eligible marketable assets into eight different classes using information provided in the daily public list of ECB collateral assets. These data identify ten different issuer groups and eight different asset-type identifiers. Using these codes, we identify 11 different financial asset classes as follows:

1. **SOVEREIGN**: assigned to issuer groups IG1 and IG2; coupon definition NOT CD1; and NOT TB-TYPE (defined in the footnote).
2. **REGIONAL**: assigned to issuer group IG5 and NOT TB-TYPE.
3. **SOVEREIGN_ZC**: assigned to issuer groups IG1 and IG2 and coupon definition CD1 and NOT TB-TYPE (defined below).
4. **TB-TYPE** (Treasury Bill type): assigned to asset type AT03 and belonging to issuer group IG1, IG2, IG5, IG6, IG7 and IG8.
5. **SUPRANATIONAL**: assigned to issuer group IG6 and NOT TB-TYPE.
6. **AGENCY**: assigned to issuer group IG7 and IG8 and NOT TB-TYPE.
7. **CORPORATE**: assigned to issuer group IG3 and IG11 and NOT CP (defined below).
8. **COVERED**: assigned to asset type AT09, AT10, AT12 and AT13.
9. **FINANCIAL**: assigned to issuer groups IG4 and IG9 & NOT COVERED.
10. **ABS**: assigned to asset type AT11.
11. **CP** (commercial paper): assigned to asset type AT03 and NOT belonging to issuer group IG1, IG2, IG5, IG6, IG7 and IG8.[18]

[18] The asset class "SOVEREIGN" includes assets issued by central governments, the EU and, potentially, by central banks (issuer group IG1), although at present none of the latter are included in the ECB list of eligible assets. "REGIONAL" refers to assets issued by local and regional governments. "SUPRANATIONAL" relates to assets issued by "multilateral development banks", and "international organisations" listed in Articles 117(2) and 118 of the REGULATION (EU) No 575/2013. "AGENCY" are assets issued by entities that engage in certain common-good activities carried out at national or regional level that the Eurosystem has classified as agencies. The list of entities classified as agencies is published on the ECB's website. The "CORPORATE" class includes assets issued by non-financial corporates. Instruments issued by financial corporates (primarily banks) are distributed between "COVERED" and "FINANCIAL", whereby the former include secured legislative covered bonds and the latter include primarily senior preferred unsecured bonds. "ABS" encompasses senior tranches of asset-backed securities with certain types of eligible underlying asset pools. The eleven asset classes defined in the text are non-overlapping, meaning that TB-TYPE assets (i.e. Treasury Bill types) are excluded from the "SOVEREIGN" asset class.

Using ESMA's and the FCA's FIRDS, we can easily identify those ECB eligible assets that fall under the scope of MiFIR and UK MiFIR and separate them from the rest. The list of ECB eligible assets neither contains the full range of financial assets traded in authorised EU or UK-regulated trading venues (e.g. equities and derivative contracts are not eligible) nor is it contained within that range. This is because certain financial assets are eligible as collateral despite not being registered for trading in either an EU or UK-regulated trading venue. As has also already been explained in Section 4.1, there are certain financial assets that are eligible as collateral for ECB credit operations which are only admitted for trading in non-regulated trading venues (classified as acceptable markets by the ECB) and are therefore not subject to the transparency requirements of MiFIR. This means that those financial instruments accepted for trading exclusively in non-regulated trading venues will not fall under the reporting obligations of MiFIR and transactions associated with those assets will not be captured by our tool.

Table 3

ECB eligible marketable assets registered in authorised trading venues.

Bond type	In European Union trading venues			In United Kingdom trading venues			NOT REGISTERED	Total
	RM	MTF	OTF	RM	MTF	OTF		
Outstanding amounts in EUR billions								
SOVEREIGN	9,476	9,495	9,390	46	9,488	9,413	1	9,505
REGIONAL	565	584	502	1	567	510	0	607
SOVEREIGN_ZC	9	9	8	-	9	7	-	9
TB_TYPE	624	631	611	-	627	492	68	708
SUPRANATIONAL	1,144	1,146	1,108	12	1,146	1,131	-	1,153
AGENCY	1,034	1,019	902	9	1,010	968	-	1,041
CORPORATE	999	1,144	1,041	85	1,128	1,105	1	1,169
COVERED	1,692	1,558	1,095	100	1,429	1,363	-	1,859
FINANCIAL	1,210	1,623	1,127	126	1,471	1,214	5	1,737
ABS	509	90	1	-	0	62	1	591
CP	43	28	2	-	1	0	398	471
Total	17,305	17,328	15,787	379	16,877	16,266	475	18,849
Number of financial instruments in units								
SOVEREIGN	1,042	972	769	39	930	806	17	1,084
REGIONAL	1,931	1,264	586	5	865	582	21	2,009
SOVEREIGN_ZC	660	722	198	-	709	210	21	923
TB_TYPE	317	187	109	-	133	88	619	959
SUPRANATIONAL	571	444	300	42	422	331	-	601
AGENCY	1,502	894	473	32	744	535	-	1,531
CORPORATE	1,846	2,058	1,601	141	1,897	1,720	40	2,284
COVERED	3,019	2,660	1,264	131	1,789	1,443	-	3,535
FINANCIAL	5,374	7,127	1,621	207	3,123	1,784	110	9,720
ABS	524	61	7	-	3	216	1	575
CP	523	189	9	-	7	3	6,429	7,146
Total	17,309	16,578	6,937	597	10,622	7,718	7,258	30,367

Source: Data assembled from our tool using the list of ECB eligible assets on 12 April 2024.

A large number of eligible financial assets are not registered for trading in regulated trading venues, amounting to 6,429 financial instruments out of a total of 30,367 (see **Table 3**). However, in terms of outstanding amount they represent only a very small share of the total volume of eligible assets, at around €475 billion out of a total of more than €18 trillion. These financial instruments consist mostly of (short-term) CP.

Table 3 also shows that the numbers and volume of ECB eligible assets registered for trading in UK trading venues are very large, with volumes registered for trading in EU trading venues roughly comparable with those for UK trading, a clear reflection of the relevance of the United Kingdom for trading in euro area bonds. There is one noticeable difference between the share of registered ECB eligible assets across type of trading venue in the United Kingdom and the EU. As **Table 3**shows, there are very few ECB eligible assets registered for trading in UK RMs, which is in stark contrast to the large share of ECB eligible marketable assets registered in EU RMs. This is most likely a reflection of the fact that in order to be eligible as valid collateral for ECB credit operations, debt instruments must be admitted either to trading on a RM within the EU or to trading on certain acceptable non-regulated markets designated by the ECB (see Section 4.1). Meanwhile, trading in bonds inside trading venues is commonly conducted in a range of MTFs rather than in RMs (see ESMA, 2021).

Table 4

Trading venues by type where ECB eligible assets are registered

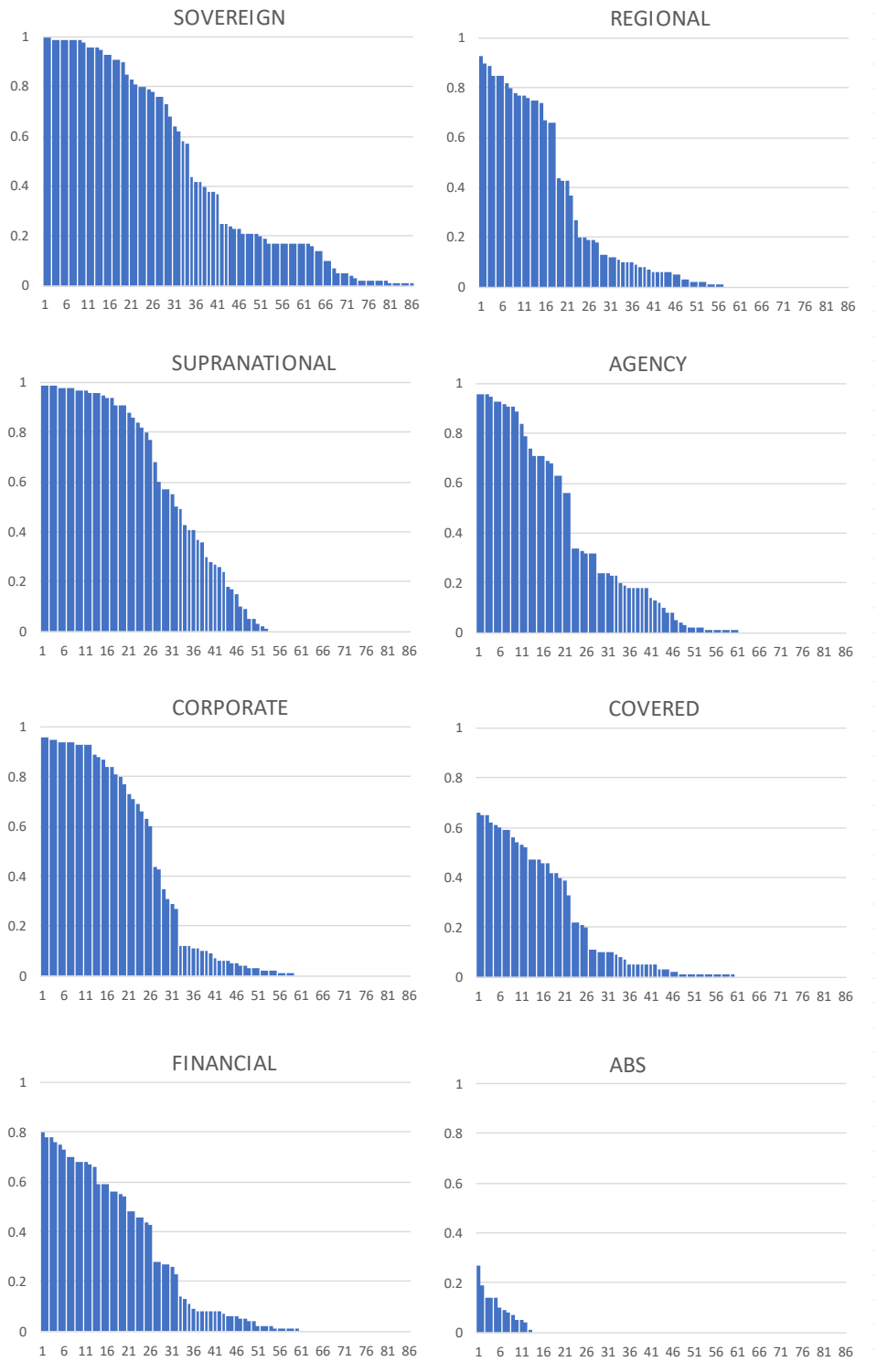
Bond type	European Union			United Kingdom		
	RM	MTF	OTF	RM	MTF	OTF
SOVEREIGN	37	33	13	1	10	12
REGIONAL	22	23	9	1	6	7
SOVEREIGN_ZC	9	10	9	0	3	4
TB_TYPE	16	23	7	0	6	5
SUPRANATIONAL	10	27	9	1	8	7
AGENCY	15	26	10	1	9	9
CORPORATE	22	30	9	1	8	9
COVERED	26	27	9	1	8	7
FINANCIAL	30	29	9	1	10	10
ABS	9	8	2	0	2	2
CP	8	12	5	0	3	2
Total	44	41	13	1	13	13

Note: Figures are in units representing the number of trading venues.
Source: Data assembled using our tool.

There are many APAs and trading venues. However, according to ESMA (2020a), pp. 63 only a limited number of APAs and trading venues account for more than 70% of the transacted volumes in non-equity financial transactions. If we look at where ECB eligible assets are registered, we do not consider the number of relevant trading venues to be particularly high. **Table 4** shows the number of trading venues in the EU and the United Kingdom in which ECB eligible assets are registered. These amount to 98 trading venues in the EU (44 RMs, 41 MTFs and 13 OTFs) and 27 trading venues in the United Kingdom (1 RM, 13 MTFs and 13 OTFs). For the purposes of our IT tool we can thus focus our attention on this narrower set of trading venues to gather details of MiFIR transactions and quotes. Furthermore, the volumes of ECB eligible assets registered for trading in some of these 125 trading venues (98 in the EU and 27 in the United Kingdom) are very small. **Chart 2** shows that only around 42 trading venues have volumes of assets registered for trading that exceed 10% of ECB eligible assets.

Chart 2

Share of ECB eligible assets registered for trading in EU and UK trading venues.



Notes: Every bar plot shown represents the share (in per unit terms) of the volume of ECB eligible assets registered for trading in a specific trading venue of the total volume of ECB eligible assets, for every asset-type class. For example, a value close to one suggests that for the trading venue represented by that bar, all ECB eligible assets are registered for trading.
Source: Data assembled using our tool.

For instruments issued by the public sector (central government, supranational organisations, public agencies and, to a lesser extent, regional or local government) or by non-financial corporates there are several venues with more than 80% of the ECB eligible universe in their registered asset class. Markets for bank-issued instruments, whether secured (covered bonds) or unsecured, are more fragmented. The fragmentation of markets becomes even more apparent in the case of asset-backed securities (ABS). For these securities the segmentation has a clear national dimension, with trading concentrated in little more than ten trading venues. Annex II: List of trading venues provides a list of trading venues ranked according to their share of the total outstanding amount of ECB eligible marketable assets registered for trading. This list also shows the trading venues and APAs targeted by our IT tool for collecting post-trade as well as pre-trade data.

6.2 The depth of the various market segments

In a context of regular systematic internaliser calculations, ESMA reports the total number of transactions and the total amount of transactions on a quarterly basis for every financial instrument registered on a regulated trading venue in the EU. These data are made available through the Financial Instruments Transparency System (FITRS).[19] In the United Kingdom the FCA manages a similar FITRS system. However, the data published by the FCA does not disclose the volumes transacted at the ISIN level – only the regulatory thresholds that are used to define what constitutes a liquid bond are disclosed. The data collected by our tool, in addition to providing information on transacted prices and quotes, also provide a broader and timelier overview of the depth of the markets for ECB eligible marketable assets than the quarterly data published by ESMA.

When collecting data on bond transactions registered in both UK and EU trading venues and APAs, it is necessary to account for and correct for the possibility of double counting. For example, a transaction conducted over-the-counter by an EU investment firm in a UK trading venue with a UK investment firm is likely to be reported in both EU and UK records. In Box 1 we explain how we handle instances of double counting in our data.

Box 1

Instances of double counting by UK and EU investment firms

Over-the-counter financial transactions conducted between UK investment firms and EU investment firms involving our set of ECB eligible assets, to the extent that many of these financial assets are also registered for trading in UK trading venues, will need to be reported in a UK APA by the UK investment firm and in an EU APA by the EU investment firm. As indicated in Section 3.3, financial transactions executed by EU firms in a UK trading venue may not need to be reported by the EU investment firm in an EU APA if ESMA's recommendations are followed. This means that the record of that transaction would be exclusively published in the reporting carried out by the UK trading

[19] See ESMA's Financial Instruments Transparency System. The data are available in xml format and details of the schema used for retrieving the information stored in those files can be found online.

venue. Meanwhile a UK investment firm conducting a financial transaction in an EU trading venue would not need to report that transaction in a UK APA following the recommendations of the FCA: that financial transaction would only appear as part of the records published by the EU trading venue.

However, using our database of post-trade transactions from both APAs and trading venues in both the EU and the United Kingdom we have encountered numerous instances where we suspect double counting of financial transactions in both over-the-counter scenarios (expected in view of the regulatory regimes in place in both the EU and the United Kingdom) and in trading venues (not expected in view of the recommendations of the supervisory authorities).

It is clear that we cannot use a transaction identification number to identify the above instances of double counting as the recorded transaction number assigned by the EU APA to the EU investment firm and that assigned by the UK APA to the UK investment firm follow two separate requests. However, we suspect that financial transactions recorded (i) for the same ISIN instrument, (ii) at the same day and time (in seconds), (iii) for an equal notional amount and quantity, and (iv) for the same price may be signalling double counting rather than two separate transactions.

Table C Volumes and numbers of financial transactions reported in both the EU and the United Kingdom

(in EUR billions)

Pair type	Number of transactions	Volume of transactions (EUR bn)	Percentage of total volume
EU APA - UK APA	4043	57.7	2.48
EU APA – UK TV	953	4.8	0.21
EU TV - UK APA	1567	1.8	0.08
EU TV - UK TV	1548	0.4	0.01

Source: Data collected from our IT tool.

As Table C shows, in May 2024 the EU APA – UK APA reported transactions that appear to be duplicates amounted to 2.5% of the volumes reported for the full month. These are associated with pure over-the-counter transactions. In addition, according to our criteria the EU APA – UK TV and EU TV – UK APA duplicate transactions reported amounted to 0.21% and 0.08% respectively. The latter transactions, executed in trading venues, would not be expected to be present if the recommendations of the supervisory authorities discussed in Section 3.3 had been followed. Those instances for EU APA – UK TV pairs could also be identified directly from the posted transaction records because MiFIR RTS 2 stipulates that the reporting of those transactions should disclose the “third-country venue of execution”. However, this reporting field would not be available in the reciprocal case (i.e. for EU TV – UK APA pairs) in view of the regulatory stipulations dictated by the FCA.

Somewhat surprisingly, even though the volumes reported are smaller (0.01%) we have also found in our sample instances of suspected or apparent double counting between EU TV – UK TV pairs. However, it is unlikely that these actually respond to double counting. Whether or not this might relate to automatised trading executed in parallel across trading venues is a matter that cannot be ascertained from the available information.

Source: Data collected from our IT tool.

Table 5 below illustrates the depth of the markets for ECB eligible assets, looking at the volumes transacted over different periods. The data employed for the period 2019-23 are data from ESMA's FITRS records, while the final column shows May 2024 transaction volumes using data collected with our tool. We split the period 2019-23 into two: 2019-21 when ESMA's FITRS data also included transactions conducted in the United Kingdom and 2022-23 when ESMA's FITRS data did not include transactions conducted in the United Kingdom. Meanwhile, the data reported for May 2024 are adjusted for instances of double counting, as discussed in Box 1.[20]

Table 5

Outstanding amounts and average monthly transactions of ECB eligible assets

Bond type	Nominal value outstanding (EUR billions)			# of ISINs (units)			Average monthly transactions (EUR billions)		
	2019-20	2021-23	May 2024	2019-20	2021-23	May 2024	2019-20	2021-23	May 2024
SOVEREIGN	7,009	8,421	9,447	787	939	1,024	3,180.4	1,356.9	1,649.2
REGIONAL	452	564	600	1,677	1,957	2,008	21.2	13.3	13.5
SOVEREIGN_ZC	62	70	3	1,481	1,544	944	52.7	21.9	19.6
TB-TYPE	494	751	688	637	800	857	25.4	21.7	84.1
SUPRANATIONAL	606	861	1,093	301	413	517	44.8	49.5	102.0
AGENCY	532	652	856	697	940	1,367	49.0	27.1	32.2
CORPORATE	904	1,082	1,124	1,900	2,121	2,213	123.2	33.9	48.4
COVERED	1,500	1,687	1,844	3,828	3,649	3,489	29.5	14.1	32.5
FINANCIAL	1,345	1,447	1,638	6,713	7,771	9,138	168.5	46.7	62.2
ABS	579	576	573	661	613	576	1.4	0.5	1.3
CP	301	279	395	4,412	4,505	6,230	-	0.0	1.7
TOTAL	13,784	16,392	18,262	23,094	25,252	28,363	3,696.0	1,585.7	2,046.6

Source: Data for the periods 2019-20 and 2021-23 are from ESMA´s FITRS registry. Data for May 2024 are collected using our IT tool. See the main text for further details of ESMA´s FITRS data and comparability with the data from our IT tool.

Table 5 shows that a far greater proportion of the transactions on ECB eligible assets relate to sovereign bonds than other categories. The transactions in eligible sovereign bonds in May 2024 amounted to €1.6 trillion, representing 17% of the outstanding amount in ECB eligible sovereign bond debt. The depth of other market segments is much less, both in terms of gross volumes traded but also in terms of the share of transactions relating to outstanding amounts. This is always well below 5%.[21]

The database also makes it possible to identify where transactions are executed, whether this be on a trading venue or over-the-counter, and whether transactions are executed in the EU or in the United Kingdom. As an example of this type of analysis, **Table 6**shows that the number and volume of post-trade recorded transactions in the EU in May 2024 appears to be much greater than for transactions posted in the United Kingdom in the same month. This contrasts slightly with the pattern reported

[20] The data have also been cleaned for some data deficiencies identified with some of the reported transactions (e.g. transacted volumes larger than the outstanding amount for the financial instrument). Unfortunately, MiFIR data are not 100% clean and ESMA routinely employs machine learning clustering techniques to detect anomalies in the data for its transparency calculations (see ESMA, 2024).

[21] We notice here that the volume of transactions reported for May 2024 in the table has been computed using data on the final records for published transactions in May 2024. These data are thus not necessarily a true reflection of the transactions actually executed in May 2024 as many of the transactions reported are subject to deferral. We follow this procedure because it allows us to compute volume figures that are comparable with those reported for previous periods.

by ESMA (2021) in the period before the exit of the United Kingdom from the EU. However, as mentioned previously, ESMA (2021) reported figures for volumes of bond transactions that included non-euro denominated assets such as US sovereign bonds.

Table 6

Transactions of ECB eligible assets across the EU and the United Kingdom, May 2024

Bond type	European Union			United Kingdom		
	TXS	Volume (bn)	Average size (mn)	TXS	Volume (bn)	Average size (mn)
	Transactio ns conducted in trading venues					
SOVEREIGN	643,321	898.7	1.4	65,313	503.1	7.7
REGIONAL	2,473	4.1	1.7	447	1.2	2.6
SOVEREIGN_ZC	1,806	1.3	0.7	212	0.5	2.3
TB-TYPE	35,839	46.2	1.3	487	7.3	15.0
SUPRANATIONAL	22,370	36.4	1.6	3,760	32.6	8.7
AGENCY	8,488	11.4	1.3	1,844	9.6	5.2
CORPORATE	42,837	19.6	0.5	18,127	11.1	0.6
COVERED	6,736	10.4	1.5	1,457	3.2	2.2
FINANCIAL	63,339	24.2	0.4	20,336	14.8	0.7
ABS	-	0.0	0.0	-	0.0	0.0
CP	64	0.0	0.1	6	0.0	11.0
TOTAL	827,272	1,052.2	1.4	111,985	583.3	7.5
	Tr ansactions conducted over-the-counter					
SOVEREIGN	32,848	101.1	3.1	28,337	142.4	5.0
REGIONAL	532	4.4	8.3	430	3.7	8.7
SOVEREIGN_ZC	555	9.6	17.3	531	8.2	15.4
TB-TYPE	1,079	14.5	13.5	42	1.3	31.1
SUPRANATIONAL	1,963	10.3	5.2	2,671	22.7	8.5
AGENCY	750	3.8	5.0	1,017	7.3	7.2
CORPORATE	5,955	6.9	1.2	12,596	10.7	0.8
COVERED	1,342	14.3	10.7	1,256	4.6	3.7
FINANCIAL	7,099	10.2	1.4	13,932	12.4	0.9
ABS	118	1.0	8.7	66	0.3	4.3
CP	75	1.6	21.4	-	0.0	0.0
TOTAL	52,314	177.8	5.6	60,876	213.6	5.6

Notes: TXS is reported in units and denotes the number of transactions. Figures under the heading "Volume" report the nominal amount of completed transactions in EUR billions, while the average size of the conducted transactions (in effect the volume divided by TXS) is reported in EUR millions.
Source: Data assembled using our tool.

By limiting our analysis to ECB eligible assets, most of the trading is registered within the EU.[22] **Table 6** also shows that the average transaction size of reported transactions in the United Kingdom is larger than in the EU for a significant majority

[22] The larger volume registered in the United Kingdom than in the EU also possibly reflects the fact that prior to the exit of the United Kingdom from the EU some EU investment firms chose to report over-the-counter trading with an APA registered in the United Kingdom. Now, however, they should report via an entity registered in the EU.

of bond market segments, indicating that UK trading is mainly wholesale. As might be expected, the average size of transactions conducted over-the-counter is larger than the average size of transactions executed in trading venues (e.g. around €1.5 million for transactions on sovereign bonds executed in trading venues versus an average of €3.1 million for such transactions executed over-the-counter).

However, there is one slightly unexpected result in the figures reported in **Table 6**. In the past, ESMA had reported that a large share of transactions in non-equity assets was conducted over-the-counter. According to our data for May 2024, fewer transactions on ECB eligible bonds were executed over-the-counter than in trading venues.

As discussed in Adler et al. (2021), the calibration of appropriate margins for valuing the collateral pledged on ECB credit operations should reflect the time (time to liquidation) likely to be required to sell an asset. The time required to liquidate an asset will depend on the depth of the market, as reflected in **Table 6**. Other than this information, it is also important to ascertain how large a volume could be traded without having a significant impact on price. It is likely that very large trades could only be accommodated at a lower price. In **Table 7** we choose to report, for the various asset classes, the share of transactions conducted at various size intervals, ranging from as little as €100,000 to more than €10 million.

Table 7

Average transaction size of ECB eligible assets in the EU and the United Kingdom, May 2024

Bond type	Average transaction size					
	[0 , 0.1]	[0.1 , 0.5]	[0.5 , 1]	[1 , 5]	[5 , 10]	> 10.0
SOVEREIGN	8.9	24.5	19.7	36.7	7.4	2.8
REGIONAL	8.9	33.8	35.2	21.2	0.5	0.3
SOVEREIGN_ZC	33.3	23.2	21.9	19.4	1.2	1.0
TB-TYPE	9.2	13.7	12.1	50.4	9.8	4.7
SUPRANATIONAL	7.0	6.7	9.0	32.1	17.4	27.8
AGENCY	12.8	27.1	14.0	32.7	10.0	3.4
CORPORATE	17.8	23.1	15.9	29.5	6.8	7.0
COVERED	5.4	19.4	13.2	40.0	11.1	10.9
FINANCIAL	2.7	11.0	11.0	37.0	24.7	13.7
ABS	2.7	3.5	8.8	25.7	24.8	34.5
CP	21.7	44.6	6.0	4.8	7.2	15.7

Notes: The average transaction size intervals are denoted in EUR millions and include the right-hand value but not the left-hand value. The table values denote the percentage share of financial instruments in a sector for a given average transaction size.
Source: Data assembled using our tool.

We choose to report these figures for the full collected dataset. However, similar figures could be reported for transactions in certain trading venues or for transactions conducted over-the-counter. The data in **Table 7**show that trading in supranational bonds and ABS is conducted in large sizes, while transactions in corporate bonds are conducted mainly in small sizes, with 20% of the total number of transactions associated with transactions smaller than €100,000.

6.3 Availability of reliable price information

The availability of pre-trade and post-trade price data published according to the MiFIR could help to provide multiple analytical insights and could become a useful day-to-day tool for central bank operations. For example, the ECB devotes a substantial amount of effort to valuing marketable assets that are eligible as collateral in its credit operations and for calibrating haircuts, see ECB (2015) and Adler et al. (2023). The data collected using our MiFIR tool could be also put to good use in the daily valuation of ECB eligible marketable assets.

The ECB has developed tools that are able to value marketable collateral in an accurate and timely manner. For this purpose, the Eurosystem operates the Common Eurosystem Pricing Hub (CEPH) which provides a daily price for every eligible marketable asset. The CEPH processes quotes from market data vendors to derive a unique aggregated market price when sufficient reliable data are available. Otherwise a theoretical price is ascertained, based on in-house pricing models. In the latter case, an additional "theoretical valuation markdown" is applied (except for central government bonds, which are exempted).[23]

Valuing close to 30,000 assets on a daily basis is a formidable task, especially when considering that a large part of these are scarcely liquid and that a non-negligible number of eligible bonds have never actually been sold to investors in the first place, as is the case for secured assets that are mobilised by their issuer or originator.[24] Indeed, looking at the frequency of transactions for the various asset classes, **Table 8** shows that there are large pockets of assets that are hardly ever traded. Various asset classes display very limited depth in terms of frequent activity in the secondary markets. For example, more than two-thirds of ISINs classified as financial bonds, covered bonds or regional bonds were not traded at all in May 2024. Meanwhile, only one out of ten ISINs classified as ABS, commercial papers or Treasury Bills were traded in May 2024. To an extent this reflects the fact that these bonds may be primarily bought as a buy-and-hold strategy. Sovereigns and corporate bonds are the most commonly transacted assets. However, zero-coupon sovereign bonds (in particular STRIPS) are also very rarely transacted.

[23] See Article 4 of Guideline (EU) 2016/65 of the European Central Bank of 18 November 2015 on the valuation haircuts applied in the implementation of the Eurosystem monetary policy framework (ECB/2015/35) (OJ L 14, 21.1.2016, p. 30).

[24] The ECB accepts self-issued legislative covered bonds as collateral, under certain conditions and subject to an additional valuation haircut. Similarly, retained senior ABS tranches are accepted even when mobilised by the originator or by an entity closely linked to the originator.

Table 8

Share of ISINs displaying a certain number of daily transactions and quotes

Bond type	Frequency per day						
	0	1/20	1/10	1/5	1	3	>3
	Transactions						
SOVEREIGN	23.6	0.9	1.6	2.8	8.2	7.6	55.2
REGIONAL	74.8	4.4	4.1	4.9	10.2	1.4	0.1
SOVEREIGN_ZC	68.4	1.8	8.4	8.1	11.3	1.3	0.7
TB-TYPE	90.3	0.9	0.7	0.8	2.4	2.1	2.9
SUPRANATIONAL	47.9	1.1	1.5	2.9	14.3	13.0	19.3
AGENCY	69.0	2.9	2.9	4.9	14.5	3.8	2.1
CORPORATE	24.8	1.7	2.1	3.0	26.5	29.7	12.1
COVERED	65.5	4.4	4.5	6.4	16.6	2.1	0.4
FINANCIAL	74.1	4.0	2.0	1.8	6.3	7.7	4.1
ABS	87.6	5.6	3.2	1.9	1.7	0.0	0.0
CP	99.0	0.6	0.1	0.2	0.0	0.0	0.0
	Quotes						
SOVEREIGN	27.1	0.2	0.0	0.0	2.0	0.4	70.4
REGIONAL	65.3	0.0	0.0	0.0	1.9	2.3	30.5
SOVEREIGN_ZC	77.7	0.0	0.1	0.0	7.9	0.1	14.2
TB-TYPE	90.8	0.0	0.0	0.1	2.0	2.9	4.2
SUPRANATIONAL	47.1	0.0	0.0	0.0	0.3	1.5	51.1
AGENCY	57.2	0.0	0.1	0.1	0.5	10.3	31.9
CORPORATE	24.0	0.0	0.0	0.0	0.4	1.8	73.7
COVERED	63.3	0.0	0.1	0.0	1.1	3.0	32.5
FINANCIAL	44.7	0.0	0.0	0.1	2.3	11.8	41.1
ABS	98.8	0.0	0.0	0.0	0.2	0.2	0.8
CP	99.4	0.0	0.0	0.0	0.0	0.0	0.6

The columns report the percentage of ISINs in an asset class that register transactions at a shown frequency per day. For example, 1/20 refers to at least one transaction every 20 working days (i.e. roughly one per month). Meanwhile, 1 denotes ISINs that are transacted at least once per day. For quotes the frequency relates to the number of days on which the ISIN registers quotes in our pre-trade records. The numbers reported relate to transactions and quotes collected during May 2024.
Source: Data collected using our tool.

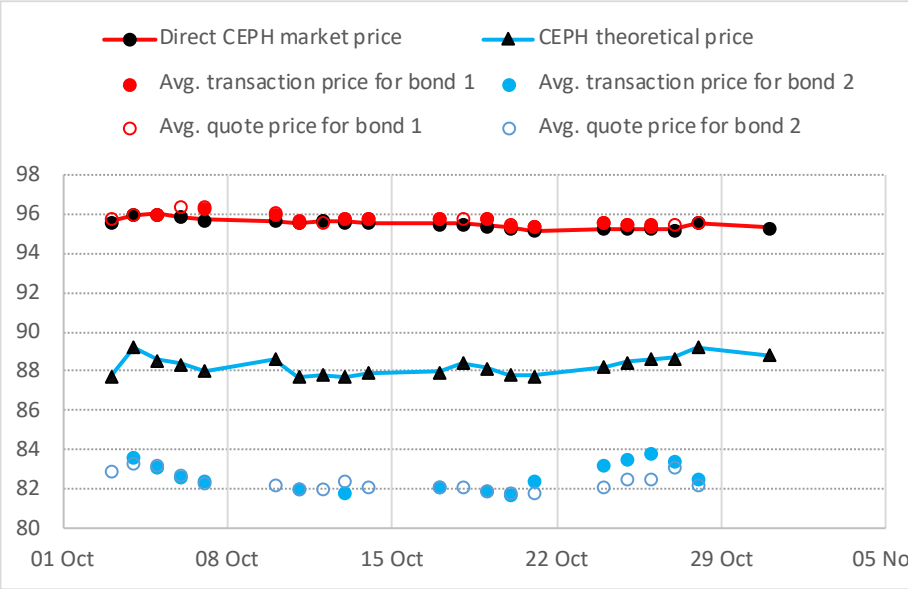
The bottom panel of **Table 8**shows the frequency with which those same asset classes registered quotes in the pre-trade data we collected using our IT tool. It transpires that the share of ISINs for which quotes can be gathered is much larger than the share of ISINs for actual transactions. This is understandable to a certain extent. However, it is interesting to note that financial bonds, and to a certain extent also covered bonds, which display very limited market activity in terms of transactions, appear relatively well represented in terms of collected quotes. For example, close to 41% of the ISINs associated with financial bonds, and 32% of the ISINs associated with covered bonds, are assigned more than three quotes per day in our collected pre-trade data.

In the context of the pricing tools operated by the Eurosystem's CEPH, it is crucial to aim to constantly improve the number and quality of the data inputs that go into the process of deriving direct market prices and calibration curves. It is also here that MiFIR pre-trade and post-trade data can be put to good use. As a concrete illustration of the benefits of expanding on price data sources, **Chart 3** displays the prices assigned by CEPH to two bonds issued by the same non-financial corporate

bond. One of the bonds was priced every day by the CEPH using market quotes, which are in line with the prices collected from both pre-trade and post-trade MiFIR data by our IT tool. By contrast, the second bond (in blue) was priced theoretically every day and the chart suggests that it was systematically overpriced compared with the pre-trade as well as post-trade prices recorded in our MiFID data (blue dots). MiFIR data therefore highlight shortcomings in the pricing model for this particular bond.

Chart 3

Example of mispricing identified with post-trade MiFID records for two bonds from the same non-financial corporate issuer



Notes: The price data disseminated by the CEPH are shown in black, with a circle for a type MKT price and a triangle for a type THE price. Data collected from our MiFID tool are shown in colour and are shown with a coloured solid circle for post-trade data (transactions) and an empty circle for pre-trade data (quotes).

In this case, the existence of pre-trade data suggests that it would be a good idea to pool these data with the input price sources used by the CEPH, thereby enriching the data. In other cases, if only post-trade transaction data are available, they can be used for valuation model diagnosis and validation purposes. For instance, the question of whether there is a pricing bias for issuers with a borderline investment grade rating or certain sectors (e.g. banks with higher than average exposure to real estate activities) can be explored.

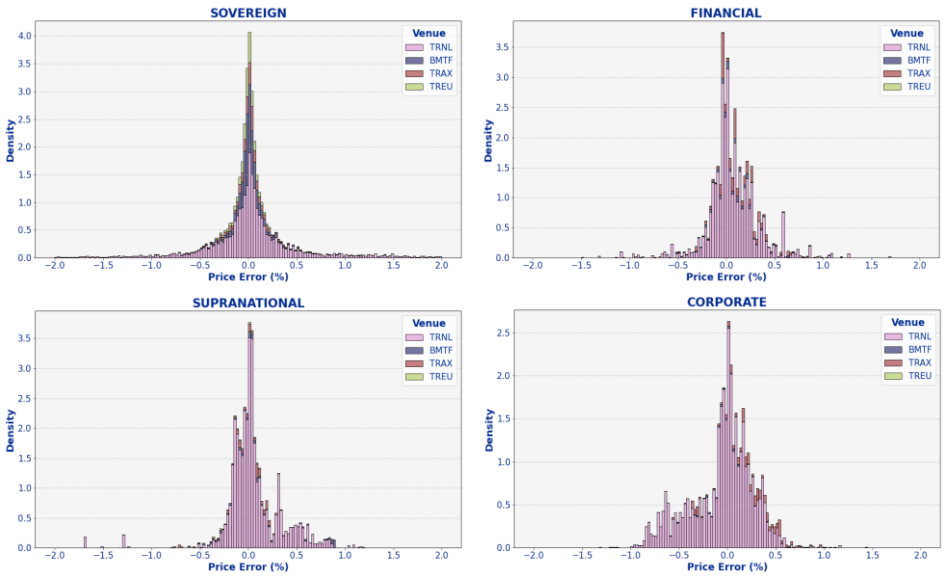
Furthermore, post-trade data can also help diagnose modelling shortcomings in theoretical valuations and guide the calibration of the theoretical valuation markdown applied in line with Article 4 of Guideline (EU) 2016/65. This markdown, like any other risk management tool, needs to be monitored and recalibrated from time to time to ensure that its protection level remains as intended.

It is equally interesting to show the dispersion of quoted prices from the median transaction prices reported on that date. Using the pre-trade reporting records from two APAs (TRNL and TRAX) and two trading venues (BMTF and TREU) in our

database, and the median transaction price per ISIN from the post-trade reported records of those same trading venues on the same day, we can visualise the distribution of the disparity between quotes and the median transacted price. As expected, the distribution of these disparities is much more widely spread for the less liquid asset classes (i.e. FINANCIAL and CORPORATE) bonds and more concentrated for the more liquid asset classes (e.g. SOVEREIGN bonds). See **Chart 4**.

Chart 4

Histogram distributions of differences between posted quotes and median transacted prices in the same trading venue on the same day



Notes: Values shown relate to the distribution of the disparity (as a percentage) between posted quotes and the median transacted price recorded that day from data for May 2024.
Source: Data assembled using our tool.

Finally, MiFIR data availability can, in principle, open other analytical avenues. For example, if the volumes attached to the quotes/transactions are sufficiently accurate and complete the price impact of transacting certain volumes can potentially be assessed. This information is useful in the context of haircut calibration, where the ECB needs to make informed assumptions about the time required to sell a certain volume of a bond, depending on its characteristics.

7 Conclusions and challenges going forward

This paper presents an overview of how European regulation on transparency in financial transactions can be put to good use to obtain a fairly complete picture of traded prices for a comprehensive list of fixed income instruments. The analysis shows that a tool used to retrieve the pre-trade and post-trade reporting data from a list of authorised trading venues in either the EU or the United Kingdom can be created with a relatively simple technical infrastructure. This provides a cost-efficient way of monitoring the actual liquidity in the market and obtaining the actual prices at which bonds change hands.

However, this paper has also documented some shortcomings in the dissemination of MiFID transparency data that hamper our ability to gather all the information that must be disclosed in compliance with current EU and UK regulation. Some of the shortcomings associated with the data are being addressed, at least in part, by a number of public initiatives. First, the 2024 MiFIR review, which was implemented in March 2024, will simplify and harmonise the deferral regime across EU countries, thereby also rendering the collected data more comparable across jurisdictions. This review will require the RTS (specifically RTS 2) to be amended. Second, a similar initiative is currently being pursued in the United Kingdom where it is expected that revisions to the UK MiFIR will contribute to a realignment of the transparency regimes of the EU and UK financial markets. Third, ESMA has recently published a manual on post-trade transparency under MiFID II/ MiFIR that promotes the adoption of common approaches for reporting (see ESMA, 2023a). Efforts are also being made to harmonise the reporting on flags, which we have also found difficult to address when collecting our data.

Our tool has concentrated on those financial instruments that are eligible as collateral for ECB credit operations. However, it could easily be applied to other financial instruments. In this context our tool (which could be replicated by the general public with little effort) profits from the availability of an ECB list documenting the type of asset a certain ISIN identifier belongs to. To decipher the information posted as part of the pre-trade and post-trade MiFIR reporting requirements for other financial instruments, an ISIN database would be necessary if we wished to create a database that is useful from the perspective of a general investor. ESMA's FIRDS data make it possible to identify the ISINs associated with the various financial instrument types but it provides only limited "static data" linked to each financial instrument.

MiFIR and the associated RTS is subject to an ongoing review process, both in the EU and in the United Kingdom. One expected outcome will be a reduction in pre-trade reporting data, such as quotes posted on request-for-quote trading venues or quotes issued over-the-counter by systematic internalisers. It also remains to be seen to what extent the relatively harmonised practices in the EU and the United

Kingdom for reporting transactions and quotes remain so in the years to come. Discussion are ongoing regarding the modification of RTS 2, both in the EU and in the United Kingdom.

Finally, it is worth pointing out that redistribution of the data associated with the pre-trade and post-trade reporting of MiFID II is feasible. However, some restrictions need to be borne in mind. Neither MiFIR/MiFID II nor RTS 13 supplementing MiFIR provide information on the potential redistribution of published data in compliance with reporting requirements. A document published by ESMA addressing a collection of questions and answers associated with MiFIR/MiFID II issues states that “Trading venues, APAs and CTPs [Consolidated Tape Providers] may not impose redistribution fees or other similar restrictions on redistributors/third parties making available data free of charge 15 minutes after the initial publication.” However, were a redistributor to charge fees for the distribution of the data, APAs could impose redistribution fees or other similar restrictions (see Questions 9 and 10 of ESMA, 2023b).

References

Adler, M., Camba-Mendez, G., Dzaja, T., Manzanares, A., Metra, M. and Vocalelli, G. (2023), "The valuation haircuts applied to eligible marketable assets for ECB credit operations", *Occasional Papers Series*, No 312, ECB, March.

Bindseil, U., Corsi, M., Sahel, B. and Visser, A. (2017), "The Eurosystem collateral framework explained", *Occasional Paper Series*, No 189, ECB, May.

Boehmer, E., Saar, G. and Yu, L. (2005), "Lifting the Veil: An Analysis of Pre-Trade Transparency at the NYSE", *The Journal of Finance*, Vol. 60, No 2, pp. 783-815.

ECB (2015), "The financial risk management of the Eurosystem's monetary policy operations", ECB, July.

ECB (2022), "On the proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 600/2014 as regards enhancing market data transparency, removing obstacles to the emergence of a consolidated tape, optimising trading obligations and prohibiting receiving payments for forwarding client orders", *Opinion of the European Central Bank of 1 June 2022* (CON/2022/19).

ESMA (2020a), "MiFID II/MiFIR review report on the transparency regime for non-equity instruments and the trading obligation for derivatives", *Consultation Paper*, ESMA70-156-2189, 10 March, p. 54.

ESMA (2020b), "Impact of Brexit on the application of MiFID II/MiFIR", *Public Statement*, ESMA70-155-10962, 1 October.

ESMA (2021), "EU Securities Markets - ESMA Annual Statistical Report 2021", *ESMA Publication ESMA50-165-2004*, 17 December, p. 6.

ESMA (2022), "FIRDS Reference Data System. Instructions on download and use of full, delta and cancellations reference data files", *ESMA Publication ESMA65-8-5014 rev. 3*, 9 February.

ESMA (2023a), "MANUAL: On post-trade transparency under MiFID II/ MiFIR", *ESMA Publication ESMA74-2134169708-6870*, 10 July.

ESMA (2023b), "Questions and Answers on MiFID II and MiFIR transparency topics", *ESMA Publication ESMA70-872942901-35*, 26 May.

ESMA (2024), "2023 Report on Quality and Use of Data", *ESMA Publication ESMA12-1209242288-852*, 11 April.

FCA (2023), "Improving transparency for bond and derivatives markets", *Consultation Paper CP23/32****, December.

Foucault, T., Pagano, M. and Röell, A. (2013), *Market Liquidity: Theory, Evidence and Policy*, Oxford University Press.

HM Treasury (2022), *Wholesale Markets Review: Consultation Response*, 1 March.

Lannoo, K. and Thomadakis, A. (2019), “Rebranding Capital Markets Union: A market finance action plan”, *CEPS-ECMI Task Force Report*, Centre for European Policy Studies, Brussels, June.

Annex I: Tables of field names

Table: ECB eligible assets

Field identifier	Data type	Definition
ISIN_CODE (id)	12 alphanumeric characters	International Securities Identification Number
OTHER_REG_NUMBER	Char (max. length 20)	
HAIRCUT_CATEGORY	3 alphanumeric characters	One of L1A, L1B, L1C, L1D and L1E (see below)
TYPE	4 alphanumeric characters	One of AT01, AT02, ..., AT13 (see below)
REFERENCE_MARKET	6 alphanumeric characters	Reference market
DENOMINATION	3 alphanumeric characters	Currency denomination (e.g. EUR, USD, ...)
ISSUANCE_DATE	Char (date and time)	DD/MM/YYY HH:MM:SS FF, e.g. 07/11/2019 12:00:00 AM
MATURITY_DATE	Char (date and time)	DD/MM/YYY HH:MM:SS FF, e.g. 07/11/2019 12:00:00 AM
ISSUER_CSD	6 alphanumeric characters	Country of location
COUPON_RATE (%)	Numeric	Coupon rate in % paid by the asset
ISSUER_NAME	Char (max. length 255)	Issuer name
ISSUER_RESIDENCE	4 char	IR**CC** with **CC** a two letter country code (e.g. IRAT for Austria)
ISSUER_GROUP	Char (max. length 4)	One of IG1, IG2, ..., IG11 (see below)
GUARANTOR_NAME	Char (max. length 255)	
GUARANTOR_RESIDENCE	4 char	GRCC with CC a two letter country code (e.g. GRAT for Austria)
GUARANTOR_GROUP	Char (max. length 4)	One of GG1, GG2, ... (see below)
COUPON_DEFINITION	3 alphanumeric characters	Value is one of: CD1 (zero coupon), CD2 (variable) or CD4 (fixed)
HAIRCUT	Numeric	
HAIRCUT_OWN_USE	Numeric	
POTENTIALLY_OWN_USABLE_COVERED_BOND	Bool	Either 'Y'or 'N

Note: In addition, see the user guide with details on the full structure of the eligible assets database.

Table: trading venues

Field identifier	Data type	Definition
authorisationNotificationDate	ISO 8601 date and time format	YYYY-MM-DDThh:mm:ssTZD, e.g. 2018-01-02T00:00:00Z
homeMemberState	Char	Full name of home member state, e.g. FRANCE.
competentAuthority	Char	Name of financial authority responsible for supervising the entity
lastUpdate	ISO 8601 date and time format	See above
authorisationWithdrawalDate	ISO 8601 date and time format	see above
entityTypeCode	3 char	Entity Legal Framework acronym. e.g. 'MIT' for Multilateral Trading Facility
MIC (id)	4 alphanumeric characters	Market identification code (MIC)
authorisationEndDate	ISO 8601 date and time format	See above
timestamp	ISO 8601 date and time format	See above
headOfficeAddress	Char	Post address of head office
authorisationWithdrawalEndDate	ISO 8601 date and time format	see above
status	Char	Either "Active" or "Inactive"
entityTypeLabel	Char	E.g. "Multilateral Trading Facility", "Regulated Market", ...
headOfficeLei	20 alphanumeric characters	Legal Entity Identifier code of head office
LEI	20 alphanumeric characters	Legal Entity Identifier code of venue
entityName	String	Name of venue

Table: ISINs registered at trading venues

Field identifier	Data type	Definition
isin	12 alphanumeric characters	International Securities Identification Number
ClssfctnTp	6 char	CFI (Classification of Financial Instruments) code, e.g. DBFTFR
MIC	4 alphanumeric characters	Market identification code (MIC)
FrstTradDt	ISO 8601 date and time format	Date when ISIN first registered at trading venue
TermntnDt	ISO 8601 date and time format	Date when ISIN ends being registered at trading venue
pub_date	8 alphanumeric char	Date of publication of records in ESMA register, as YYYYMMDD

Notes: The FIRDS is a large database that should be assembled following instructions from ESMA, as reported in the main text. This table only reports the main fields relevant to assembling our transactions database.

Table: posted quotes (pre-trade)

Field identifier	Data type	Definition
date and time	ISO 8601 date and time format	YYYY-MM-DDThh:mm:ssTZD, e.g. 2018-01-02T00:00:00Z
instrument identifier type		e.g. ISIN
instrument identifier	12 alphanumeric characters if ISIN	
price	Numeric	
venue of publication	4 alphanumeric characters	Market identification code (MIC).
price type		
quantity	Numeric	
notional amount	Numeric	

Notes: Unfortunately, neither the conventions for the fields that need to be reported nor the format for the reported fields are precisely defined by RTS 2 supplementing MiFIR. What needs to be reported is defined in Article 2 and Annex I of RTS 2. However, the information to be provided is specific to the market microstructure of each trading venue. The fields shown describe how these records are integrated into our database.

Table: recorded transactions (post-trade).

Field identifier	Data type	Definition
trading date and time	ISO 8601 date and time format	YYYY-MM-DDThh:mm:ssTZD, e.g. 2018-01-02T00:00:00Z
ISIN	12 alphanumeric characters	International Securities Identification Number
price	Numeric	
venue of execution	4 alphanumeric characters	Market identification code (MIC). Mandatory field RTS 2.
price currency	3 alphanumeric characters	
quantity	Numeric	
publication date and time	ISO 8601 date and time format	
venue of publication	4 alphanumeric characters	Market identification code (MIC). Mandatory field RTS 2.
transaction identification code	Char (max. length 52)	
instrument identification code type	4 char	Either "ISIN" or "OTHR"
price notation	4 char	One of 'MONE' (monetary value), 'PERC' percentage, 'YIEL' yield or 'BAPO' basis points
notional amount	Numeric	
notional currency	3 alphanumeric characters	

Annex II: List of trading venues

Table: Annex II

Share of volume of ECB eligible assets registered for trading

	Name	mic	type	cou	ALL	SOV	REG	SOV_ZC	TB	SUPRA	AGE	COR	COV	FIN	ABS	CP
1	Bloomberg Trading Facility B.V.	BTFE	MTF	ESMA	87%	100%	93%	99%	88%	99%	96%	96%	62%	80%	0%	1%
2	EuroMTS Limited	BVUK	MTF	FCA	86%	99%	85%	99%	88%	96%	96%	94%	65%	78%	0%	0%
3	MTS S.P.A. - Bond Vision Europe	SSOB	MTF	ESMA	86%	99%	85%	99%	88%	96%	96%	94%	65%	78%	0%	0%
4	Bloomberg Trading Facility Limited	BMTF	MTF	FCA	86%	100%	89%	98%	87%	99%	95%	96%	59%	76%	0%	0%
5	MarketAxess NL B.V.	MANL	MTF	ESMA	85%	99%	90%	0%	45%	98%	93%	95%	61%	75%	0%	0%
6	Tradeweb EU B.V.	TWEM	MTF	ESMA	85%	99%	82%	92%	87%	98%	91%	94%	56%	70%	0%	0%
7	BGC Brokers L.P	BGCO	OTF	FCA	84%	99%	76%	78%	58%	98%	92%	93%	66%	67%	8%	0%
8	Tradeweb Europe Limited	TREU	MTF	FCA	84%	99%	77%	97%	86%	98%	89%	94%	53%	68%	0%	0%
9	MarketAxess Europe Limited	MAEL	MTF	FCA	84%	99%	85%	0%	32%	99%	93%	95%	60%	73%	0%	0%
10	AUREL BGC	AURO	OTF	ESMA	80%	98%	80%	84%	51%	95%	84%	77%	59%	55%	0%	0%
11	GFI Securities Limited	GFSO	OTF	FCA	80%	96%	78%	27%	8%	97%	91%	93%	54%	68%	10%	0%
12	BADEN-WUERTTEMBERGISCHE WERTPAPIERBOE	STUB	MTF	ESMA	71%	81%	75%	0%	44%	96%	79%	84%	47%	68%	0%	5%
13	BOERSE MUENCHEN (FREIVERKEHR)	MUNB	MTF	ESMA	69%	80%	75%	0%	65%	94%	71%	81%	42%	56%	0%	0%
14	BOERSE MUENCHEN - GETTEX - FREIVERKEHR	MUND	MTF	ESMA	69%	80%	74%	0%	65%	94%	71%	80%	42%	56%	0%	0%
15	Tradition (UK) Limited	TCDS	OTF	FCA	69%	93%	67%	6%	41%	91%	74%	29%	46%	23%	0%	0%
16	FRANKFURTER WERTPAPIERBOERSE (FREIVERKEH	FRAB	MTF	ESMA	69%	76%	66%	0%	40%	97%	63%	93%	47%	70%	5%	3%
17	FRANKFURTER WERTPAPIERBOERSE (FREIVERKEH	FRAV	MTF	ESMA	68%	76%	66%	0%	40%	97%	63%	93%	47%	66%	5%	1%
18	Eurex Repo GmbH	XERE	MTF	ESMA	68%	90%	77%	0%	77%	77%	71%	12%	52%	26%	0%	0%
19	DUESSELDORFER BOERSE (FREIVERKEHR)	DUSB	MTF	ESMA	67%	79%	43%	0%	34%	91%	69%	88%	40%	59%	0%	0%
20	DUESSELDORFER BOERSE QUOTRIX (FREIVERKEH	DUSD	MTF	ESMA	66%	78%	37%	0%	34%	91%	68%	87%	39%	59%	0%	0%
21	CME Amsterdam B.V.	BTAM	RM	ESMA	59%	96%	19%	99%	86%	84%	32%	0%	0%	0%	0%	0%
22	TSAF OTC	TSAF	OTF	ESMA	57%	93%	13%	0%	65%	57%	32%	9%	9%	9%	0%	0%
23	EBM - MTF	EBMX	MTF	ESMA	57%	95%	0%	0%	80%	80%	18%	0%	0%	0%	0%	0%
24	Borsa Italiana S.P.A. - MOT	MOTX	RM	ESMA	55%	96%	0%	0%	22%	86%	14%	0%	0%	0%	0%	0%
25	Mercado de Renta Fija, AIAF	SEND	RM	ESMA	53%	91%	6%	0%	54%	41%	0%	3%	11%	1%	14%	4%
26	Mercado de Renta Fija, AIAF	XDRF	RM	ESMA	53%	91%	6%	0%	54%	41%	0%	3%	11%	1%	14%	4%
27	BOERSE BERLIN (FREIVERKEHR)	BERB	MTF	ESMA	51%	58%	44%	0%	21%	82%	56%	71%	33%	48%	0%	0%
28	Tradition España OTF	TEUR	OTF	ESMA	51%	85%	10%	0%	80%	43%	18%	6%	1%	5%	0%	0%
29	ICAP EU OTF	ICOT	OTF	ESMA	50%	83%	27%	0%	13%	50%	23%	6%	10%	6%	0%	0%
30	CAPI OTF	CAPI	OTF	ESMA	39%	73%	0%	0%	0%	26%	0%	2%	0%	1%	0%	0%
31	HANSEATISCHE WERTPAPIERBOERSE HAMBURG	HAMB	MTF	ESMA	37%	42%	13%	0%	0%	60%	34%	69%	20%	43%	0%	0%
32	CIMD OTF	CIMB	OTF	ESMA	37%	68%	0%	0%	64%	3%	0%	0%	0%	0%	0%	0%
33	TRADEGATE EXCHANGE (FREIVERKEHR)	XGAT	MTF	ESMA	36%	40%	12%	0%	0%	49%	34%	73%	22%	46%	0%	0%
34	Tullett Prebon EU OTF	TPEU	OTF	ESMA	36%	62%	6%	0%	0%	36%	18%	12%	1%	8%	0%	0%
35	King Shaxson Limited	DOWG	MTF	FCA	33%	64%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%
36	VORVEL Bonds	HMTF	MTF	ESMA	32%	57%	0%	0%	18%	27%	1%	6%	0%	6%	0%	0%
37	NIEDERSAECHSICHE BOERSE ZU HANNOVER (FRE	HANB	MTF	ESMA	31%	38%	8%	0%	0%	57%	23%	44%	10%	27%	0%	0%
38	Boerse Hamburg Lang and Schwarz Exchange (	HAMN	MTF	ESMA	28%	38%	3%	0%	0%	30%	20%	43%	5%	28%	0%	0%
39	TP ICAP (EUROPE)	TPIO	MTF	ESMA	27%	20%	2%	0%	0%	68%	24%	89%	10%	59%	0%	0%
40	MTS S.p.A. - MTS Cash Domestic MTF	MCAD	MTF	ESMA	25%	44%	0%	0%	36%	28%	0%	0%	0%	0%	0%	0%
41	TP ICAP (EUROPE)	TPIR	MTF	ESMA	22%	37%	19%	0%	0%	15%	13%	11%	5%	5%	0%	0%
42	TP ICAP MTF LIMITED	IMSB	MTF	FCA	21%	16%	12%	0%	0%	55%	18%	60%	7%	44%	0%	0%
43	TP ICAP Broking Limited	TSGB	OTF	FCA	21%	42%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
44	Euronext Paris SA	XPAR	RM	ESMA	21%	25%	5%	0%	0%	0%	33%	31%	22%	14%	27%	1%
45	TP ICAP Broking Limited	IOFI	OTF	FCA	20%	19%	2%	0%	0%	18%	19%	63%	1%	48%	0%	0%
46	Forte Securities Limited	FRTE	OTF	FCA	20%	10%	43%	0%	0%	88%	56%	1%	46%	2%	0%	0%
47	TP ICAP Broking Limited	TSFI	OTF	FCA	18%	21%	2%	0%	0%	37%	18%	27%	0%	27%	0%	0%
48	Bourse de Luxembourg	XLUX	RM	ESMA	17%	2%	5%	0%	2%	99%	32%	35%	21%	28%	19%	0%
49	FRANKFURTER WERTPAPIERBOERSE (REGULIERTI	FRAA	RM	ESMA	14%	21%	20%	0%	0%	0%	24%	0%	5%	8%	0%	0%
50	FRANKFURTER WERTPAPIERBOERSE (REGULIERTI	FRAU	RM	ESMA	14%	21%	20%	0%	0%	0%	24%	0%	5%	8%	0%	0%

Notes: The table shows the share of the total outstanding amount of ECB eligible marketable assets registered for trading in the various trading venues across the EU and the United Kingdom. “mic” stands for market identifier code; the column under the heading “cou” indicates whether the trading venue is authorised in the EU (using the label “ESMA”) or in the United Kingdom (using the label “FCA”). “ALL” relates to all types of ECB eligible marketable assets. These include the following types of bonds: sovereign (SOV), sovereign zero-coupon (SOV_ZC), Treasury Bills (TB), local and regional governments (REG), supranationals (SUPRA), agencies (AGE), non-financial corporations (COR), covered bonds (COV), financial corporations (FIN), asset backed securities (ABS), and Commercial Paper (CP). See the main text for further details. Trading venues shown in pale orange (for the EU) or dark orange (for the United Kingdom) highlight those trading venues with a share of at least 20% for one of the asset types. Finally, those index numbers highlighted in blue in the first column indicate that trading venues are included in the IT tool used for collecting post-trade data. If the number is highlighted in red then that point is also used to retrieve pre-trade data.

Table Annex II (continued)
Share of volume of ECB eligible assets registered for trading

	Name	mic	type	cou	ALL	SOV	REG	SOV_ZC	TB	SUPRA	AGE	COR	COV	FIN	ABS	CP
51	VORVEL RFQ	HRFQ	MTF	ESMA	13%	25%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%
52	MTS France SAS	FMTS	MTF	ESMA	13%	24%	0%	0%	25%	0%	0%	0%	0%	0%	0%	0%
53	KEPLER CHEUVREUX	KOTF	OTF	ESMA	12%	23%	1%	0%	0%	0%	8%	0%	0%	0%	0%	0%
54	Tradeweb EU B.V.	TWEO	OTF	ESMA	12%	2%	9%	0%	0%	24%	12%	66%	3%	46%	0%	0%
55	MTS S.P.A. - MTS Italia	MTSC	RM	ESMA	12%	23%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%
56	Tradeweb Europe Limited	TREO	OTF	FCA	12%	2%	1%	0%	0%	5%	10%	84%	1%	54%	0%	0%
57	AFS - OTF - BONDS	AFSO	OTF	ESMA	12%	17%	6%	0%	14%	17%	5%	4%	1%	6%	0%	0%
58	HPC eTrading OTF	HPCO	OTF	ESMA	11%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
59	DUESSELDORFER BOERSE (REGULIERTER MARKT)	DUSA	RM	ESMA	9%	17%	18%	0%	0%	0%	4%	0%	1%	0%	0%	0%
60	BOERSE MUENCHEN (REGULIERTER MARKT)	MUNA	RM	ESMA	9%	17%	2%	0%	0%	0%	1%	0%	5%	1%	0%	0%
61	HANSEATISCHE WERTPAPIERBOERSE HAMBURG	HAMA	RM	ESMA	9%	17%	10%	0%	0%	0%	0%	0%	2%	0%	0%	0%
62	BOERSE BERLIN (REGULIERTER MARKT)	BERA	RM	ESMA	9%	17%	11%	0%	0%	0%	1%	0%	1%	0%	0%	0%
63	DUESSELDORFER BOERSE QUOTRIX (REGULIERTE	DUSC	RM	ESMA	9%	17%	10%	0%	0%	0%	2%	0%	0%	0%	0%	0%
64	BOERSE MUENCHEN - GETTEX - REGULIERTER MA	MUNC	RM	ESMA	9%	17%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%
65	NIEDERSAECHSICHE BOERSE ZU HANNOVER (REG	HANA	RM	ESMA	9%	17%	8%	0%	0%	0%	0%	0%	1%	0%	0%	0%
66	BADEN-WUERTTEMBERGISCHE WERTPAPIERBOE	STUA	RM	ESMA	9%	17%	3%	0%	0%	0%	1%	0%	1%	0%	0%	0%
67	HPC Voice OTF	HPCV	OTF	ESMA	8%	17%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
68	Sistema Electrónico de Negociación de Activos	XNAF	MTF	ESMA	7%	14%	0%	0%	9%	0%	0%	0%	0%	0%	0%	0%
69	TRADEGATE EXCHANGE (REGULIERTER MARKT)	XGRM	RM	ESMA	7%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70	Boerse Hamburg Lang and Schwarz Exchange (I	HAMM	RM	ESMA	5%	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
71	Euro MTF	EMTF	MTF	ESMA	5%	7%	6%	0%	4%	0%	2%	5%	1%	8%	0%	0%
72	Euronext Amsterdam N.V.	XAMS	RM	ESMA	4%	4%	0%	0%	4%	0%	0%	4%	10%	2%	14%	0%
73	Euronext Dublin	XMSM	RM	ESMA	4%	2%	0%	0%	0%	0%	0%	10%	8%	13%	4%	5%
74	Euronext Brussels	XBRU	RM	ESMA	3%	5%	7%	0%	5%	0%	0%	1%	3%	0%	7%	0%
75	TP ICAP (EUROPE)	LNFI	MTF	ESMA	3%	1%	0%	0%	0%	9%	1%	11%	1%	8%	0%	0%
76	TP ICAP MTF LIMITED	IMGB	MTF	FCA	3%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
77	MTS Belgium	BMTS	MTF	ESMA	3%	5%	0%	99%	3%	0%	0%	0%	0%	0%	0%	0%
78	Wiener Börse AG	WBAH	RM	ESMA	2%	3%	0%	0%	0%	0%	0%	2%	5%	1%	0%	0%
79	LONDON STOCK EXCHANGE	XLON	RM	FCA	2%	0%	0%	0%	0%	1%	1%	7%	5%	7%	0%	0%
80	BORSA ITALIANA S.P.A.	ETLX	MTF	ESMA	2%	0%	0%	0%	0%	0%	1%	10%	1%	11%	0%	0%
81	Creditex Brokerage LLP	CXRT	MTF	FCA	1%	0%	0%	0%	0%	0%	0%	12%	0%	8%	0%	0%
82	BADEN-WUERTTEMBERGISCHE WERTPAPIERBOE	STUD	MTF	ESMA	1%	0%	0%	0%	0%	5%	8%	2%	0%	2%	0%	0%
83	Kyte Broking Limited	KBLM	OTF	FCA	1%	2%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
84	TP ICAP MTF LIMITED	IMMM	MTF	FCA	1%	0%	0%	0%	3%	10%	2%	0%	0%	0%	0%	0%
85	TP ICAP MTF LIMITED	IMRD	MTF	FCA	1%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
86	Euronext Access Milan	XMOT	MTF	ESMA	1%	0%	0%	0%	0%	0%	1%	5%	0%	4%	9%	0%
87	Euronext Lisbon - Sociedade Gestora de Merca	XLIS	RM	ESMA	1%	2%	1%	0%	0%	0%	0%	0%	2%	0%	1%	0%
88	Nasdaq Helsinki Oy	XHEL	RM	ESMA	1%	1%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%
89	MTS Finland	MTSF	MTF	ESMA	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90	Liquidnet Europe Limited	LIQF	MTF	FCA	1%	0%	0%	0%	0%	2%	2%	2%	0%	2%	0%	0%
91	ELECTRONIC SECONDARY SECURITIES MARKET	HDAT	RM	ESMA	1%	1%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
92	The Irish Stock Exchange plc Global Exchange M	XEYE	MTF	ESMA	1%	0%	0%	0%	0%	0%	0%	3%	0%	4%	0%	0%
93	Hellenic Exchanges - Athens Stock Exchange SA	XATH	RM	ESMA	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
94	Burza cenných papierov v Bratislave, a.s.	XBRA	RM	ESMA	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
95	Ljubljana Stock Exchange Inc.	XLJU	RM	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
96	42 Financial Services a.s.	FTFS	OTF	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
97	TP ICAP Broking Limited	IOGB	OTF	FCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
98	TP ICAP Broking Limited	IOCD	OTF	FCA	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
99	BondSpot S.A.	TBSP	MTF	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100	Wiener Börse AG	WBDM	MTF	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
101	Bloomberg Data Reporting Services Ltd	BAPA	APA	FCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
102	London Stock Exchange plc (RIE)	ECHO	APA	FCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
103	MarketAxess Post-Trade Limited	TRAX	APA	FCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
104	Tradeweb Europe Limited	TREA	APA	FCA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
105	BME REGULATORY SERVICES	BMEA	APA	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
106	UnaVista TRADEcho B.V.	ECEU	APA	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
107	MarketAxess Post-Trade B.V.	TRNL	APA	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
108	Bloomberg Data Reporting Services B.V.	BAPE	APA	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
109	Tradeweb EU B.V.	TWEA	APA	ESMA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Notes: The table shows the share of the total outstanding amount of ECB eligible marketable assets registered for trading in the various trading venues across the EU and the United Kingdom. “mic” stands for market identifier code; the column under the heading “cou” indicates whether the trading venue is authorised in the EU (using the label “ESMA”) or in the United Kingdom (using the label “FCA”). “ALL” relates to all types of ECB eligible marketable assets. These include the following types of bonds: sovereign (SOV), sovereign zero-coupon (SOV_ZC), Treasury Bills (TB), local and regional governments (REG), supranationals (SUPRA), agencies (AGE), non-financial corporations (COR), covered bonds (COV), financial corporations (FIN), asset backed securities (ABS), and Commercial Paper (CP). See the main text for further details. Trading venues shown in pale orange (for the EU) or dark orange (for the United Kingdom) highlight those trading venues with a share of at least 20% for one of the asset types. Finally, those index numbers highlighted in blue in the first column indicate that trading venues are included in the IT tool used for collecting post-trade data. If the number is highlighted in red then that point is also used to retrieve pre-trade data.

Annex III: Metadata retrieval with Python

ECB eligible assets

```
import requests
import pandas as pd
from io import StringIO
webservice = r"https://www.ecb.europa.eu/paym/coll/assets/html/dla/ea_MID/ea_csv_230613.csv"
ret = requests.get(webservice, verify=ssl_certificate)
# verify = False is an alternative, but not recommended
df = pd.read_csv(StringIO(ret.content.decode('utf-16')), sep='  ')
```

Trading venues

```
import requests
import pandas as pd
from io import BytesIO
webservice =
    r"https://registers.esma.europa.eu/solr/esma_registers_upreg/select?q=ae=%7B!join+from%3Did+to%
    3D_root_%7Dae_entityTypeCode%3AMIR+ae_entityTypeCode%3AMIT+ae_entityTypeCode%3AMIO+
    ae_entityTypeCode%3AMIS+ae_entityTypeCode%3AMIP&fq=(type_s%3Aparent)(entity_type%3AaeA
    ctivity)(entity_type%3AaeActivityHistory)&fq=(type_s%3Aparent)&rows=1000&wt=csv&indent=true&fl=
    ${FIELDS_TVS}"
ret = requests.get(webservice, verify= ssl_certificate)
# verify = False is an alternative, but not recommended
df = pd.read_csv(BytesIO(ret.content))
```

ISINs registered at trading venue

```
import requests
import pandas as pd
from lxml import etree
import zipfile
import io
import xml.etree.ElementTree as ET
from itertools import chain
from datetime import datetime, timedelta
import numpy as np

def flatten_xml(elem, path='', ns={}, data=[]):
    if len(elem):
        # Recurse children of element
        for child in elem:
            child_path = f'{path}_{child.tag.split("}")[-1]}' if path else child.tag.split("}")[-1]
            flatten_xml(child, child_path, ns, data)
    else:
        # Append the path and text to the data list
        data.append((path, elem.text))
        # Handle attributes of elements
```

```
        for attr_name, attr_value in elem.attrib.items():
            attr_path = f"{path}_{attr_name}"
            data.append((attr_path, attr_value))

def process_data(root, ns):
    data_rows = []
    # Find all NonEqtyTrnsprncyData elements
    for eq_data in root.findall('.//auth:RefData', ns):
        row_data = {}
        data = []
        flatten_xml(eq_data, '', ns, data)
        for path, value in data:
            column_name = path.split('/')[-1].lstrip('_')
            if column_name in row_data:
                if not isinstance(row_data[column_name], list):
                    row_data[column_name] = [row_data[column_name]]
                row_data[column_name].append(value)
            else:
                row_data[column_name] = value
        data_rows.append(row_data)
    return data_rows

def download_data(links, ns, date):
    all_dfs = pd.DataFrame({})
    for link in links:
        try:
            response = requests.get(link)
            assert response.status_code == 200
            print(f"Processing: {link}")
            with zipfile.ZipFile(io.BytesIO(response.content)) as thezip:
                xml_filename = thezip.namelist()[0]
                with thezip.open(xml_filename) as xmlfile:
                    tree = ET.parse(xmlfile)
                    root = tree.getroot()
                    data_rows = process_data(root, ns)
                    df = pd.DataFrame(data_rows)
                    df['file_date'] = date
                    df['url'] = link
                    all_dfs = pd.concat([all_dfs, df],
                                        ignore_index=True)
        except Exception as e:
            print(f"Failed to download or process file at: {link}")
            print(e)
    return all_dfs

# For ESMA FIRDS retrieval

# Define the namespace if needed for XML processing
ns = {'auth': 'urn:iso:std:iso:20022:tech:xsd:auth.017.001.02'}

# Define the initial start date and end date
start_date = datetime.strptime("2024-05-01", "%Y-%m-%d")
end_date = datetime.strptime("2024-05-31", "%Y-%m-%d")

# Take the next Saturday as the first date
current_date = start_date + timedelta((5 - start_date.weekday()) % 7)
```

```
# Loop until you reach the end_date
while current_date <= end_date:
    date_str = current_date.strftime("%Y-%m-%d")
    url =
      f"https://registers.esma.europa.eu/solr/esma_registers_firds_files/select?q=*&fq=publication_date:%5B
      {date_str}T00:00:00Z+TO+{date_str}T23:59:59Z%5D&wt=xml&indent=true&start=0&rows=100"
    response = requests.get(url)
    if response.status_code == 200:
        tree = etree.fromstring(response.content)
        all_links = tree.xpath("/response/result/doc/str[@name='download_link']/text()")
        pattern = f"https://firds.esma.europa.eu/firds/FULINS_D_{date_str.replace('-', '')}"
        filtered_links = [link for link in all_links if link.startswith(pattern)]
        df = download_data(filtered_links, ns, date=current_date)
        formatted_date = date_str.replace('-', '')
        df.to_csv(f"ESMA_FIRDS_{formatted_date}")
        print(f"Data for {date_str} was successfully downloaded. The dataframe has {len(df)} observations.")
    else:
        print(f"Failed to retrieve data for {date_str}, HTTP status code:", response.status_code)
    # Increment current_date by 7 days for next Saturday and clear memory
    current_date += timedelta(days=7)
    del df


# For FCA FIRDS retrieval

# Define the namespace if needed for XML processing
ns = {'auth': 'urn:iso:std:iso:20022:tech:xsd:auth.017.001.02'}

# Define the initial start date and end date
start_date = datetime.strptime("2024-05-01", "%Y-%m-%d")
end_date = datetime.strptime("2024-05-31", "%Y-%m-%d")

# Take the next Saturday as the first date
current_date = start_date + timedelta((5 - start_date.weekday()) % 7)

# Loop until you reach the end_date
while current_date <= end_date:
    date_str = current_date.strftime("%Y-%m-%d")
    url = f"https://api.data.fca.org.uk/fca_data_firds_files?q=publication_date:[{date_str} TO
      {date_str}]&from=0&size=100&pretty=true"
    response = requests.get(url)
    if response.status_code == 200:
        data = response.json()
        formatted_date = date_str.replace('-', '')
        pattern = f"https://data.fca.org.uk/artefacts/FIRDS/FULINS_D_{formatted_date}_"
        download_links = [hit['_source']['download_link'] for hit in data['hits']['hits'] if
      hit['_source']['download_link'].startswith(pattern)]
        df = download_data(download_links, ns, date=current_date)
        df.to_csv(f"FCA_FIRDS_{formatted_date}")
        print(f"Data were successfully downloaded. The dataframe has {len(df)} observations.")
    else:
        print("Failed to retrieve data, HTTP status code:", response.status_code)
    # Increment current_date by 7 days for next Saturday and clear memory
    current_date += timedelta(days=7)
    del df
```

Annex IV: Example of data retrieval with Python from a trading venue

MTS

```
# Imports
import pandas as pd
from io import BytesIO
import sys
from datetime import datetime, timedelta
import pytz
import requests
import logging
import os

# 1. Data source description
mts_channels = ['deferredtime/type/cmf/export/all', 'delaytime/type/cmf/export/all', 'deferredtime/type/bvs/export/all',
    'delaytime/type/bvs/export/all']
mts_url = 'https://www.mtsmarkets.com/Mts-dataportal/'
isin_column_name_mts = 'instrument_id_code'
mts_columns_type = {'Trading date and time': 'datetime64[ns]', 'Instrument id code type': str,
                    'Instrument id code': str, 'Price': float,
                    'Venue of execution': str, 'Price notation': str, 'Price currency': str, 'Quantity': float,
                    'Notional amount': float, 'Notional currency': str, 'Publication date and time': 'datetime64[ns]',
                    'Transaction id code': str, 'Post trade deferral': str, 'Report status': str,
                    'Flag': str, 'Cnt': float, 'MIC': str, 'File_source': str, 'trade_type': str}

# 2. Functions
def download_single_url(mifid_url):
    req = None
    try:
        req = requests.get(mifid_url, verify=False)
        req.raise_for_status()
    except requests.exceptions.HTTPError as errh:
        logging.warning("HTTP Error:" + str(errh))
    except requests.exceptions.ConnectionError as errc:
        logging.warning("Error Connecting:" + str(errc))
    except requests.exceptions.Timeout as errt:
        logging.warning("Timeout Error:" + str(errt))
    except requests.exceptions.RequestException as err:
        logging.warning("Other Error" + str(err))
    return req

def get_urls_mts(channel_list, mifid_url):
    urls = []
    for channel in channel_list:
        urls.append(mifid_url + channel)
    return urls

def download_mts(col_list, urls):
    df = pd.DataFrame(columns=col_list)
    for url in urls:
```

```
        ret = download_single_url(url)
        if not ret:
            continue
        df_tmp = pd.read_csv(BytesIO(ret.content))
        df_tmp['MIC'] = df_tmp.get('Venue of execution')
        df_tmp['File_source'] = url
        df_tmp['trade_type'] = 'post_trade'
        df = pd.concat([df, df_tmp])
    return df

def manipulate_data(df, col_type):
    df = df[[v for v in col_type.keys()]]
    col_type_dt = {c: col_type[c] for c in col_type.keys() if col_type[c] == 'datetime64[ns]'}
    col_type_not_dt = {c: col_type[c] for c in col_type.keys() if col_type[c] != 'datetime64[ns]'}
    df = df.astype(col_type_not_dt)
    for c in col_type_dt:
        df[c] = pd.to_datetime(df[c]).round("S")
    df.columns = [c.replace('#', '').replace(' ', '_').lower() for c in df.columns]
    return df

# 3. Initiate the retrieval procedure
if __name__ == '__main__':
    try:
        today = datetime.now(pytz.timezone('Europe/Berlin'))
        yesterday = today - timedelta(hours=23)
        snapshot_date = yesterday
    except Exception as e:
        sys.stderr.write('Error occurred attempting to define the datetime at which downloading the files.\n')
        sys.stderr.write(str(e))
        sys.exit(-1)
    try:
        urls = get_urls_mts(channel_list=mts_channels, mifid_url=mts_url)
    except Exception as e:
        sys.stderr.write('Error occurred attempting to retrieve the urls.\n')
        sys.stderr.write(str(e))
        sys.exit(-1)
    try:
        df = download_mts(col_list=list(mts_columns_type.keys()), urls=urls)
        if df.empty:
            raise RuntimeError('Dataframe is empty')
    except Exception as e:
        sys.stderr.write('Error occurred in downloading data.\n')
        sys.stderr.write(str(e))
        sys.exit(-1)
    try:
        df = manipulate_data(df=df, col_type=mts_columns_type)
    except Exception as e:
        sys.stderr.write('Error occurred in manipulating data.\n')
        sys.stderr.write(str(e))
        sys.exit(-1)
    try:
        df = filter_eligible_assets(df=df, isin_column_name=isin_column_name_mts, snapshot_date=snapshot_date)
        if df.empty:
            raise RuntimeError('Dataframe is empty')
    except Exception as e:
        sys.stderr.write('Error occurred in cleaning the data.\n')
```

```
        sys.stderr.write(str(e))
        sys.exit(-1)

# 4. Subsequently, the data are uploaded to an external database.
```

Acknowledgements
The authors would like to thank Jakub Brettl and Erica Conter from the European Securities and Markets Authority for their comments and constructive discussion during the preparation of our paper and tool. We also thank our European Central Bank colleagues Martin Adler, Jonathan Drake, Tomislav Dzaja, Elke Heinle, Amparo Jareño García, Marek Micuch, Simon Patterson, Sébastien Pérez-Duarte, Stephan Sauer, Marek Svoboda and Maria Anna Toulouki for their useful comments. Special thanks go to Giorgio Vocalelli, now at the University of Verona, for his contribution to the design and implementation of various parts of our database tool.
The authors remain responsible for any mistakes still present.

Gonzalo Camba-Méndez
European Central Bank, Frankfurt am Main, Germany; email: gonzalo.camba-mendez@ecb.europa.eu

Jan Jerzy Dareck
European Central Bank, Frankfurt am Main, Germany; email: jan_jerzy.darecki@ecb.europa.eu

Andrés Manzanares
European Central Bank, Frankfurt am Main, Germany; email: andres.manzanares@ecb.europa.eu

Matteo Metra
European Central Bank, Frankfurt am Main, Germany; email: matteo.metra@ecb.europa.eu

Riccardo Vergnano
European Central Bank, Frankfurt am Main, Germany; email: riccardo.vergnano@ecb.europa.eu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

PDF ISBN 978-92-899-7382-3, ISSN 2314-9248, doi:10.2866/9789691, QB-01-25-157-EN-N