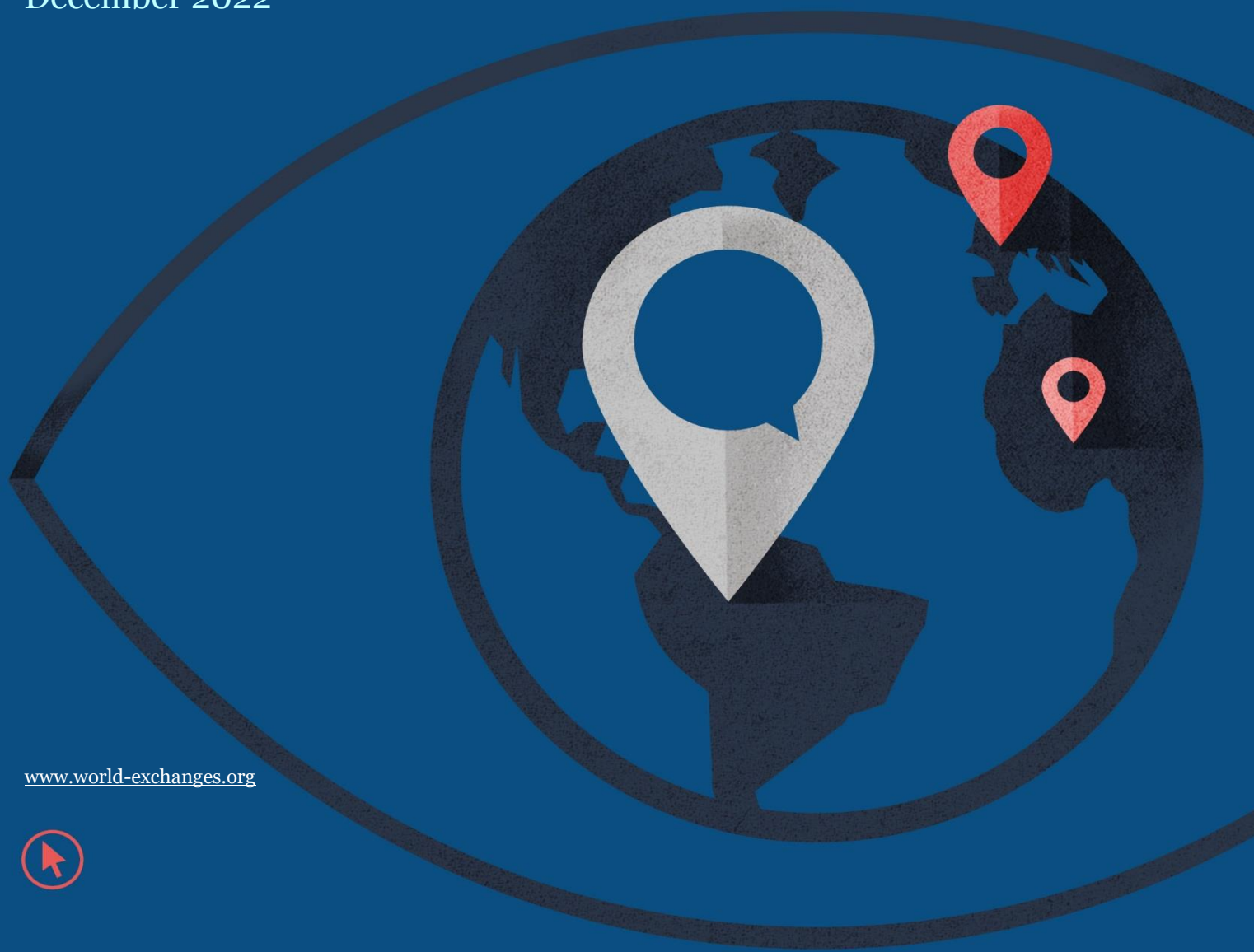


WFE Research

Centralising bond trading

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Executive Summary

The majority of bond trading around the world takes place in over-the-counter (OTC) markets where liquidity is provided by a relatively small number of financial institutions (dealers), who use their balance sheets to intermediate trades. This is in stark contrast to stock markets, where trading is mainly done on exchange-based central limit order books (CLOBs), which are fully transparent and facilitate all-to-all trading. Why is there such a discrepancy between bonds and stocks? And could more bonds also be traded on exchange-based CLOBs, whereby any market participant (including dealers) would provide liquidity in a more transparent and competitive environment? This report argues that further centralising bond trading, by encouraging larger parts of the bond market to move onto transparent all-to-all platforms, such as exchange-based CLOBs, is not only feasible, but will also likely improve bond market functioning and will benefit the wider financial system. In particular, it would render bond markets fairer and more competitive and would reduce execution costs for most market participants, especially retail investors. All the while, it would likely render bond markets more resilient to stress. However, such a transition is unlikely to happen without changes in the current market environment, including regulation, and it may also have to be gradual to avoid market disruption. For this reason, we articulate specific proposals that we believe could constitute a roadmap to help bond trading become more centralised, or at least stimulate debate about how well bond markets function, distinguishing as appropriate according to the characteristics of bond issues. Our analysis has benefited from discussions with market participants and from the results of a survey conducted with exchanges around the world. The highlights of this report are as follows:

Key points

- Liquidity supply in most bond markets is oligopolistic with dealers extracting significant rents at the expense of other market participants and particularly retail investors.
- Recent improvements in pre-trade and post-trade bond market transparency are steps in the right direction. There is ample empirical evidence that they have lowered execution costs, when effectively implemented, by forcing dealers to offer more competitive prices. Absent any initiatives to further centralise bond trading, these initiatives are a second-best alternative.
- Further centralising bond trading will likely confer additional benefits in terms of execution costs, financial stability, and overall market functioning. This is mainly because trading via CLOBs will decouple liquidity provision from the balance sheet capacity of relatively few dealers. This, in turn, will impose further limits on dealers' market power but, crucially, will also cushion market functioning from vulnerabilities in dealers' balance sheets at times of stress.
- Contemporary and past examples of bond trading on CLOBs suggest that further centralising bond trading is feasible.
- Dealers currently have little incentive to give up their market power in bond markets and, for this reason, transitioning to centralised trading is unlikely to occur spontaneously. Any

changes would therefore likely need to be supported by policy initiatives – which should also support market-making incentives, as these will continue to be important.

- Policy makers have several options to help bond markets become more centralised. For example, they could require brokers to publicly disseminate their clients' orders to venues accessible by all market participants. This could be accompanied by order protection rules (like those enforced in equity trading) to ensure that orders are executed at the best available prices. Other options include introducing exchange-based designated market maker schemes to support liquidity and removing issuer's incentives to issue high denomination bonds, to further encourage retail trading. The exact form and shape of these initiatives will depend on the market characteristics of each jurisdiction.

1. Introduction

Most bond trading around the world takes place in over-the-counter (OTC) markets, where liquidity is provided by a relatively small number of institutions (dealers), typically affiliated with a bank.¹ OTC bond trading is either purely bilateral, with deals being closed over the phone or, increasingly, utilizes electronic platforms where users can have access to multiple dealer quotes. Either way, OTC trades are exclusively intermediated by dealers, precluding direct contact between non-dealer market participants. Furthermore, trading is relatively opaque, with information on quotes and/or completed trades typically not being widely and promptly disseminated, thus not allowing market participants to efficiently shop around for better prices. This is in stark contrast to equity markets, where central limit order books (CLOBs) allow all market participants to trade directly with one another, while offering maximum transparency both before and after the completion of a trade. This renders the market more efficient and reduces execution costs for end-users.²

It is often suggested that the prevalence of OTC trading in bond markets is due to three main factors:³ First, the large number of bond issues: a firm may issue few types of shares, but it may issue tens of bonds with different coupons, maturities and seniority.⁴ Second, the larger trading sizes: equities trade in smaller average sizes compared to bonds.⁵ Third, the smaller number of bond trades: shares trade on average more frequently than bonds with some bonds only trading a few times a year.⁶

On the one hand these arguments may justify OTC trading for bonds in some cases; for example, when there are only a few buyers and sellers present at a given point in time. On the other hand, it is not clear to what extent the smaller number of participants and the fewer trades in bond markets is less of a justification for the market to be OTC and exclusively dealer-intermediated, rather than a direct consequence of it. For example, while it is true that there are bonds that trade infrequently, in some cases this could be a consequence of market design choices (e.g., high denominations).⁷ Additionally, there is concrete evidence that attempts to increase competition, for example by

¹ OTC markets are typically two-tiered comprising a dealer-client and an interdealer segment. The focus of our report is on the dealer-client segment as this is the one in which market end-users participate.

² The average transaction costs that market end-users incur when trading in bonds are several times those observed in equities for trades of similar size. See [Harris \(2015\)](#).

³ See, for example, <https://www.icmagroup.org/Regulatory-Policy-and-Market-Practice/Secondary-Markets/Bond-Market-Transparency-Wholesale-Retail/So-why-do-bonds-trade-OTC/>

⁴ For example, in Europe there were around 7,000 companies with listed shares on European exchanges as of July 2020 (see <https://www.fese.eu/statistics/>) but around 119,000 outstanding corporate bonds issued by firms incorporated in the EEA (including Switzerland) and denominated in an EEA currency ([ICMA, 2020](#)).

⁵ For example, the median trade size of US equities, in recent years, has been around 100 shares, which corresponds to a value of about US\$ 3,000 – US\$ 5,000 for a typically priced stock ([O'Hara and Ye, 2014](#)). On the contrary, the average trade size in US corporate bonds is more than US\$1 million ([Bessembinder et al, 2018](#)).

⁶ For example, the monthly share of non-traded instruments in 2019 averaged 63% for corporate bonds. Over 2019, only 17% of corporate bonds available for trading were traded at least once a year ([ESMA, 2020](#)).

⁷ For example, the adoption of lower denomination corporate bonds can be a way to offer individuals greater access to bonds and increase liquidity. See [Time to open up UK bond markets to give investors more options](#), Financial Times, November 10, 2022.

simultaneously requesting quotes from multiple dealers, via electronic platforms, has reduced transaction costs (**O'Hara and Zhu, 2019; Bank for International Settlements, 2016**). There are also examples of markets where bonds are (or have been) trading successfully through an exchange CLOB for many years (e.g., the Israeli bond market).

In this report we make the case for further centralising bond trading, that is, for migrating trading volumes in bonds (corporate, municipal, agency, government, etc.) to widely accessible and fully transparent platforms. Such a transition would likely have to be gradual and dependent on the characteristics of bond issues and on the structure of each individual market, but the wider access and full transparency that it would entail are, in our view, necessary conditions for bond markets to ultimately become fairer and more liquid.⁸ We think in most cases there is no intrinsic reason why bond trades should exclusively be intermediated by dealers or why bond trading cannot be as transparent as equity trading. Instead, we argue that relying exclusively on the balance sheet intermediation capacity of just a few dealers renders the market oligopolistic and inefficient in good times and poses financial stability risks in stressed times. The March 2020 “dash for cash” episode in US Treasuries, which resulted in an almost ten-fold increase in bid-ask spreads, highlights precisely these limitations in dealers’ intermediation capacity in a stressed period.⁹ To be clear, we do not advocate abandoning dealer intermediation and OTC trades in bonds altogether. As mentioned earlier, there are circumstances when dealer intermediation is useful for bond market functioning, as is the case in equities. But dealers can complement and compete with other liquidity providers in transparent and widely accessible platforms, in a similar way to equity trading.

For bond trading to become more centralised and thus more widely accessible, transparent, and competitive, it is necessary that policy makers and industry engage in setting up a roadmap: to the extent that liquidity provision in bond markets is oligopolistic, there is limited scope for anything to change spontaneously. If anything, past experience suggests that attempts to reform bond markets are likely to be resisted. In addition, the fact that bond trading largely remains OTC and opaque, with efforts to improve transparency and competition being relatively slow and piecemeal, already suggests that the impediments to change are substantial.

However, the time may be ripe for bond markets to become more centralised mainly because the intermediation capacity of dealers could be approaching its limits. This is a result of both the ever-increasing amounts of outstanding corporate and government debt in many jurisdictions (further fuelled during the recent Covid pandemic) as well as the regulatory limits imposed on dealers’ own balance sheets in the aftermath of the financial crisis (**Duffie, 2020**). These two factors combined, imply that liquidity provision in bond markets will likely need to utilize hitherto untapped balance sheet capacity. Our report argues that the best way to achieve this is by allowing all interested parties to become liquidity providers in an inclusive and transparent marketplace.

⁸ In a recent report on bond markets, IOSCO found that stakeholders are largely supportive of all-to-all trading and of improved data and post-trade transparency, as ways of improving bond market functioning and liquidity provision (**IOSCO, 2022b**).

⁹ See **Duffie (2020)**.

In compiling this report, we have brought to bear evidence from a sizeable academic literature that has been using ever more sophisticated datasets and statistical techniques to shed light on opaque markets such as those for bonds.¹⁰ We have also gathered supplementary information from WFE members through a survey of 30 exchanges distributed across the Americas, EMEA and Asia-Pacific regions, and we complemented this information with interviews and discussions with market participants.¹¹

The rest of the report is organized as follows: In Section 2 we provide general background information on contemporary bond market trading.¹² In Section 3 we argue that OTC bond trading is fundamentally oligopolistic and thus inefficient. We summarize extensive empirical evidence from the academic literature supporting this view. Section 4 highlights the benefits of pre- and post-trade transparency in bond markets, citing empirical evidence. In Section 5 we make the case for CLOB trading and discuss its potential advantages for bond market functioning. Section 6 contains our policy recommendations and Section 7 concludes.

Unless otherwise stated, throughout the report *corporate bonds* refer to bonds issued by corporations, *municipal bonds* refer to bonds issued by state and local governments and *government bonds* include government and state-owned organizations' bonds and bills and bonds issued by state-related institutions whose instruments are guaranteed by the state.

2. The global bond market: some basic facts

Bond markets are one of the most important sources of capital for both the public and private sectors. They are substantially larger and account for more capital raised compared to equity markets. For example, at the end of 2020, the total amount of bonds outstanding (including both corporate and government debt) was US\$ 123 trillion compared to US\$ 106 trillion of global equity market capitalization (WFE and BIS data).

Bond markets are larger than equity markets across jurisdictions, including in both high-income and emerging economies.¹³ This is true despite the fact that high-income and emerging economies differ substantially in terms of size and overall development of their financial markets, with the former having financial markets that are, on average, almost twice as large in relative (to GDP) terms (**Figure 1, Panel A**).

As of H2 2019, the total amount of bonds outstanding was roughly equally split between corporate and government bonds with the latter also including bonds issued by local governments,

¹⁰ For an overview of the recent academic literature on bond markets, see [Bessembinder et al, 2020](#).

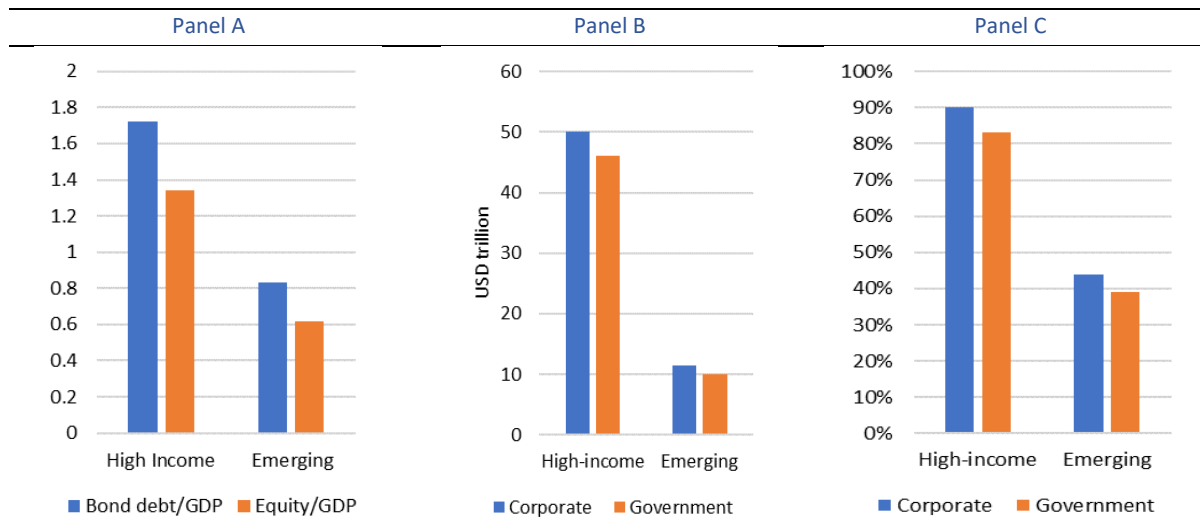
¹¹ The survey was conducted between June and October 2020. See the Annex for details.

¹² Readers well-versed with the details of bond trading may skip this section.

¹³ We use the World Bank classification for high-income economies which, as of December 2019, included those countries with a Gross National Income per capita equal to USD 12,375 or more. (see <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519>). Our group of emerging economies includes Argentina, Brazil, China, India, Indonesia, Malaysia, Mexico, Philippines, Russia, South Africa, Thailand, and Turkey. *Source*: WFE calculation using World Bank and BIS data.

municipalities and state-backed agencies. In particular, the total amount of corporate bonds outstanding, in high-income countries, was around US\$ 50 trillion (or 90% of their GDP) versus US\$ 46 trillion (or 83% of GDP) for government bonds. For our sample of emerging economies, these numbers were respectively US\$ 11.5 trillion (or 44% of GDP) and US\$ 10.1 trillion (or 39% of GDP) (Figure 1, Panels B & C).

Figure 1: Bonds outstanding across high-income and emerging economies



Total nominal amounts of bonds outstanding for high-income and a selection of emerging economies (See footnote 7). Panel A: Bond debt (corporate and government) vs equity market capitalization relative to GDP. Panel B: Absolute levels of corporate and government bonds outstanding. Panel C: Corporate vs government bond debt outstanding as percentage of GDP. Data as of Q4 2019. (Source: WFE calculations using BIS, WFE, and World Bank data).

2.1. Overview of bond trading

2.1.1. Over-The Counter bond trading

The majority of bond trading, in most jurisdictions, takes place Over-the-Counter (OTC) where a number of financial institutions (dealers) act as market makers. Dealers provide bid and ask quotes, upon solicitation, to interested buyers and sellers, which could be clients or other dealers. To facilitate these trades, dealers maintain, on their books, an inventory of bonds whose size fluctuates depending on the direction in which they trade. This inventory carries market risk which dealers generally try to minimize or at least be compensated for. One way for dealers to manage their inventories is to trade with other dealers in what is called the “inter-dealer” market which is typically out of reach for most other market participants and, as such, constitutes a separate tier in OTC bond markets.¹⁴ Overall, the key feature of OTC bond markets is that trades are exclusively intermediated

¹⁴ Dealers often trade with each other anonymously. This is done either via an electronic central limit order book (CLOB) or via inter-dealer brokers (IDBs). IDBs ensure anonymity by trading separately with each dealer

by dealers who use their balance sheets to temporarily warehouse any imbalances in their clients' orders.

Dealers profit from the bid-ask spread, i.e., the price difference of their client-initiated sell and buy trades. As such, the bid-ask spread, in its various incarnations, is effectively the price at which dealers provide liquidity and at the same time it represents the cost for executing a trade. A voluminous literature suggests that key determinants of the dealer bid-ask spread are the above-mentioned *inventory risk* as well as *adverse selection*, i.e., the risk that dealers trade with better informed clients and thus end up on the losing side of these trades. In both cases, dealers will seek compensation for these risks via higher bid-ask spreads.

Most OTC bond markets are generally pre- and post-trade opaque, meaning that little information on dealer quotes and execution prices is disseminated before and after the completion of a trade. This opacity makes it difficult for liquidity-seeking market participants to establish a benchmark against which to compare the quotes that dealers offer them. As we explain in detail in Section 3, this opacity reduces dealers' incentives to compete on prices and renders OTC bond markets oligopolistic. Thus, *market power* is an additional determinant of prevailing bid-ask spreads in bond markets.

Despite the overall opacity in OTC bond markets, transparency has improved in some jurisdictions, over the recent years, often as a result of regulatory initiatives. Bond trading protocols have evolved accordingly: whereas before the 1990s most OTC bond trading was voice-based and prices were bilaterally negotiated, today there are electronic platforms where clients can simultaneously send multiple requests for quotes (RFQs) to dealers. Additionally, regulators have in several instances mandated that information on bond transactions be promptly reported and disseminated to the public. Examples of such regulatory initiatives include the Trade Reporting and Compliance Engine (TRACE) requirement in the US and the new Markets in Financial Instruments Directive (MiFID II) in Europe. As we shall discuss in our report, these transparency initiatives have sought to increase competition between dealers and to reduce execution costs in bond markets. Despite these initiatives however, OTC bond markets remain relatively opaque.

In most jurisdictions, virtually all of bond trading is OTC i.e., dealer-intermediated. In others, where electronic trading platforms are available, most trading is also dealer-intermediated utilizing the RFQ protocol. These electronic platforms may enable in some cases all-to-all trading (i.e., trading without dealer intermediation) but the current evidence suggests that these volumes are relatively small.¹⁵

on a matched principal basis, meaning that they warehouse no risk on their books. IDBs thus act as conduits for inter-dealer trades.

¹⁵ For example, Open Trading, an all-to-all electronic trading platform for US corporate bonds, operated by MarketAxess, accounted for only about 12% of trades executed on MarketAxess in 2018 (Hendershott et al, 2021), which itself accounted for less than 14% of the total dealer-to-client volume (O'Hara and Zhou, 2021).

2.1.2. Central Limit Order Book (CLOB) trading

An alternative method of bond trading is via a CLOB, the same way the majority of stocks are traded on the world's exchanges. CLOBs are all-to-all, fully transparent platforms where anyone can provide or consume liquidity in what is effectively a (continuous) double auction for buy and sell trades.¹⁶ CLOBs display the best available quotes and their depth in real time and allow all market participants to either post quotes or trade against them. CLOBs may use various rules to prioritize orders with the most common ones being price and then time priority. Furthermore, CLOBs may also feature opening and closing auctions at the beginning and the end of the continuous trading session. During these auctions, buy and sell orders from all market participants are accumulated and the market is then cleared at a price that maximizes trading volume. Importantly, CLOBs are not exclusively reliant on dealer intermediation although dealers can access the CLOB and provide liquidity alongside - and in direct competition with - other market participants. Furthermore, when orders are matched and trades are executed on a CLOB, this information is typically promptly communicated to all market participants.

While OTC bond trading is more voluminous and widespread across jurisdictions, there are several examples of exchanges where bonds are successfully traded on CLOBs reaching sizable volumes, tight spreads and high levels of liquidity. One such example is the Korean government bond market whose trading takes place on a CLOB at the **Korea Exchange (KRX)** and which accounts for nearly US\$ 2 trillion of trading volume annually or about 40% of the total Korean government bond trading volume.¹⁷ Another example is the Israeli bond market where most of trading in corporate and government bonds takes place on a CLOB at the **Tel Aviv Stock Exchange (TASE)**. The **TASE** corporate bond volumes were on the order of US\$ 288 billion annually as of 2020 (WFE data) and execution costs on **TASE** are comparable or lower than those prevailing in much larger OTC bond markets (**Abudy and Wohl, 2018**).

CLOBs are also used for inter-dealer trading in some otherwise predominantly OTC markets. One such example is the U.S. Treasury market, commonly regarded as one of the deepest and most liquid bond markets in the world, where inter-dealer trading is largely concentrated on order-book based electronic platforms.

2.1.3. Exchange-based Negotiated Trades (The "Upstairs" Market)

In addition to a CLOB, exchanges may also facilitate bond trading via *negotiated deals* which constitute the "upstairs" market for on-exchange bond trading.¹⁸ These are typically large sized

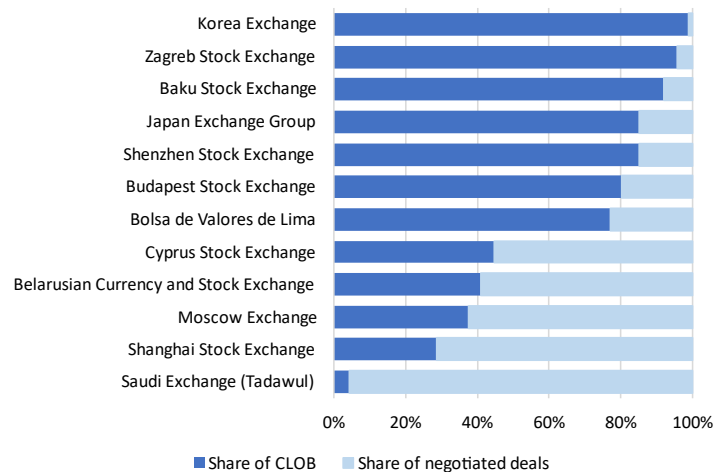
¹⁶ Formally, a double auction is a process by which multiple buyers and sellers trade goods by competing on prices. In a double auction, the best available buyer (ask) price is matched with best available seller (bid) price.

¹⁷ See **Jang et al (2016)**. The 40% figure is as of 2016 and reported by the Korean Ministry of Economy and Finance: <https://ktb.moef.go.kr/eng/scdMkts.do>

¹⁸ The term "upstairs" is used to contrast this market segment with the "downstairs" market that facilitates CLOB trading.

(block) trades that are bilaterally negotiated between investors (or their brokers) with little pre-trade information being disclosed. The main purpose of this trading mechanism is to avoid front-running and its associated price impact: should a market participant fully disclose their intention to trade a large quantity of bonds, this would likely generate opportunistic trade flow that would seek to profit from the expected price impact. This opportunistic flow would exert price pressure and would thus increase the execution cost of the original order. By negotiating directly with each other, in a relatively opaque manner, market participants can avoid such costs.

Figure 2: Shares of bond trading value in CLOBs and negotiated deals across a sample of exchanges.



The figure illustrates, for a sample of exchanges, the share of total bond value traded in 2020 through a CLOB compared with the value traded through negotiated deals, where negotiated deals are offered through a platform that is directly or indirectly managed by the exchange. (Source: WFE database)

Although this mode of trading also involves bilateral negotiations between counterparties, it is different from OTC trading in a number of ways: First, it allows for wider participation: any exchange member who wishes to execute a large order can access this market segment. As such, ultimate buyers and sellers can directly transact with one another without relying on a dealer to intermediate their trades. Second, if a CLOB is also present on the exchange, the prices at which negotiated trades are filled may be linked to the prevailing CLOB prices (e.g., they may not deviate, by more than a specified percentage, from the best bid and offer available on the CLOB). More generally, in negotiated deals, prices are agreed bilaterally but may still fall under certain rules set out by the exchange. **Figure 2** provides additional information on the relative size of on-exchange CLOB and negotiated bond trading volumes in a sample of exchanges. As one can see, while many exchanges combine both methods of trading, the shares of CLOB versus negotiated trading volumes vary substantially across exchanges, with some exchanges relying primarily on CLOBs while others relying mostly (or exclusively) on negotiated deals.

A more recent development in block trading have been the so-called *dark pools*. These are electronic platforms which match buy and sell interest with no pre-trade transparency at all (justifying their name). They are usually operated by banks or by brokers although some are operated by exchanges. The prices at which trades are executed in a dark pool are usually derived from a lit (or CLOB-based)

market. While dark pools have been in use in equity trading for some time, they have recently also been introduced in bond trading.¹⁹

Table 1 summarizes the key attributes of the various bond trading protocols that we discussed in this Section and **Box 1** summarizes some of reasons that the exchanges in our survey put forward as to why OTC trading prevails in bond markets.

Table 1: Stylized attributes of different trading protocols

	<i>All-to-all trading</i>	<i>Trade size restrictions</i>	<i>Pre-Trade Transparency</i>	<i>Post-trade transparency</i>	<i>Trading protocol</i>
<i>OTC - voice</i>	No	No	No	No	Bilateral negotiation
<i>OTC - platform</i>	No	No	Some	Some	Request for Quote (RFQ)
<i>EB- CLOB</i>	Yes	No	Yes	Yes	Continuous Double Auction
<i>EB-Negotiated deals</i>	Partially	Yes	No	Yes	Bilateral negotiation
<i>Dark pools</i>	No	No	No	No	Automatic matching at mid-point

¹⁹ [Managers turn to dark pools to carry out trades](#), Financial Times, March 1st, 2015

Box 1 (WFE Survey): Why do bonds mostly trade OTC across jurisdictions?

In addition to the larger number of bond issues, the larger trade sizes, and the lower trading frequencies, the exchanges participating in our survey listed some additional reasons for the prevalence of OTC trading in their bond markets, some of which are specific to individual jurisdictions. These included:

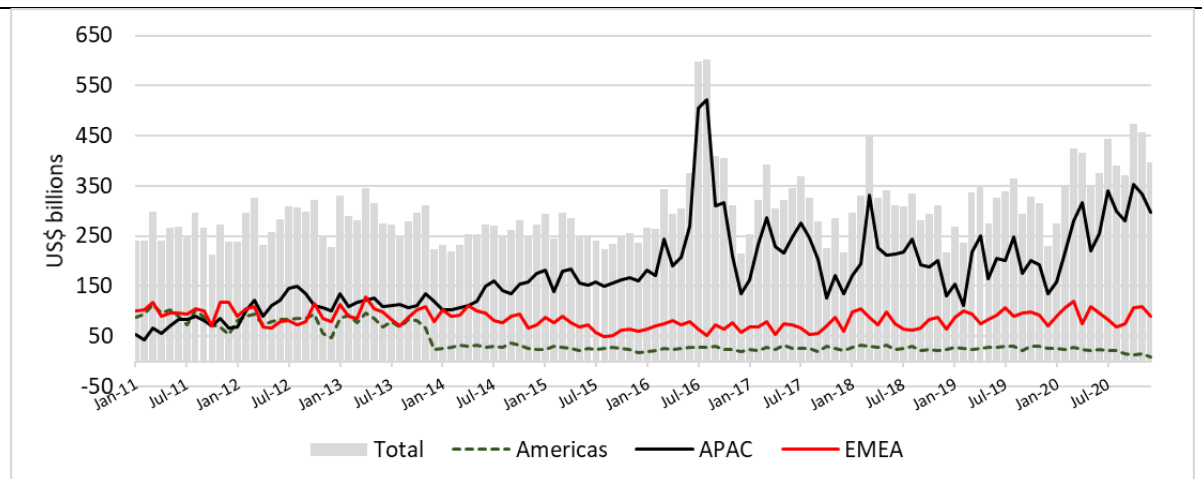
- **Local trading fee structure:** In some markets, fees at the exchange increase with the size of the transaction, while fees in the OTC market segment are fixed.
- **Dealer incentives:** There are no incentives in place for dealers to move their trading to an exchange-based CLOB.
- **Institutional investor incentives.** Institutional investors trade in larger sizes and may thus prefer to negotiate bilaterally with dealers, as this allows them to exert bargaining power.
- **Regulation:** In some jurisdictions there are no rules requiring trade transparency. On the other hand, sometimes the regulatory requirements are lower in the OTC market, making OTC operations cheaper and easier. This would be the case, for example, when OTC trades are not required to be carried out through licensed professional participants.
- **Local market structure.** In countries where the banking sector is a major issuer of debt and where the financial sector is highly concentrated, banks tend to control the trading of their own debt. In other cases, a very concentrated institutional investor base and a small number of active traders can dissuade dealers from providing liquidity to the markets.

2.2. Bond CLOB trading around the world

Bonds have been traded on exchange-based CLOBs for many years, but their trading volumes have remained small relatively to their respective OTC market segments. Bond CLOB volumes have also remained relatively stable in absolute terms in most geographic regions (**Figure 3**). As we discuss further in **Section 6**, this is likely due to the significant influence that local dealers have on bond markets and the associated network externalities.²⁰ Nevertheless, bond CLOB trading has been slowly growing in the APAC region, mainly driven by an increase in CLOB trading in the Korean and Chinese bond markets. As of the end of 2020, total CLOB bond trading around the world was around US\$ 400 billion monthly. More generally, there is substantial variability in CLOB-based bond traded volumes across countries (**Figure 4**). For instance, there are countries (e.g., Thailand) where all government bond trading is OTC and others (e.g., Israel) where it is mostly CLOB-based. This significant variability in CLOB-based volumes suggests that CLOB trading is, in principle, feasible in a wide range of bond markets.

²⁰ A network externality in the context of security trading means that the liquidity of a given trading mechanism increases with the number of its users. As such, once a trading mechanism is established, it is more difficult for alternative trading mechanisms to emerge.

Figure 3: Bond CLOB trading over time

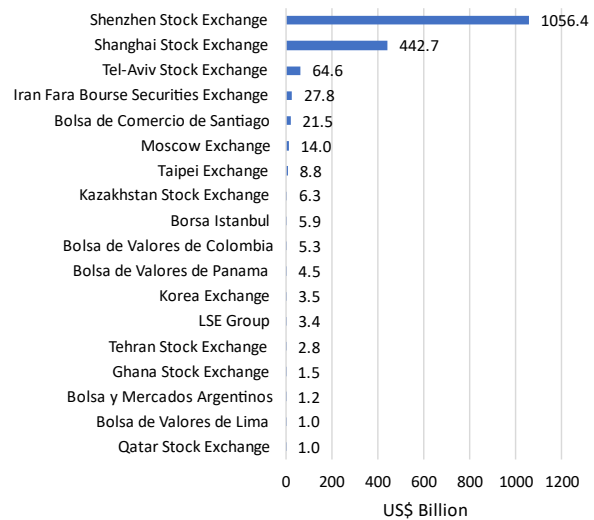


Monthly values (in US\$ billions) of corporate and government bonds traded on exchange CLOBs, for different regions. (Data source: WFE database).

Figure 4: CLOB trading volumes (in US\$ billions) for government and corporate bonds by exchange, as of 2020.

A: Government bonds

B: Corporate bonds



Annual CLOB-based traded volumes (in US\$ billions) for domestic government and corporate bonds for those exchanges where these volumes were above 1 US\$ billion in 2020. (Source: WFE database)

3. Dealer market power in bond markets

Most contemporary bond trading around the world takes place in OTC markets. While OTC trading is in some cases necessary, the major drawback of this trading arrangement is that dealers can exercise market power.

One reason for this is that there are typically relatively few dealers, resulting in a concentrated market. For example, **O' Hara and Zhou (2021)** report that, as of 2017, the top 10 dealers in the electronic segment of the US corporate bond market accounted for around 65% of market share in investment grade bonds and 75% the market share in high yield bonds. Furthermore, entry into the market for bond liquidity provision is difficult not only because a potential entrant would need to have a sizeable balance sheet but also because they would need to trade with incumbent dealers for inventory management purposes. The latter would presumably have little incentive to trade with the new entrant as that would likely erode their own market power. Another, complementary, reason for dealers' market power is that OTC bond trading is highly opaque with limited information on best-available quotes or on prices of recently completed trades. As a result, market participants cannot effectively shop around for better prices and dealers get to compete less with one another on those prices.

The combined effect of a concentrated and opaque market is that dealers charge their clients, in the form of a bid-ask spread, higher execution costs than what dealers' own marginal costs would justify. The evidence for such oligopolistic behaviour in bond markets is strong. While dealers' own marginal costs are unobservable, and thus cannot directly be compared with the prices they charge their clients, it is nevertheless possible to infer market power by comparing what dealers charge across markets (for example, across equities and bonds), and across clients within a given market (for example, across clients differing by order size or by the degree to which they are likely to be informed). Below we discuss some related evidence from the US corporate and municipal bond markets:

a. Equities versus bonds

Dealers are often active in both equity and bond markets and, to provide immediacy to their clients, they need to maintain stock and bond inventories and bear the associated market risk on those inventories. If the spreads that dealers charge in each market reflect the associated inventory risk, one would expect that execution costs in equities would be higher than those for same-sized trades in bonds, since the former are generally riskier than the latter. Furthermore, execution costs in stocks should also be higher because there is more scope for dealers to be adversely selected (i.e., lose money by trading against a better-informed client), since stock prices are more sensitive to information than bond prices.

The empirical evidence however shows that, contrary to what one might expect, execution costs in bond markets are generally much higher than those in stocks. For example, in a study of US municipal bond trades between November 1999 and October 2000, **Harris and Piwowar (2006)** reported that US municipal bond trades were substantially more expensive than similar-sized equity trades: the effective bid-ask spreads for retail-sized trades of US\$ 20,000 in municipal bonds

averaged about 2% compared to less than 0.4% for retail-size equity trades. That is, municipal bond retail trades were, on average, during the sample period of this study, *at least five times* more expensive than equity trades when they should have been cheaper. **Harris and Piwowar (2006)** attribute this finding to the lack of price transparency in bond markets and the resulting dealer market power.

b. Large versus small bond orders

The same inventory risk considerations suggest that bond dealers would charge a higher price for the execution of larger client orders, as dealers face larger potential losses in these trades. Paradoxically however, in several bond markets execution costs *decrease* with trade size. For example, based on a two-year sample period from 2003 to 2005, **Edwards et al, (2007)** found that in the US corporate bond market execution costs decreased monotonically from around 75 bps for trades of US\$ 10,000 to less than 25 bps for institutional-sized trades of US\$ 10 million. This pattern has remained remarkably stable over time. Over a more recent sample period from 2010 to 2017, **O’Hara and Zhou (2021)** report that for voice-traded investment-grade US corporate bonds, relative half-spreads for trades of up to US\$ 100,000 are around 70 bps whereas average relative half-spreads of block trades of US\$ 5 million and above are around 10 bps. A similar pattern is found in US municipal bonds where the **Harris and Piwowar (2006)** study also reported that the average 2% effective spread for retail-size trades of US\$ 20,000 in size dropped to an average of 1% for institutional-size trades of US\$ 200,000 in size.

This is the opposite of what one observes in CLOB-based equity markets where execution costs generally increase with trade size. This “paradox” is again explained by the OTC nature of the market which mostly involves bilateral trades where counterparties negotiate prices using their bargaining power. Since larger orders are usually placed by institutional clients, who themselves have bargaining power, dealers are forced to offer them better prices than what they offer their retail clients. This, in turn, implies that dealers are able to exert market power at the detriment of retail investors, whereas institutional investors use their own bargaining power to secure better deals. In both cases, this is made possible by the inherent opacity of the OTC trading process.²¹

c. Informed versus uninformed investors

Even if OTC-traded bonds are more expensive to trade than equities and even if smaller trades are more expensive than larger ones, one would expect, at the very least, that same-sized trades of the same bond would have the same cost. Yet, a study by **Green et al, (2007a)** of the market for newly-issued municipal bonds in the US showed that even this is not true. These authors showed that the prices at which retail-sized trades, on the same security and on the same day are completed, can vary by 5% or more. This price dispersion represents almost the entire annual yield of a municipal bond during the period that the authors study. One explanation of this pattern is that dealers effectively price-discriminate based on the sophistication of their clients. As smaller clients are less

²¹ This rationale is confirmed by the work of **Green et al (2007b)**, who use data on US municipal bond trades to estimate a structural model of dealer bargaining power. The model allows the authors to decompose observed prices into dealer costs and markups. They find that dealer markups decline substantially with trade size.

homogeneously informed than larger ones, there is more scope for dealers to offer worse prices to clients who are less likely to be informed. The lack of transparency in the market guarantees that clients receiving worse prices will not be able to compare their costs with those of better-informed clients and will therefore have no way of negotiating better prices for themselves.

The above-described empirical evidence from the US corporate and municipal bond markets suggests that the opaque nature of the OTC trading process is harmful to investors and to societal welfare because it allows dealers to exert market power. And while the evidence presented here is from specific bond markets, the same is likely to be true in other bond markets that are exclusively intermediated by dealers and lack sufficient pre- and post-trade transparency.

4. The impact of transparency on bond yields and trading costs

OTC bond markets around the world are generally opaque with little transparency on available executable quotes (pre-trade transparency) or on prices and volumes of completed trades (post-trade transparency). This is particularly acute in their dealer-client segments, as dealers often trade with one another on much more transparent terms.²² This lack of transparency in the dealer-client segment renders price comparison by market end-users difficult, inhibits competition between dealers and has resulted in bond markets being largely oligopolistic with major dealers charging their clients, especially the smaller ones, substantial premia. Naturally, if bond markets became more pre- and post-trade transparent, these effects would be minimized: dealer competition on prices would increase, leading to lower execution costs for end-users.

Over the past 20 years there have been instances of improvements in transparency in several bond markets, either as a result of regulatory interventions or of technological developments and market electronification. In all cases, bond trade execution costs have dropped as a result. In what follows, we discuss the available evidence on the positive impact of transparency on trading costs, on liquidity externalities, and on issuing costs.

4.1. Transparency and bond market trading costs

a. Evidence on pre-trade transparency

A market is pre-trade transparent if those who seek liquidity can easily obtain price quotes by those who are willing to provide it. Traditional voice-based markets are the least pre-trade transparent as market participants need to bilaterally contact dealers and negotiate a price for a given security and a given quantity. This is a time-consuming process that restricts the ability of market end-users to compare multiple quotes within a relatively short period of time. Of course, multiple quotes can be obtained over longer periods of time but that cannot facilitate competition as it is difficult to tell if differences in quoted prices are due to some dealers being more competitive or due to changes in

²² For example, in some countries, inter-dealer trading of government bonds is done on fully transparent electronic limit order books.

market fundamentals. In any case, end-user trades are often time-critical which leaves end-users with little capacity to wait for a better deal.

As noted above, over the last 20 years bond trading has seen increased electronification, especially in the US and Europe, utilizing request-for-quote (RFQ) protocols. Trading in this case is done using electronic platforms that allow end-users to solicit quotes from multiple dealers simultaneously. This represents an improvement in pre-trade transparency as it facilitates quote comparisons, thus stimulating competition among dealers. Bond trading via RFQs is largely concentrated in the US and Europe and until recently had been growing steadily albeit relatively slowly. For example, **O'Hara and Zhou (2021)** report that RFQ trading of US corporate bonds on MarketAxess - the main RFQ electronic platform for corporate bond trading in the U.S.- increased from around 5% of volume in 2010 to about 14% in 2017. However, recent reports suggest that this trend has accelerated as a result of the global Covid-19 pandemic, with US corporate bond electronic volumes on MarketAxess and Tradeweb (another major trading platform) nearly doubling from early 2019 to the end of 2020.²³

What impact does this improvement in pre-trade transparency then have on execution costs? Using data from the earlier days of electronification (beginning of 2010 to early 2011) a study by **Hendershott and Madhavan (2015)** found that execution costs in RFQ electronically traded US corporate bonds were significantly lower than those of bilaterally traded bonds, to the extent that if all US corporate bond trading were to migrate to RFQ platforms, the overall cost savings would amount to US\$ 2 billion annually. Furthermore, trading costs decreased by around 10 bps with each additional dealer responding to an RFQ, suggesting that the driver of this cost reduction was increased dealer competition.

More recently, **O'Hara and Zhou (2021)** have reported that execution costs for electronic dealer-client US corporate bond trades are less than half those of voice-based trades. For instance, when benchmarked against inter-dealer trades, electronically executed dealer-client trades for investment grade bonds have an average effective half-spread of 10 bps, whereas voice-executed trades have an average effective half-spread of 45 bps. A similar pattern is found for trades of high-yield bonds.

Another interesting finding from the same study is that the small-size premium, discussed in the previous section, disappears for electronically executed trades. For example, whereas voice-executed block trades (of value greater than US\$ 5 million) are on average about 50 bps cheaper than voice-executed micro trades (of value less than US\$ 100K), electronically executed block trades are only 5 bps cheaper than electronic micro trades. Given that the small-size premium is a manifestation of dealer market power, its disappearance, in the electronic segment of the market, suggests that the RFQ trading protocol increases competition between dealers. The authors' additional finding that the top 10 dealers have a 5% smaller market share in the electronic segment, than they do in the voice-based segment, corroborates this.

The evidence on the competition and cost benefits brought about by the increased pre-trade transparency of the electronic RFQ protocol, relative to a bilateral pure OTC market, extends to

²³ [Bond trading finally dragged into the digital age](#), Financial Times, February 22, 2021

other fixed-income markets as well. **Allen and Wittwer (2021)**, study the Canadian government bond market over a recent period (2016-2019) and find that dealer markups are lower for institutional investors (who use the RFQ platform more frequently) than for retail ones. Furthermore, the authors calculate that if RFQ platform access were extended to all market participants, the markup difference between institutional and retail investors would drop by at least 30%.²⁴

b. Evidence on post-trade transparency

A market is post-trade transparent if information on completed trades is readily available to market participants. This information pertains to the price and size of each trade as well as the time that the trade took place. Such information on completed trades is valuable to market participants because it allows them to infer fundamental values and to negotiate better prices for their own trades. Naturally, the value of this information declines with the amount of time that passes between the trade execution and the disclosure of the trade details.

Bond markets around the world have been - and largely continue to be - post-trade opaque. This is because in OTC markets transactions are bilateral and information on them is consequently scattered across a wide number of market participants. As such, achieving post-trade transparency requires aggregating this information. This is automatically achieved in an exchange-based market where all the information is collected, aggregated, and disseminated by the exchange.

Nevertheless, over the past 20 years there have been improvements in post-trade transparency, especially in the American and European bond markets.²⁵ In the US, the Trade Reporting and Compliance Engine (TRACE) system was introduced on July 1, 2002, to disseminate information on corporate bond trades. The scope of trade reporting in TRACE was initially more limited by capturing only the most liquid bonds and transactions were only reported within 75 minutes of execution. However, coverage gradually expanded to capture almost 99% of transactions.²⁶ Similar gradual improvements in post-trade transparency have taken place in the US municipal bond market with real-time reporting and public dissemination of trades commencing in January 2005.

²⁴ This effect has also been observed in other fixed income markets as well. For instance, **Benos et al. (2020)** show that the mandated (by Dodd-Frank) introduction of RFQ electronic platforms (called Swap Execution Facilities) in the interest rate swap market, reduced execution costs by 12%-19% relative to a control group of swap contracts that were less affected by the mandate. Furthermore, and like the evidence on corporate bonds, this cost reduction was accompanied by a substantial increase in the number of unique dealers with whom end-users traded, suggesting again that prior to the trade mandate competition was being inhibited by the lack of pre-trade transparency.

²⁵ Other jurisdictions with regimes in place for the dissemination of post-trade information in bond markets include Australia, Canada, Japan, Korea, Philippines, and Turkey (**ICMA, 2022**).

²⁶ In January 2001, the SEC required the National Association of Securities Dealers (NASD), the predecessor of the Financial Industry Regulatory Authority (FINRA), to report all OTC transactions in an initially restricted set of nearly 500 corporate bonds with issuance size larger than one billion USD. Reporting obligations became increasingly broader, and since January 2006 all trades in all publicly issued bonds have been disseminated to the public, with few instruments being exempt. Since 2005, trades must be reported within 15 minutes from execution. The list of TRACE eligible securities is made available daily at 7:00 a.m., Eastern Time.

In Europe, OTC bond markets were entirely opaque prior to the implementation of MiFID II in January 2018. MiFID II requires, in principle, market operators and investment firms to publicly disseminate information on executed trades as close to real time as possible. However, national authorities retain the right to defer the publication of such information for large orders or for bonds that are illiquid. This has meant that, in many cases, improvements in post-trade transparency in European markets have been modest.²⁷

Given the relatively small and recent transparency improvements in European markets, the bulk of available evidence on the impact of transparency improvements comes from the US bond markets. Shortly after the introduction of TRACE reporting in the US, several independent studies concluded that execution costs in US corporate bonds had decreased substantially as a result. Comparing market conditions six months before and after the introduction of TRACE, **Bessembinder et al. (2006)** found that, in a sample of trades by insurance companies, average one-way execution costs dropped by around 50% (or 5-8 bps) from an original cost of 11-13 bps to 5-6 bps, or about US\$ 2000 per trade. Extrapolating these savings to the entire corporate bond market, these authors calculated that TRACE had reduced annual execution costs by around US\$1 billion. A second study by **Edwards et al. (2007)** arrived at the same conclusion and also calculated the market-wide annual cost savings to be in the range of US\$1 billion. Another study, by **Goldstein et al. (2007)**, reached similar conclusions for a sample of BBB-rated bonds, with the cost reductions being largest for intermediate-sized trades. Comparing the drop in execution costs between a sample of disseminated bonds and a control group of non-disseminated ones, these authors found that TRACE reporting reduced round-trip execution costs by anywhere between 22 and 38 bps. They also found that post-trade transparency did not benefit thinly traded bonds. This is to be expected, as trade information on these bonds is bound to be stale and therefore of little value.

The US municipal bond market followed suit a few years later and became post-trade transparent on January 31, 2005, with the commencement of real-time trade reporting. **Schultz (2012)** studied this event and found that the price dispersion in newly-issued bonds, documented by **Green et al. (2007a)** over an earlier period (and discussed in the previous section as evidence of dealer market power), declined sharply and significantly.

As post-trade transparency in US bond markets continued to expand over the years, the evidence on its benefits kept accumulating. On June 27, 2014, Rule 144A bonds became subject to reporting requirements.²⁸ These, more loosely regulated bonds, are almost exclusively traded by institutional investors and one might have expected that the effect of post-trade transparency in this market could have been smaller, given that institutional investors have more bargaining power and enjoy lower trading costs than retail investors, as discussed in Section 3. Nevertheless, a study by **Jacobsen and Venkataraman (2018)** found that one-way transaction costs decreased by about 10% following

²⁷ For a detailed description of MiFID II, see **Busch (2018)**

²⁸ Rule 144A bonds are privately placed, non-registered, corporate bonds. These are less regulated securities that allow firms to quickly raise funds without having to meet US disclosure standards. As such, as per 1990 SEC Rule 144A, these bonds can only be sold to qualified institutional buyers with more than US\$ 100 million under management. Retail investors rarely meet this threshold. Rule 144A bonds have captured over 20% of issuance activity in recent years.

the reporting of trades with the benefits being concentrated on block transactions (of value greater than US\$ 25 million) to the extent that the share of block trades in overall volume increased. Furthermore, costs were reduced more in bonds with lower dealer competition and smaller dealers gained market share and closed the trading cost advantage enjoyed by larger dealers. This finding is particularly important because it provides evidence on the direct impact of transparency on competition. It also demonstrates, along with the study on insurers' trades by **Bessembinder et al. (2006)**, that transparency can also benefit larger and more sophisticated institutional investors.

4.2. Transparency and liquidity externality

Some bonds are closely related to each other (e.g., if they are issued by the same entity) but their trading volumes can be very different as trading activity usually concentrates around a few tenors and around the most recently issued, on-the-run, bonds. For this reason, market practitioners often estimate the value of less traded securities using *matrix pricing*, whereby information from more heavily traded bond issues is used to price less traded ones. This gives rise to a *liquidity externality* whereby more competitive quotes on some bond issues, whose trading is more transparent, translate into more competitive quotes for related bonds, whose trading is less transparent. In other words, once market participants are exposed to competitive prices in one bond, they can infer what a competitive price in another, related bond, ought to be, even if trading in the latter is opaque. This knowledge gives them bargaining power and allows them to negotiate better prices for these, more opaquely traded, bonds.

Such liquidity externalities can also spill across markets when different securities and products are closely related to each other. Accordingly, there is strong evidence for such effects arising both when markets become pre-trade and post-trade transparent. For instance, the study by **O'Hara and Zhou (2021)**, on electronic corporate bond trading, found that electronic trading causes execution costs in the less transparent voice market to also drop by around 10 bps, on average, over their sample period. Similarly, the study by **Bessembinder et al. (2006)** discussed earlier, found that execution costs of bonds, who were not eligible for TRACE reporting, also dropped by 20% or about 3.5 bps.²⁹

Overall, the existence of liquidity externalities implies that any execution cost reductions resulting from increased transparency in some bonds tend to spill over to less transparent ones. This strengthens the case for more pre- and post-trade transparency in bond markets.

4.3. Transparency and bond issuing costs

Improving the transparency of secondary bond markets also benefits bond issuance in primary markets. According to a study by **Brugler et al. (2022)**, this is because investors are better able to

²⁹ These results are also consistent with transparency effects in other fixed income markets. For instance, **Benos et al. (2020)** show that upon the introduction of RFQ trading protocols, in specific interest rate swap contracts, as part of the Dodd-Frank trade mandate, liquidity for non-mandated contracts also improved, albeit less than that of mandated contracts.

benchmark the prices of new issues by observing the trading activity and the prices of comparable bonds. Thus, secondary market transparency reduces issuing costs by improving the overall information environment of a bond. Importantly, this effect is independent of any of the effects of transparency on bond market liquidity discussed earlier. The effect can be economically significant: studying the impact of TRACE reporting in US corporate bonds over a seven-year period, **Brugler et al. (2022)** found that it reduces issuance costs (yield spreads) by 14 bps on average from a sample mean of 144 bps. Furthermore, this effect is primarily driven by newly issued bonds with fewer underwriters and by bonds whose issuers have fewer other bonds outstanding, suggesting that post-trade transparency helps mitigate the information asymmetry in the issuing process.

5. The case for increasing centralised bond trading

Despite the gradual improvements in bond market transparency in some jurisdictions, and the associated reduction in execution costs, bond markets around the world remain generally opaque. Furthermore, electronic bond trading still relies on the balance sheet capacity of relatively few dealers to provide market liquidity. This has negative implications for bond market quality but also for financial stability, especially in the context of the regulatory landscape that has emerged since the financial crisis of 2008-09. In this section, we describe in more detail some of these issues and why migrating bond trading volumes onto all-to-all, fully transparent platforms (such as CLOBs), will likely help address them.

5.1. Improved competition for liquidity provision via centralised trading

Trading bonds on all-to-all and fully transparent (CLOB-like) platforms is likely to further enhance competition for liquidity provision, both because it will be easier for prospective liquidity providers to enter the market and because competition between existing liquidity providers will increase as the market becomes more pre- and post-trade transparent. Entry into the market for liquidity provision will become easier for several reasons. First, CLOBs are open to all market participants allowing them to act as liquidity providers by placing limit orders. Second, CLOB-based trading will make it easier for prospective liquidity providers to manage their inventory by placing market (or marketable limit) orders. This contrasts with an OTC market where dealers adjust their inventories by trading in the inter-dealer segment. Trading there is typically restricted to dealers and some principal trading firms employing market making strategies. Therefore, a potential entrant to an OTC market may not be able to access the inter-dealer segment and thus be prevented from effectively managing their inventory. Finally, CLOB quotes are electronically executable whereas execution of RFQ quotes typically requires human input. This is an additional barrier to entry for market participants relying on algorithms to supply liquidity.

Recent empirical evidence suggests that lifting these barriers can incentivize entry by new liquidity providers. **Hendershott et al. (2021)**, for example, studied the impact of the introduction, in the US corporate bond market, of *Open Trading*, an anonymous all-to-all platform operated by MarketAxess. They found that since its introduction in 2012, *Open Trading* has steadily gained market share accounting for 12% of all MarketAxess trades as of 2018. More importantly however,

the largest fraction of this share (7%) is accounted for by trades between clients and new liquidity providers whereas only a smaller share (3%) is accounted for by trades between clients and legacy dealers. According to **Hendershott et al. (2021)**, *Open Trading* has resulted in a reduction of execution costs both because new liquidity providers bid more aggressively (resulting in an average price improvement of 2 bps) and because traditional dealers are forced to improve their prices to compete (resulting in an additional average price improvement of 1 bp).³⁰

Apart from facilitating entry of new liquidity providers, trading on a CLOB also affords maximum transparency both before and after the completion of a trade. Prior to a trade, all interested parties post their offers in the form of quoted prices, for specific quantities, and these quotes are continuously visible to all other market participants. On the contrary, in electronic RFQ markets, displayed quotes are typically only visible to the party requesting them, which means that market participants cannot compare the quotes they are being offered with those being offered to other participants. This, in principle, enables dealers to price-discriminate based on the identity of their clients, which may also be revealed to dealers in the RFQ process. On the contrary, the CLOB is anonymous and quotation is consolidated and standardized with all market participants having access to all quotes. This allows all interested counterparties to compete on an equal basis for each trade offer. Finally, information about completed trades on a CLOB is concentrated, easily accessible, and can therefore be easily disseminated. On the contrary, such information in an OTC market is scattered across dealers and additional information aggregation is required to recreate the full picture of completed trades.

For these reasons, electronic OTC markets utilizing the RFQ protocol have natural limitations in the degree of transparency and competition between liquidity providers that they can deliver. This can also be deduced from the study by **O'Hara and Zhou (2021)** which calculates the trading costs in the electronic (RFQ) dealer-client segment of the US corporate bond market to be 15 bps-25 bps higher than the costs prevailing in the inter-dealer segment of that market.

Despite these limitations of electronic RFQ trading, one might be sceptical as to whether bonds could be traded at a low cost on a CLOB, given that there are many more bond issues than there are stocks and liquidity might be dispersed as a result. The evidence on that is sparse, not the least because there are indeed few instances of bonds trading in such a manner. However, the few cases that do exist are quite instructive. Apart from the all-to-all functionality of *Open Trading* discussed earlier, the best contemporary and well-documented example is, perhaps, the Israeli bond market where trading (in both corporate and government bonds) has been taking place on the CLOB of the **Tel Aviv Stock Exchange (TASE)** since its founding in 1953. A study of the Israeli corporate bond market by **Abudi and Wohl (2018)** documented average one-way relative effective and quoted spreads of 0.078% and 0.082%, respectively, in a large sample of trades executed in 2014. For comparison, the study by **O'Hara and Zhou (2021)** on US corporate bonds reported average one-way relative effective spreads of 0.15% and 0.45% for investment grade electronic and voice trades,

³⁰ Price improvement is defined here as the relative difference between a winning bid and a counterfactual winning bid in the absence of *Open Trading*. The latter is the highest (lowest) bid submitted by legacy dealers as a response to an RFQ to sell (buy).

respectively, as of 2017. In other words, despite being less than 1% the size of its US counterpart, the Israeli corporate bond market delivers comparable or smaller execution costs.

Furthermore, some of the puzzling effects about bond trading costs identified in Section 3 and attributed to market power, are not present in the Israeli market. For instance, **Abudi and Wohl (2018)** also compare the trading costs of corporate bonds with those of stocks issued by the same companies and find that the former are cheaper to trade as one might expect and contrary to what is the case in US markets. In particular, for the subsample of bonds for which their issuers also have publicly traded stocks,³¹ the average quoted and effective spreads are between 0.16%-0.18% whereas those of the corresponding stocks are between 0.55%-0.65%. The Israeli data also exhibit negligible price dispersion across within-minute transactions and a very weak relationship between execution costs and trade size.

Another indicative piece of evidence comes from the US bond market's own history. In the early part of the 20th century, both municipal and corporate bonds were traded via a limit order book on the New York Stock Exchange (NYSE). According to a comparative analysis by **Biais and Green (2019)**, execution costs of CLOB-traded municipal bonds in the 1920s were substantially lower than they are today. In particular, comparing a historical sample of New York City (NYC) municipal bonds with a contemporary one, these authors calculate round-trip costs (including the exchange commission) for NYC munis in the 1920s to be less than half than those of the modern sample. Similarly, execution costs for retail trades in corporate bonds in the 1940s were also lower than they are today with the trading frequencies per bond issue being also comparable, suggesting that the CLOB on the NYSE was able to support volumes not below those of modern OTC bond markets. Furthermore, contrary to what is observed in today's US bond markets, neither of the early 20th century markets exhibited the inverse relationship between execution costs and trade size that is indicative of market power. These results are striking and suggest that the observed differences between early 20th century and today's trading costs are due to market structure and the different trading protocols (i.e., CLOB vs RFQ) since technological developments over the past century have otherwise dramatically decreased the costs of matching buyers with sellers.

The examples presented so far suggest that, in most cases, not only bond trading on a CLOB is feasible but that it is also more efficient. The efficiency gains result from a reduction in dealers' market power, which in turn results from lower barriers to entry for new liquidity providers and from superior pre- and post-trade transparency afforded by CLOBs. Corroborating this, a counterfactual analysis by **Plante (2017)**, shows that if US corporate bonds were to be traded in limit order markets, execution costs would drop by 70% on average. Even if the actual drop in costs were somewhat smaller, it would still represent an efficiency gain that is difficult to ignore.

5.2. Dealer balance sheet constraints and CLOB trade disintermediation

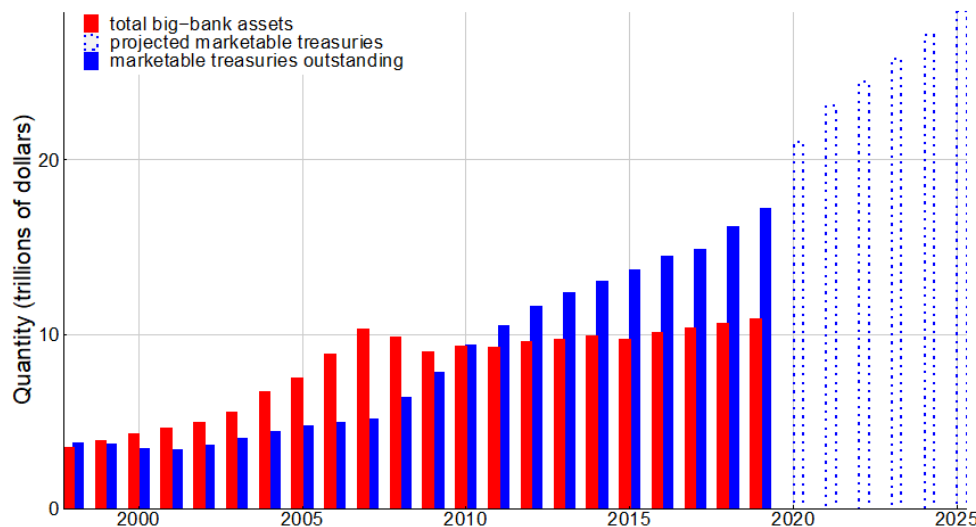
Since the financial crisis of 2008-09, new bank regulation and failure-resolution rules, in several jurisdictions, have placed restrictions on the size and usage of banks' balance sheets and in some cases have increased banks' debt funding costs (**Andersen et al, 2019**). This has meant that riskier

³¹ In Israel there are companies with publicly traded bonds but whose stocks are not publicly traded.

bank operations such as proprietary trading and lending have been competing more fiercely with market-making activities for limited balance sheet space. As a result, over the past few years, fixed income securities markets have seen a withdrawal of committed balance sheet capacity by dealers active in these markets. For instance, dealer inventories in US corporate bonds shrank from a peak of around US\$ 400 billion just before the financial crisis, to less than US\$ 100 billion by 2016 (**Adrian et al., 2017**). As we will see, this has generally resulted in a deterioration of market liquidity and in fewer trade opportunities for market end-users.

At the same time, issuance in corporate and government bonds has been increasing and this trend is likely to continue. **Figure 5** demonstrates the increasing disparity between US dealers' intermediation capacity (as captured by the size of their balance sheets) and the total outstanding amounts of US Treasuries. To the extent that trades in government and corporate bonds are almost exclusively intermediated by dealers, these developments suggest that the current dealer-centric business model for liquidity provision will likely come under increased pressure in the near future and may altogether become unsustainable in the longer term.

Figure 5: Value of outstanding US Treasuries & total asset value of large US banks.



In blue are shown year-end total outstanding amounts of marketable Treasuries, 1998-2019 (data: FRED), with projections for 2020-2025 based on federal deficit projections made on April 13, 2020, by the Committee for a Responsible Federal Budget. In red are shown the total assets of the holding companies of Goldman Sachs Group, Morgan Stanley, Merrill Lynch, Lehman Brothers, Bear Stearns, Bank of America, JP Morgan Chase, Citigroup, and Wells Fargo, from 10K disclosures.

Reproduced from Darrell Duffie "Still the World's Safe Haven? Redesigning the U.S. Treasury Market After the COVID19 Crisis", Hutchins Center Working Paper # 62, 2020

Signs of this pressure became evident during the market events related to the outbreak of the Covid pandemic. In March of 2020, in several jurisdictions (including the US, the UK, and Germany), investors with leveraged positions came under pressure to unwind them, partly because of

increased margin requests.³² This forced them to liquidate holdings in government bonds and dealers were thus faced with substantial sell flow which they were not able to fully accommodate. The result of this “dash for cash” was a sizeable and sudden drop in the prices of government bonds that have traditionally been considered “safe heaven” assets. This was accompanied, in most cases, by a substantial increase in bid-ask spreads and a decrease in market depth.³³ More importantly for our discussion, this episode demonstrated dealers’ limited capacity to intermediate large trades even in the safest of securities. In the rest of this subsection, we discuss additional evidence of dealers’ increasingly limited intermediation capacity and how this relates to post-crisis regulation. **Box 2** summarizes the key post-crisis regulatory initiatives that have affected US dealers’ balance sheet usage.

Several recent studies have assessed the impact of post-crisis regulations on dealers’ role in bond markets. Overall, the evidence from these studies suggests that dealers have become less able or willing to intermediate trades in bond markets. For instance, in a study of dealer activity in US corporate bonds, **Bessembinder et al. (2018)** find that dealers reduced their daily capital commitment by around 40% between 2009 and 2016.³⁴ Importantly, this effect was only observed for dealers affiliated with banks, suggesting that regulation targeting banks (such as the Volcker Rule and the Basel capital Accords) is the likely reason for the observed paucity in dealer committed capital. The authors also document a reduction in market turnover (i.e., traded volume over total bond values outstanding), in the frequency of block trades and in average trade size. All of these effects represent missed trade opportunities associated with the diminishing intermediation capacity of dealers.

Some studies have pinned down the effects of specific post-crisis regulations on market quality. For example, **Bao et al. (2018)** examine the impact of the Volcker Rule by looking at the liquidity of downgraded US corporate bonds. When bonds are downgraded from investment to speculative grade, some market participants (e.g., insurance firms) are forced to offload them leading to temporary order flow imbalances and a deterioration in liquidity. The authors find that this liquidity deterioration of downgraded bonds is much more pronounced following the implementation of Volcker Rule in 2014 than in the previous years. In particular, following the implementation of Volcker Rule, the price impact of downgraded bonds sales increased by around 28%, relative to that of a control sample of BB-rated bonds. Similar to the previous study, this is driven by dealers affected by Volcker rule provisions and whose monthly capital commitment decreases. Non-affected

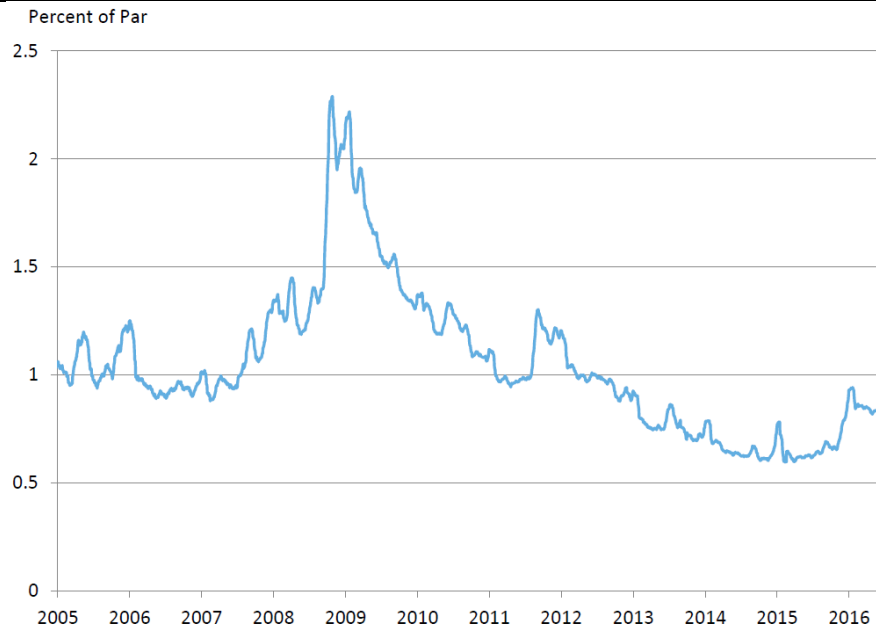
³² In the US, some of these margin requests were associated with derivatives trades that were part of relative value strategies involving US Treasuries. Once margins started to increase in March 2020, as a result of market volatility, several hedge funds, that were unable to meet their margin requests, were forced to liquidate their Treasury holdings (**Schrimpf et al, 2020**). In the UK, institutional investors with substantial dollar-denominated assets, hedged via foreign exchange swaps, were forced to liquidate UK government bonds to cover variation margin requests associated with these swaps (**Czech et al, 2022**).

³³ See, for example, **Fleming and Ruela (2020)** for a description of market conditions and liquidity in US Treasuries at the peak of the Covid-19 crisis, in March 2020.

³⁴ Capital commitment in this study is defined as the absolute cumulative net trading volume over a day, normalized by a dealer’s trading volume for that day. As such, it captures the extent to which a dealer would allow its inventory to expand overnight for a given level of trade intermediation.

dealers increase their capital commitment and market share but not to a sufficient degree to fully compensate the overall loss of committed capital.

Figure 6: US corporate bond bid-ask spreads



The figure shows the 21-day moving average of realized bid-ask spreads for US corporate bonds. The spreads are computed daily for each bond as the difference between the average (volume-weighted) dealer-to-client buy price and the average (volume-weighted) dealer-to-client sell price, and then averaged across bonds using equal weighting. The data are from FINRA’s TRACE database.

Reproduced from Tobias Adrian, Michael Fleming, Or Shachar, and Erik Vogt, “Market Liquidity After the Financial Crisis,” *Federal Reserve Bank of New York Staff Reports*, no. 796 (2017), available at https://www.newyorkfed.org/research/staff_reports/sr796.html.

Interestingly however, despite these findings on dealer constraints due to post-crisis regulations, headline measures of liquidity (such as quoted and effective bid-ask spreads) do not seem to have deteriorated over this period. **Figure 6**, taken from **Adrian et al. (2017a)** shows, for example, that realized bid-ask spreads in US corporate bonds have returned to pre-crisis (if not lower) levels. How is this consistent with the withdrawal of dealer capital from bond trade intermediation?

Part of the answer to that is the changing nature of dealer intermediation in the post-crisis years. In particular, because of balance sheet constraints, dealers have increasingly been offering agency or riskless-principal trades by matching buyers and sellers. That is, upon receiving a request by a client to trade, dealers search for potential counterparties among their clients and should one be found,

they arrange for the trade between their clients without committing their own capital.³⁵ In this setup, liquidity is effectively provided by another client, rather than the dealer. Several empirical studies, including those on the impact of post-crisis regulation discussed earlier, point to a substantial increase in agency bond trading since the financial crisis. For example, **Choi et al (2022)** estimate that the proportion of agency trades in Investment Grade US corporate bonds, increased from a low of around 6% of volume in 2011 to about 12% in 2015.

Importantly, and related to the seeming paradox of reduced bond bid-ask spreads, in the post-crisis years, **Choi et al (2022)** also point out that agency trading results in traditional liquidity measures being substantially downward biased, since these are calculated on the assumption that clients always initiate trades with dealers. However, in agency trades, only the first leg of the trade is client-initiated with the second leg being initiated by the dealer. If the dealer must then compensate the liquidity-supplying client with a preferential price (and potentially with a negative bid-ask spread), inclusion of those trades in the overall liquidity measures will mis-classify liquidity supplying trades as liquidity-taking ones and will substantially understate true execution costs. **Choi et al (2022)** estimate that when accounting for this downward bias, execution costs in US corporate bonds have increased by 35-50% in the post-crisis period relative to the pre-crisis one.

Is dealer capital commitment likely to increase in the future? We think this is unlikely. The post-crisis regulatory reforms have been instrumental in making the global financial system safer and for this reason their impact on banks' balance sheets is likely here to stay. While the studies mentioned in this section document a negative impact of these reforms on bond market liquidity, this effect is only present because bond markets rely too heavily for their functioning on dealers' balance sheets. The problem therefore does not lie with regulation. If anything, in the pre-crisis years, the institutional setup effectively subsidized the funding of dealers that were deemed "too big to fail" and through them effectively subsidized bond market liquidity.³⁶

We therefore argue that the best way forward is to make, to the extent possible, liquidity provision in bond markets less reliant on dealers' balance sheets. This will inevitably mean that a wider range of market participants should be allowed to step in and become active liquidity providers. The overall balance sheet capacity necessary to support liquidity provision in these markets will thus be distributed across a greater number of individually smaller market participants. A way of achieving this is via fully transparent and fully accessible CLOB-like trading platforms that facilitate all-to-all trading. Recent evidence from the Israeli bond market during the Covid-19 "dash for cash" episode shows that this can also have a stabilizing effect on markets: In a comparative study of government bond liquidity during this episode, **Kutai et al. (2021)** documented that bid-ask spreads in Israeli government bonds (traded on the TSA CLOB) did not significantly increase compared to those of US Treasuries despite having also experienced substantial sell flow. The authors calculate that had US

³⁵ In those instances, the dealer will typically transact with the liquidity-supplying client and then execute an offsetting trade with the liquidity-demanding client within a short period of time. As such, the dealer's capital commitment is minimized.

³⁶ Consistent with this interpretation, a study by **Adrian et al, (2017b)** found that, prior to the 2008-09 crisis, corporate bonds traded by more levered institutions and by institutions with investment-bank characteristics, were more liquid. This relationship was reversed after the financial crisis.

Treasuries been traded on an exchange instead of OTC, their bid-ask spreads would have been 60% lower during the March 2020 “dash for cash” episode.

5.3. Improving financial stability by decoupling market and funding liquidity

A likely benefit of expanding all-to-all trading in bond markets is improving financial stability by preventing potential funding shortages, by major dealers, from causing market liquidity dry-ups in these markets. This can happen because dealers may be less able (or willing) to fund the necessary inventories to continue intermediating trades at times of stress. Importantly, any funding constraints faced by dealers at times of stress, will not only impair their individual ability to accommodate their clients’ flows but also their collective ability to manage their inventories in the inter-dealer segment. This will likely further reduce market liquidity. For example, **Benos and Zikes (2018)** show that a reason for reduced liquidity in UK gilts, during the financial crisis, was a reduction in inter-dealer trading which, in turn, was partly driven by dealers’ own balance sheet constraints.

Furthermore, dealers facing funding shortages may be forced to liquidate securities in their attempt to continue funding their operations, thus exacerbating the illiquidity of the underlying securities markets.³⁷ To the extent that these securities are pledged as collateral to obtain funding, this may create a potentially destabilizing feedback loop between funding and market illiquidity (**Brunnermeier and Pedersen, 2009**). There is evidence that such a feedback loop materialized during the peak of the financial crisis in 2008-09 when reductions in the size of dealers’ balance sheets were accompanied by elevated bid-ask spreads in a number of bond markets.

³⁷ Dealers may also liquidate securities as a result of trying to maintain an equity level that is proportional to the overall Value-at-Risk of their trading book. Such a rule would render dealers’ leverage procyclical in the sense that any drop in the value of their security holdings would lead the dealers to de-leverage possibly by selling these securities. For evidence of leverage procyclicality during the peak of the crisis, see **Adrian and Shin (2010)**.

Box 2. Post-crisis regulations in the US affecting dealers' intermediation capacity

Several regulatory initiatives that have been implemented in the US, in the aftermath of the financial crisis of 2008-09 have had an impact on dealers' balance sheets and ultimately on bond trading. The most important of these initiatives are:

- **The Volcker Rule:** The Volcker Rule is a section of the Dodd-Frank Act that prohibits banks with access to the Fed discount window or to FDIC deposit insurance, from engaging in risky proprietary trading. The rule allows banks to engage in proprietary market making and, to monitor compliance, it requires banks to report a number of quantitative metrics (such as inventory turnover, the standard deviation of daily trading profits, etc). The rule became effective on April 1st 2014 with full compliance required from July 21st, 2015.³⁸ Although the Volcker Rule exempts market making, there have been concerns (e.g., **Duffie, 2012**) that it could impair the ability of dealer-banks to intermediate trades. One reason for that is that it is often difficult to distinguish between market making and speculative directional trading. This ambiguity could prevent dealers from accommodating larger customer trades if these trades might falsely be classified as speculative, in which case dealers could risk being declared in breach of the Volcker Rule.
- **The Supplementary Leverage Ratio (SLR):** The SLR is the US implementation of the Basel III leverage ratio requirement. It requires banks to maintain, at minimum, a 3% ratio of book Tier 1 equity to total, unweighted, assets while the largest and most systemically important US banks are subject to an additional 2% supplement for a total minimum ratio of 5%. The SLR treats all assets equally, regardless of their riskiness and thus creates incentives for banks, that want to maintain a certain level of risk exposure, to reorient their portfolios toward riskier assets. This however could happen at the detriment of relatively low-risk, yet balance sheet-intensive activities, such as market making.
- **New Resolution Regime:** The introduction of a new bank resolution regime in the US, in the aftermath of the financial crisis of 2008-09, has aimed at reducing the "too-big-to-fail" subsidy of large banks, some of which act as dealers in bond markets. The new resolution rules (e.g., Section 165 of the Dodd-Frank Act) enable authorities to more seamlessly and quickly bail-in major bank creditors in case of bank insolvency. This helps prevent an otherwise costly liquidation of the failing bank's assets. Furthermore, the new resolution rules explicitly aim at maintaining a failing bank's critical functions and services. Taken together, these provisions aim at reducing the systemic effects of a major bank failure and thus the need for unsecured creditors to be bailed out. As a result, banks have seen an increase in their funding costs, relative to the pre-crisis period, despite their improved capitalization (**Duffie, 2018**). These increased funding costs have made it more costly for major dealers to maintain bond inventories for market-making purposes.

³⁸ More information on the Volcker rule is available at:
<https://www.federalreserve.gov/supervisionreg/volcker-rule.htm>

5.4. Facilitating centralised clearing in bonds

In light of the constraints on dealers' balance sheets discussed earlier and the associated risk for liquidity dry-ups (such as the March 2020 “dash for cash” episode), **Duffie (2020)** proposes that centralised clearing is expanded for US Treasuries. **Duffie (2020)** estimates that, currently, only about a quarter of US Treasury transactions are centrally cleared all of which are (either direct or brokered) inter-dealer trades. The proposal is then to expand central clearing to the entire market, including the dealer-customer segment.³⁹

Although clearing is fundamentally aimed at reducing post-trade counterparty risk, the motivation for centralised clearing in this case is mainly to ameliorate the problem of reduced dealer balance sheet capacity via multilateral netting. If fully centrally cleared, Treasury bond trades would be netted across counterparties and would therefore consume less balance sheet space, thus ameliorating somewhat the problem of constrained dealer balance sheets. In principle, multilateral netting could particularly benefit dealers as they trade with many counterparties and generally maintain balanced inventories.⁴⁰

This is a sound recommendation and one that could in principle be applied not just to Treasuries but to any bonds that are sufficiently liquid to be centrally cleared. However, it may not be sufficient to fully resolve the issue of limited dealer balance sheet capacity. One reason for that is that, at times of stress, order flows tend to become more directional and dealers, consequently, use their balance sheets to accommodate them. In those cases, the benefits of multilateral netting are reduced as dealers become the ultimate sources of liquidity and there is less scope for their clients' flows to be netted against each other. Thus, given dealer's constraints, it is important in those circumstances for the market to rapidly muster any contra-side liquidity to help accommodate these directional flows. This is likely to be achieved by all-to-all trading protocols such as those supported by CLOBs.

Furthermore, central clearing could more easily be implemented if bond trading is also centralised. Clearing houses have long-established relations with exchanges (with the two often being part of the same business group) and thus, there is a great amount of operational know-how in seamlessly clearing CLOB-executed trades.

5.5. Reducing reliance on the central bank balance sheet

Finally, an additional benefit of centralised bond trading via CLOBs will be to reduce the need for central banks to deploy their balance sheets and act as “market makers of last resort” at times of

³⁹ . On September 14, 2022, the US Securities and Exchange Commission (SEC) proposed rules that would require central clearing of a larger portion of US Treasuries. See <https://www.sec.gov/news/press-release/2022-162>

⁴⁰ For example, Fleming and Keane (2021) estimate that “...clearing of all outright trades would have lowered dealers' daily gross settlement obligations by roughly \$330 billion (60 percent) in the weeks preceding and following the market disruptions of March 2020, but nearly \$800 billion (70 percent) when trading was at its highest.” However, some dealers argue that the calculations in Fleming and Keane (2021) overstate the netting benefits of centralised clearing as they do not take into account the extent of bilateral netting of dealer-to-client trades. See Thiruchelvam (2022).

stress. In the context of the March 2020 “dash for cash” episode and the subsequent forceful reaction by major central banks around the world, some policy makers (e.g., [Hauser, 2021](#)) have suggested that central banks should be ready to act as market-makers of last resort in order to maintain liquidity in critical markets such as those for government securities.

There is no doubt that well-functioning government bond markets are essential for financial stability not the least because government securities are also pledged as collateral in funding markets and are also used to satisfy margin requirements. There is also no doubt that, owing to their ability to create liquidity, central banks can restore normalcy in a market they choose to intervene in. However, the decision to deploy a central bank’s balance sheet is always fraught with concerns as to whether the central bank warehouses excessive risk, whether a particular subset of market participants disproportionately benefits from the central bank’s actions and whether the central bank ultimately acts for the benefit of the financial system and the economy as a whole. It is for these reasons that central bank interventions are supposed to be “last resort” measures.

However, in the context of liquidity provision in bond markets, central banks acting as market makers may at present not be a “last resort” measure, even at times of heightened volatility. This is because the recent episodes of illiquidity were ultimately due to the excessive reliance of bond markets on dealers’ diminishing intermediation capacity and not necessarily because the market as a whole had exhausted its ability to supply liquidity. That is, the dealer-centric model, with its many weaknesses, is not a good benchmark for liquidity provision and central banks should probably not use it to define market conditions that justify “last resort” measures. In this respect, if liquidity levels and liquidity resilience are improved in a centralised CLOB-based trading environment (as we expect them to), this will protect central banks from the risks (financial, reputational, or other) of having to use their balance sheet for market making purposes under conditions that might not necessarily justify such an action.

5.6. Implementation issues and concerns around CLOB bond trading

In the last part of this section, we address some possible concerns about the efficacy and impact of centralising bond trading.

a. Are bond characteristics an impediment to CLOB trading?

A potential concern about migrating bond trading on exchanges is that this will not be feasible because the larger number of bond issues (relative to that of stocks for example) implies that there will be relatively thin end-user supply of and demand for liquidity in each issue, rendering dealer intermediation necessary. A related argument posits that bonds are too complex instruments and not sufficiently standardized to attract a high enough level of activity that would support centralised trading.

The best response to these arguments is the current and past empirical evidence on centralised bond trading which shows that there have been (and still are) cases of successful centralised bond trading. For example, as discussed previously, corporate and government bond trading in Israel is mostly centralised and takes place on the electronic limit order book of the **Tel-Aviv Stock Exchange**.

In this market, end-users supply liquidity alongside market-making participants and, given the size of that market, this arrangement produces far lower execution costs than other OTC bond markets (**Abudy and Wohl, 2018**). The **Shenzhen Stock Exchange** is another example of contemporary bond trading of corporate instruments through a CLOB: in 2020, volumes of corporate bonds through its CLOB reached US\$ 1tn.

Furthermore, as mentioned earlier, **Biais and Green (2019)**, documented that in the first half of the 20th century US corporate and municipal bonds were successfully traded on the order book of the NYSE. Those low-tech markets delivered similar or lower execution costs than their contemporary OTC variants while facilitating similar levels of volume. For instance, the trading frequencies reported for US corporate bonds in the 1940s was about 2 trades per issue, per day, which is comparable to today's frequencies for US corporate bonds. Additionally, if bond trading were to be centralised in today's markets and liquidity were to improve, more investors would likely enter the market, further increasing volumes and improving liquidity.

b. Can dealers provide liquidity in a fully transparent environment?

Centralised trading occurs in a fully pre- and post- trade transparent environment where all offers to provide liquidity are visible to every market participant and similarly, information on completed trades is promptly and widely disseminated. A potential concern about this, and especially for larger trades, is that dealers will not be able to effectively make markets because of the risk of being front-run. That is, should a dealer acquire from a client a large position that subsequently needs to be offloaded, it will be difficult to do so if other market participants are aware of the dealer's position and trade intention. For example, potential buyers could either mark down the price or even trade ahead of the dealer. As a result, the dealer would be unwilling to obtain the position from a client in the first place. And even if transaction reporting is anonymous, the argument goes, the market could potentially guess which dealer is warehousing a given position. For reference, these arguments have also been used against further post-trade transparency initiatives in the context of US corporate bond markets (e.g., **ICMA, 2017**).

We think that these concerns about the potential costs of enhanced transparency can be addressed. First, continuous and anonymous centralised trading makes it possible for anyone who wishes to trade a larger quantity, to split the initial "parent order" into smaller "child orders" and execute them over time (and potentially across trading venues) thus minimizing price impact. In the above example, this would be true of both the initial seller's and the subsequent dealer's trades. In fact, optimal order execution, typically via sophisticated algorithms, is one of the pinnacles of modern exchange-based trading. Second, market participants can always resort to negotiated deals, typically facilitated by exchanges (see Section 2), which allow investors to trade large blocks directly with one another and with minimal price impact.

More generally, had the concerns about liquidity provision in a fully transparent environment been valid, there would be visible and profound implications for liquidity in exchange-based equity markets which are fully transparent and where inventory and front-running risks are also much

higher than in bonds.⁴¹ That is, the supposed negative effects should be more pronounced in equities than bonds; yet, as discussed already in this report, execution costs in equity markets are typically lower than those in bond markets.

c. Will dealers withdraw from bond markets?

A more general concern with centralised bond trading is that there will be no role for dealers in the new trading landscape or that it will not be profitable for them to participate in the first place, especially if spreads tighten because of increased competition. Either way, dealers might withdraw altogether from bond markets which could then permanently compromise liquidity.

In response to this concern, it is important to first emphasise that centralised trading does not preclude dealer participation. Dealers will still have the option to participate in the market and provide liquidity, should they choose to do so, the same way they do in equity markets. That is, they would be posting public quotes via limit orders which would be visible to all and as such would be competing with the quotes of other dealers and market participants.

Of course, if spreads tighten and overall execution costs drop, dealers will likely be hurt financially and some of them may decide to withdraw from the market. However, they will only do so to the extent that they face competition from other liquidity-supplying dealers and/or end-users who post limit orders. In this case, much of the liquidity will already be provided by these other participants so that the withdrawal of some dealers from a market that is already sufficiently competitive should not be of major concern. Dealers who manage to adapt and stay in the market will likely see tighter spreads but increased volumes which may partially offset losses resulting from reduced spreads. In effect, dealer rents will decrease but the market as a whole will likely grow and, with it, revenue from liquidity provision. In any case, the primary focus of bond market design and public policy should not be whether a given group of participants earns higher profits but whether trading is competitive, fair, and efficient.

If equity markets offer (yet again) any indication as to what the role of dealers in a centralised bond trading landscape is likely to be, then we should expect dealers to be fairly active in bond issues that are thinly traded and for which only one side of the market (i.e., a buyer or a seller) is usually present in the marketplace at any given point in time. Dealers can intermediate these bond trades the same way they do in thinly traded stocks. In other words, there will be a role for dealer-intermediation. However, the fact that some bond issues may require dealer intermediation does not imply that dealers should exclusively intermediate all bond trades, at all times.

⁴¹ Front running in bonds is less of a risk than in stocks both because borrowing to sell bonds is more expensive and because bonds are less information-sensitive than stocks, meaning that the likely profits from front-running will be smaller.

6. Incentivizing centralised bond trading

In the last section of our report, we share some thoughts on why bond market liquidity matters, what a potential implementation roadmap for centralising bond trading might look like and what are some possible initiatives that regulators and industry could take to help with implementation.

6.1. Why does bond market liquidity matter?

As discussed in Section 2, bond markets are substantially larger and account for more raised capital compared to equity markets and, as such, they play an important role in funding new investment projects (**ICMA, 2014**). They also allow firms to diversify their funding sources by reducing their reliance on bank credit or venture capital. We also discussed (in Sections 3 and 4) the limitations of the prevailing OTC structure of most bond markets around the world, as well as the benefits to market liquidity that result from improved (pre- and post-trade) transparency. We then argued (in Section 5) that increasing centralised bond trading by migrating a larger share of it onto all-to-all transparent venues, would likely further improve liquidity and reduce execution costs. But why does bond market liquidity matter and how is it linked to bond yields, which ultimately reflect issuers' funding costs?

Bond market functioning and liquidity have economically significant effects since, *ceteris paribus*, the more liquid a bond market is, the lower bond yields are. The impact of liquidity on bond yields has been demonstrated on numerous occasions. For example, in a study of US corporate bonds, **Chen et al. (2007)** find that, in normal times, liquidity can explain as much as 7% of the cross-sectional variation in yields for investment grade bonds and 22% of the variation in yields for speculative grade bonds. Also, changes in liquidity explain *more* of the variation in yield spread changes than do changes in credit ratings. Looking at US corporate bonds as well, **Bao et al. (2011)** report that for two bonds with the same credit rating, a one standard deviation difference in their liquidity leads to a difference of up to 65 bps in their yield spreads, with the less liquid bond having the higher yield. These considerations are of equal importance in the case of government bonds. For instance, **Casey and Lannoo (2005)**, show how the introduction in Italy of the Mercato dei Titoli di Stato (MTS) Spa, an inter-dealer electronic platform for government bonds, helped enhance bond market liquidity, thus reducing the cost of capital for the Italian government. Importantly, the effect of liquidity on bond yields is even more pronounced at times of stress. In their studies of US corporate bonds, during the financial crisis of 2008-09, **Bao et al. (2011)** and **Dick-Nielsen et al. (2012)** both report that liquidity explained more of the variation in yields than it did prior to the crisis.

These well-documented effects of liquidity on bond yields matter because they ultimately affect the real economy. Lower corporate bond yields imply a lower funding cost for firms, which incentivizes investment and leads to output growth and higher employment. For example, an analysis of US corporate investment by **Gilchrist and Zakrajsek (2007)** shows that a one percentage point decrease in firms' cost of capital leads to an increase in investment by 50-75 bps and, in the long run, a one percent increase in the stock of firm capital. Similarly, lower yields on government and municipal

bonds enable countries and communities to improve their public services through ongoing investment.

Bond market liquidity is also of first order importance to retail investors. In many countries, bonds are a significant component of household portfolios as they offer lower risk and provide a good hedge against equity investments given that bond and stock returns tend to be negatively correlated. Higher liquidity and reduced transaction costs are therefore beneficial to retail investors, with these benefits being potentially larger in aging societies, whose senior citizens tend to rebalance their portfolios into less risky assets, such as bonds.

6.2. The importance of regulatory support

As discussed in Section 3, the current trading landscape in bond markets is oligopolistic with trades being exclusively intermediated by dealers in a largely opaque manner. This allows dealers to extract substantial rents. Furthermore, there are instances of dealers taking advantage of the opacity and lack of competition in bond markets to engage in outright illegal anti-competitive practices. **Box 3** lists three such recent examples that have resulted either in large settlement payments or fines. Overall, dealers have little incentive to challenge the status quo in bond trading.

A similar argument can be made for brokers who are often paid by dealers to route their customer orders to them, a practice known as “payment for order flow”. Brokers thus also have an incentive to maintain the status quo and avoid any trading protocols that bypass dealers as that would likely reduce the income they receive for directing client order flow to dealers.

One could nevertheless argue that other market participants including aspiring liquidity providers, buy-side investors and perhaps exchanges themselves could set up, on their own initiative, alternative trading platforms and re-direct *their* trade flows to these venues without the need of supporting regulatory initiatives. A likely obstacle for such a development are the network externalities associated with market liquidity: *ceteris paribus*, a trade is cheaper to execute where there is *currently* more liquidity. In other words, liquidity begets liquidity, which means that if only a smaller fraction of bond trading volume were to initially migrate to these venues, given that dealers would presumably opt out, execution costs would likely increase substantially. An example illustrating the difficulty of exchanges or other participants of effecting change, was the attempt by **Nasdaq OMX** to enter the US Treasury market via its acquisition of the eSpeed platform in 2013. According to the financial press,⁴² this initiative was resisted and shunned by major dealers who feared that allowing investors to participate on the platform would erode their profits.

Thus, if any changes in bond market structure are to be successful, they must likely be “horizontal” in nature; i.e., all-encompassing and all-inclusive, so as to maintain the benefits associated with increased and diverse market participation. To avoid market disruption, any changes should probably also need to be incremental by affecting specific bond issues at a time. However, given the market inertia and the lack of incentives for change, the above can likely only be achieved with regulatory support.

⁴² [US traders resist Nasdaq’s Treasury push](#), Financial Times, January 29, 2014.

Box 3. Examples of recent anti-trust cases in bond trading

The conflicting incentives between dealers and their clients in OTC bond markets have been at the core of several litigations where investors have complained that dealers collude to set prices. Below we list two recent examples of anti-trust litigations that were settled and one example of anti-trust regulatory action in bond markets.

- **16 Financial Firms Settle GSE Bonds Litigation for US\$ 386.5 million:** The plaintiffs argued that a set of dealer banks “fixed, maintained, and charged artificial prices for FFBs to investors”. The case was settled on February 28, 2020 for US\$ 386.5 million Source: <https://www.issgovernance.com/16-financial-firms-settle-gse-bonds-litigation-for-386-million/>
- **Investors and Big Banks Agree to a US\$ 95.5 million SSA Bonds Antitrust Settlement:** This antitrust class action concerns collusive activities of banks to fix the prices of Sovereign, Supranational and Agency (SSA) bonds sold to and purchased from investors in the secondary market. The lawsuit alleges that “...the defendants engaged in anticompetitive acts that affected the market for SSA Bonds in violation of Section 1 of the Sherman Act, 15 U.S.C. §1. Specifically, allegations relate to a brazen conspiracy to manipulate the market. Rather than the defendants competing with each other for the purchase and sale of SSA bonds to investors, the defendants worked as one team. This includes sharing sensitive pricing information, their customers’ trading histories and requests for quotes, their positions and trading strategies, and inside information about the pricing and demand for new issues of SSA bonds.” Sources: <https://news.bloomberglaw.com/antitrust/bofa-deutsche-hsbc-bond-settlements-worth-96-million-get-nod>; <https://www.battea.com/case-spotlight/ssa-bond-antitrust-litigation/>
- **EU fines three banks US\$ 452m over bond cartel.** The European Commission said the European government bond cartel ran from 2007 to 2011 and “...the seven investment banks participated in a cartel through a group of traders working on their EGB desks and operating in a closed circle of trust. These traders were in regular contact with each other mainly in multilateral chatrooms on Bloomberg terminals. In these chatrooms, the relevant traders exchanged commercially sensitive information. They informed and updated each other on their prices and volumes offered in the run up to the auctions and the prices shown to their customers or to the market in general. They discussed and provided each other with recurring updates on their bidding strategy in the run up to the auctions of the Eurozone Member States when issuing Euro denominated bonds on the primary market, and on trading parameters on the secondary market.” Sources: <https://www.reuters.com/business/eu-antitrust-regulators-fine-nomura-ubs-unicredit-371-mln-euros-2021-05-20/>; https://ec.europa.eu/commission/presscorner/detail/en/ip_21_2565

An illustrative example of the importance of regulatory support is the case Colombia, where bonds were mostly traded at the exchange until 2008, because of a regulatory requirement, but largely stopped trading there and moved OTC when this requirement was withdrawn (See **Box 4** for more details).

Box 4: Corporate bond trading at the Bolsa de Valores de Colombia (BVC)

Up to 2008, regulation in Colombia mandated bonds to be electronically traded by all participants, with the only exceptions of banks and stockbrokers trading on their own (Valderrama et al., 2012). At that point, the exchange had approximately a 70% share of total bond trading. But in April 2008 the regulation changed (Decreto 1120 and 1121), allowing OTC trading in the fixed income market for all market participants. The change did not result in the expected increase in volumes, but it meant that bond trading became almost fully OTC, with the exchange retaining only a small share of volume (Valderrama, et al., 2015). In 2020, only 15% of value traded was exchange-based and 85% was OTC (WFE Survey).

In the rest of this Section, we discuss some specific initiatives that may constitute a broad roadmap for increasing bond trading through a central order limit book. We also highlight, in **Box 5**, some of the actions that exchanges themselves believe they could take to incentivize on-exchange bond trading, as communicated to us via the WFE’s survey. These are all broad initiatives whose specifics are likely to depend on local market characteristics.

6.3. A roadmap for incentivizing centralised bond trading

We next list some examples of specific policy and industry initiatives that could help centralise bond trading. Several of these initiatives have been implemented in some markets, while others have been previously put forward by academics, policy makers and market participants. In all such cases we make reference to the original sources of these proposals. In general, as Harris et al. (2015) point out, there are significant efficiency gains to be made in bond trading with rule changes designed to “harness the forces of competition and technology to better serve bond investors”. The exact initiatives needed will largely depend on the market characteristics in each jurisdiction. Some examples of such initiatives would be the following:

Trading venue mandates: One option is to require all (or a proportion of) trades in certain bond issues to take place exclusively on fully (pre- and post-trade) transparent, all-to-all electronic platforms functioning as CLOBs. This mandate would presumably need to capture the most heavily traded bonds, whose liquidity would be less reliant on dealer intermediation. One implementation challenge with this recommendation would be to determine, measure and enforce liquidity thresholds to decide whether a bond should be captured by the trade mandate.⁴³

⁴³ Determining such thresholds has proved challenging elsewhere. For instance, liquidity thresholds are used in the context of MiFID II to determine the post-trade transparency requirements for a given bond. However, these thresholds have been deemed as too narrow, thus allowing only a small number of bonds to be captured by the regulation. For example, according to ESMA (2020), 595 bonds were deemed as liquid at the end of 2019, more than three times the number in 2018 (175 instruments), but still only representing 0.3% of all available bonds.

Order Display Requirements: An alternative to a trading mandate is the recommendation by **Harris et al. (2015)** to require brokers to post their customers' limit orders on a platform that facilitates all-to-all trading. This does not require that bond trades necessarily take place on that platform, but only that all client orders are displayed there. Such a requirement would significantly increase pre-trade transparency, would allow market participants to compare prices more easily and thus would likely force dealers to offer more competitive quotes. In practice, dealers would likely still provide liquidity for much of the trade volume, especially in thinly traded issues. However, execution costs would likely be substantially lower (as a result of improved pre-trade transparency) and dealer intermediation would be avoided altogether whenever end-user orders could be matched.

Order protection rule: If more competitive quotes end up being displayed because of an order display requirement, regulators could additionally require that trades are also executed at these better prices. For this reason, **Harris et al. (2015)** further propose that if an order display requirement is introduced, this should be accompanied by an *order protection rule* that would prohibit trade-throughs, i.e., instances where the best available price on display is ignored and instead a dealer executes a client trade at an inferior price.⁴⁴ This rule would effectively enforce price priority across the entire market and would incentivize liquidity provision by rewarding those market participants offering the best prices. A dealer faced with a better quote on the CLOB than her own, would have two options: a) fill the CLOB order before giving a client a worse price or b) give the client an equally good price as the one on the CLOB.

The order display requirement along with the order protection rule have the attractive feature of building upon and expanding the existing bond trading infrastructure instead of replacing it. They add one transparent, all-to-all trading platform and effectively use the prices being displayed on that platform as a reference point for the entire market, no matter where or how trades are actually executed. The idea is to use this transparent, all-to-all venue to facilitate price formation and trade dis-intermediation and then subject all trades to strict price priority, thus ensuring that prices are benchmarked against those prevailing on the platform and that the benefits of transparency consequently spill over to the entire market.

⁴⁴ Trade-throughs are prevalent in bond markets. According to **Harris (2015)**, many trade throughs occur when a broker adds a markup to the trade price, and many of these trade throughs occur in the normal course of business because bonds generally are traded net and often not with commissions. The markup serves as a commission to compensate the broker-dealer for arranging the trade. Trade throughs also may occur when a broker routes an order to a dealer in exchange for payment-for-order flow. The results in Harris' study show that the trade through rate in US corporate bond markets in 2015 was about 43%.

Box 5 (WFE Survey): What can exchanges do to incentivize on-exchange trading for bonds?

When asked about actions that exchanges could take to incentivize on-exchange bond trading, survey participants provided the following responses:

- **Fee-related incentives:** Some exchanges suggested that on-exchange bond trading could be made more attractive by setting a lower commission rate for those exchange members who provide liquidity in the secondary bond market; or, more generally, by optimizing the fee structure to incentivize the provision of liquidity.
- **Market design:** Other suggestions included decreasing the tick size or adding flexibility in trading hours and settlement cycles. The **Bolsa de Valores de Colombia (BVC)**, for example, has been implementing programs for market makers (in corporate debt) and liquidity providers (in government debt) which aim to facilitate market participation by maintaining an agreed spread during a specified period of the trading session.
- **Technology and market access:** Providing adequate bond trading infrastructure and improving its connectivity and reporting capabilities were also seen as important steps to support on-exchange bond trading. The provision of modern trading, clearing and settlement infrastructures, which can provide services at a reasonable cost, is of particular relevance in Africa. In Botswana, for example, the greater availability of market infrastructure has led to some bond trading moving to the **Botswana Stock Exchange (BSE)** and away from the OTC market segment. Furthermore, providing access to a broader investor base (including retail investors) and, more generally, creating conditions for the development of direct access solutions for market participants to trading on the exchange, were also seen as important steps that exchanges could take to promote and facilitate on-exchange bond trading.
- **Education:** Several exchanges in the survey thought that demand for exchange-based bond trading would increase if investors had a better understanding of the mechanics of bond trading and of the potential efficiency gains and cost reductions associated with exchange-based trading. This is especially true if the aim is to attract retail investors seeking relatively low risk investments.

Interdealer platform access requirement: In several bond markets (e.g., US Treasuries), dealers trade with one another on fairly transparent and competitive terms using CLOBs. However, access to these platforms is often restricted to dealers (or whoever dealers may wish to grant access) and all other market participants must instead trade with the dealers on the less transparent and less competitive terms described in our report. As such, it appears that one relatively straightforward way to centralise bond trading would be for a wider set of market participants to be allowed to gain access to inter-dealer trading platforms. More generally, it could be stipulated that dealers trade on the same terms and under the same protocols with their clients as they do with one another.

Box 6 (WFE Survey): What can regulators do to incentivize on-exchange bond trading?

Most of the WFE survey respondents agreed that there are measures regulators could take to incentivize and facilitate bond trading on exchanges. These include:

- **Bond listing incentives:** Several exchanges thought that on-exchange bond trading could be made easier by increasing the incentives for bond listing. This could mean, for example, simplifying the listing procedures for domestic and foreign bonds and allowing securities transactions to settle in foreign currencies. The underlying rationale is that easier to complete bond listings could increase the overall supply of marketable debt securities which would make it easier for these bonds to also trade on exchanges.
- **On-exchange trade incentives:** Some exchanges also thought that regulators could provide more direct incentives for on-exchange bond trading in the form of tax benefits.
- **Incentives for liquidity provision:** Survey respondents thought that giving incentives to market participants to provide liquidity on the exchange is crucial if bonds are to successfully trade through CLOBs. These incentives could target any participant providing liquidity or they could take the form of designated market-making schemes with the associated obligations and incentives for designated market makers.
- **Lower minimum denomination sizes.** Large minimum denomination sizes are clearly a strong impediment to develop trading activity for bonds on CLOB outside of the interdealer market. From a trading point of view, issuers should have a neutral regulatory framework and no incentives to issue with high minimum denomination.⁴⁵

Platform design: If transparent, all-to-all platforms are to be ultimately used to trade bonds, attention should be paid to their various design features. Two such related features are the trade frequency made possible by the platform and the presence of designated market makers (DMMs).

- a) *Trade frequency:* While CLOBs allow for continuous trading, this may not be necessary for bond trading. An all-to-all platform that would operate using frequent batch auctions⁴⁶ and which

⁴⁵ In the EU, for example, the Prospectus Regulation (EU Regulation 2017/1129) differentiates between denominations over and under EUR 100,000, creating an artificial incentive to issue high-denomination securities. In its UK Prospectus Regime Review, the UK has already signaled that the government “does not intend to include denomination as a factor which would permit differing disclosure for non-equity securities” (HM Treasury, 2022b). More generally, the adoption of lower denominations can be a way to offer individuals greater access to bonds and increase liquidity. See, for example, [Time to open up UK bond markets to give investors more options](#), Financial Times, November 10, 2022

⁴⁶ A batch auction first accumulates buy and sell interest, in terms of orders of specific volumes and desired prices, over a given period. These orders are then cleared at a price that maximizes trading volume. As a result, some market participants trade at a better price than that indicated but not at an inferior one. Batch auctions are frequently used to open and close the continuous trading sessions in many CLOB-based markets, typically those for equities.

would then display the prices and volumes of completed auctions, would likely be equally (or perhaps better) suited at matching orders in the more thinly populated bond markets.

- b) **DMMs:** If bond trading were to become more centralised, then DMMs could be helpful in supporting liquidity provision. DMMs are currently present in many equity markets and are obliged to provide (or enhance) liquidity in exchange for certain benefits. Although DMMs were more prominent in equity markets in the past, they remain relevant as they help uphold liquidity, especially for less frequently traded small-cap stocks.⁴⁷ Given that many bonds also trade relatively infrequently, it is conceivable that DMMs might be beneficial for on-exchange bond trading as well.⁴⁸ Current bond dealers could easily become DMMs in a CLOB-like platform for bonds.

Trade reporting: As discussed in Section 4, it is important that post-trade transparency in bond markets is strengthened.⁴⁹ The empirical evidence suggests that disseminating information on completed trades substantially improves market liquidity. Centralised trading will ease the reporting and dissemination of trade information as most trades will be executed electronically on one (or few) limit order book(s), thus minimizing the need to aggregate and standardize trade data prior to disseminating it.

These policy initiatives are high-level and were any of them to be implemented, they would likely have to be calibrated and fine-tuned to account for local market conditions. **Box 6** includes suggestions provided by the exchanges in our survey on what regulators could do to further incentivize on-exchange bond trading. Finally, **Box 7** briefly describes the policy initiatives adopted in South Korea that led to its government bond market becoming largely centralised.

⁴⁷ Although most liquidity in modern equity markets is provided on a voluntary basis by various market participants, DMMs play an economically important role, especially for small-cap stocks. For instance, **Panayides (2007)** showed that the price continuity obligation of NYSE specialists was associated with better market quality. **Menkveld and Wang (2013)** found that in a sample of 74 small-cap European stocks, the presence of DMMs improved the level of liquidity and reduced liquidity risk. Similarly, using more recent US data, **Clark-Joseph et al (2017)** find that DMMs significantly improve liquidity. For a general overview of DMMs and their role in financial markets, see **Benos and Wetherilt (2012)**. In a survey on emerging markets conducted by IOSCO, almost all the bond markets that have some form of a primary dealer or market making system in place are also those that have higher liquidity levels in their respective secondary markets. On the other hand, several jurisdictions reported that the lack of market makers in their bond markets had been one of the factors behind the relatively low level of liquidity in the secondary market (**IOSCO, 2002**)

⁴⁸ Related to this point is the analysis by **Biais and Green (2019)** on the reasons for US bond markets migrating from the NYSE order book to the OTC space in the first half of the 20th century in contrast to equities whose trading remained on the NYSE order book. **Biais and Green (2019)** argue that the DMMs present in US equity markets attracted retail order flow which likely helped keep institutional order flow on the exchange as well. On the contrary, NYSE bond markets did not benefit from the presence of DMMs which meant that liquidity could not be anchored as effectively on its order book.

⁴⁹ While in some jurisdictions timely trade reporting is the norm, in others it is much less frequent or may even be the exception. In Europe, for example, while there is a MiFID II requirement for post-trade reporting, the regulation also includes waivers and deferrals that have led to a watering-down of the desired transparency requirements. According to the UK Wholesale Markets Review, the complex assortment and long length of deferrals have compromised transparency objectives (HM Treasury 2022).

Box 7: Government bond trading at the Korea Exchange (KRX)

Following the 1997 Asian Financial Crisis, **Korea Exchange (KRX)** in collaboration with the Ministry of Economy & Finance of South Korea, sought to modernize the market infrastructure used for trading South Korean government bonds. The resulting reform mandated that Korea Treasury Bonds (KTBs) be increasingly traded on KRX's CLOB. This was implemented gradually, with the percentage of KTB benchmark issues to be traded on KRX by the primary dealers increasing to 20% (by 2002), to 40% (by 2003), to 50% (by 2005). In 2008 the obligation was lifted because it was not fully achieving the intended outcomes (according to **Jang et al., 2016** the primary dealers still preferred trading in the OTC market segment and used the exchange market purely for fulfilling their legal obligations). In 2010 the obligation was replaced by a primary dealer responsibility to post tighter spreads on the KRX order book when making markets in KTBs. The new rules were implemented gradually, starting in January 2010.

According to **Jang et al. (2016)**, the 2010 rule changes imposed on the primary dealers have had a positive effect on KTB market quality, resulting in a decrease in trading costs and an increase in market depth. Moreover, spill-over effects subsequently led to an increase in market liquidity for the 5- and 10-year maturity bonds in the OTC KTB market.

Overall, despite challenges that these reforms initially faced, they have resulted in improved market quality with trading volumes having increased almost fivefold, since the implementation of the new rule in 2010, to around US\$ 1.8 trillion annually in 2020. The proportion of bonds traded on the exchange, most of which were KTB trades, has climbed gradually from around 11% in 2010 to about 40% of total bond trades in 2016 (**Asian Development Bank, 2018**). Currently, the government bond market in South Korea is the largest in Asia in terms of trading volume (WFE data).

While there likely is no "one-size-fits-all" solution for facilitating on-exchange bond trading, the South Korean experience shows that clear mandates and strong stakeholder engagement are vital to ensuring successful outcomes in this respect.

7. Concluding remarks

We have argued in this report that bond markets around the world are ripe for change. Their current OTC structure, whereby trades are exclusively intermediated by a few dealers, has substantial drawbacks. One such drawback is dealers' ability to exercise market power, effectively creating an oligopoly for liquidity provision, which raises execution costs, particularly for smaller investors. This means that fewer investors can afford to participate in bond markets and to a lesser degree than what would have been otherwise possible, with issuers (whether they be governments or private firms) bearing the cost from this limited participation.

Given the substantial increase of bond issuance across major markets over the recent past and the concurrent regulatory restrictions imposed on major banks in the aftermath of the global financial crisis, the very ability of dealer-banks to continue intermediating bond markets in the future, is also questionable. Thus, a second drawback of bond markets' OTC structure is that it is excessively reliant on the balance sheet capacity of few institutions in each jurisdiction. Should these balance sheets come under stress, the respective bond markets will also be affected. The much discussed "dash for cash" during the early stages of the Covid pandemic, in March 2020, is a case in point.

Our report has argued that, to address these issues, trading protocols in bond markets should gradually switch from bilateral OTC to all-to-all trading, by utilizing widely accessible and fully transparent - limit order book - platforms. While there will still be a role for OTC trading, the centralised trading protocols would allow market end-users to directly trade with each other, thus ending the complete reliance of bond markets on dealer intermediation. This would essentially render bond trading more similar to equity trading. Importantly, we think such a change is feasible and our report has discussed both past and current examples of bonds trading seamlessly on such platforms.

Overall, we believe that such a change would make bond markets fairer by reducing trade execution costs, particularly for retail investors. This, in turn, would make bond markets more inclusive by allowing a wider set of participants to access them. Given the likely wider benefits of such a transition, we also think that policy makers could play a critical role in enabling change.

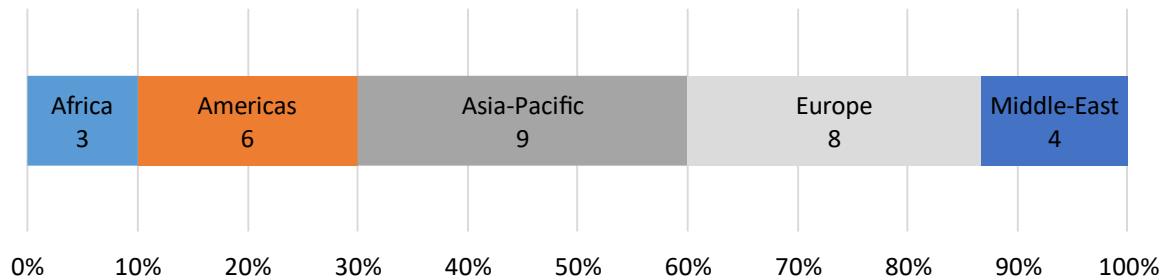
8. Annex: The WFE survey

To gather data for this report, we designed and fielded a questionnaire to collect information on bond trading activity from exchanges in different jurisdictions. The questionnaire collected qualitative information as well as quantitative data points. It was distributed among WFE members and affiliates between July and October 2020 and response collection continued until February 2021.

We gathered a total of **30 responses**, with all regions represented, including 15 exchanges from the Europe-Middle East-Africa region, nine exchanges from the Asia-Pacific region, and seven from the Americas. **Figure 7** below provides a representation of the respondents' regions.

Finally, to bolster the questionnaire results with additional evidence on themes of relevance, we conducted unstructured interviews with selected exchanges.

Figure 7: Distribution of survey participants by regions



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