

WFE Research

A review of crypto-trading infrastructure

Exchanges' engagement with crypto market functioning & development

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1. Executive summary

Around the world, there are currently more than 500 crypto-currency trading platforms, many of which also facilitate the trading of other crypto-assets and offer related products and services.¹ The rapid development of these platforms and the technological innovations they rely on, their lack of regulatory authorisation and transparency, and the volatile nature of crypto-currencies have sparked questions and concerns about the quality and stability of these markets and the potential implications for mainstream finance. Regulators are looking closely at how these markets should be regulated so that innovation is not constrained and investors are protected.

As part of its mission to ensure that technology is an enabling, effective, and powerful force for good in the financial markets, the WFE is conducting a two-part research project to improve our understanding of the crypto market infrastructures and contribute to the discussion around the benefits and risks they entail. This report, which is the first part of this research, presents the results of a survey that the WFE conducted among its members and affiliates in 2022. The report offers a snapshot of the evolution of crypto-trading platforms across different jurisdictions and reports the exchanges' engagement with these developments and their views on the future opportunities or challenges that these new technologies bring. We also provide an overview of the setup and operation of crypto-trading platforms, contrasting the models of centralised platforms (CEXs) with those of the decentralised platforms (DEXs). We study the implications that the differences in model design between DEX and CEX have on liquidity provision, price discovery and the custody of assets; and we review the academic literature findings about the market microstructure of these platforms. In addition, we discuss what these differences may imply in terms of three fundamental aspects of financial markets regulation: anti-money laundering, prudential regulation and financial stability, and investor protection.

Key points:

- About 60% of the crypto-currency trading platforms use Central Limit Order Books (CLOBs), similar to those operated by regulated exchanges, to facilitate crypto-asset trading. To fully benefit from the efficiency and transparency of CLOBs (e.g., instant order matching, handling of a large number of orders), the CLOBs are set up on a centralised server and off the blockchain.
- About 40% of the crypto-currency trading platforms are decentralised and most of them implement DLT-based Automated Market Making protocols to set prices. These platforms only allow access from self-custodial wallets, offering anonymity to their users.

¹ In this paper, we adopt the definition of crypto-assets as *cryptographically secured digital representations of value or contractual rights that use distributed ledger technologies (DLT) and can be transferred, stored or traded electronically* (UK Cryptoassets Taskforce 2018). This includes:

- native tokens or “coins” (i.e., tokens that are minted through the consensus mechanism of the blockchain, e.g., Bitcoin and Ether)
- tokens created using smart contracts built on a blockchain (e.g., utility tokens)
- tokens linked or pegged to other assets as a stabilization mechanism (e.g., stablecoins)
- security tokens: tokens that exist in the blockchain and entitle the holder to certain rights to future cash flows or a share in future profits (e.g., initial coin offerings or ICOs).

While central bank digital currencies (CBDC) are a type of crypto-asset, they are not in the scope of this paper.

- In the survey, twelve regulated exchanges reported offering crypto-related products and services, such as trading of tokens and stablecoins, in response to the increasing demand from investors, especially from the retail segment.
- According to the survey responses, retail demand of crypto-related products and services is generally more pronounced than institutional demand, except for custody services, where institutional demand is higher. This result suggests that, at the time of the survey at least, retail customers were perhaps less aware of the lack of investor protection surrounding many crypto-platforms.
- The respondents to the survey see the crypto market as an opportunity for technology development and to expand investor's choice. At the same time, they raise concerns about the lack of uniform regulatory standards, the volatile market conditions, and potential cybersecurity threats.
- In contrast with regulated exchanges that are authorised to offer crypto-assets and services, crypto-trading platforms currently implement much less stringent KYC measures. For CEX, this seems mainly a consequence of lack of regulation and enforcement. In the case of DEX, unless there is an identifiable node or group of nodes exercising some control over the network, there is less clarity on how KYC processes could be effectively implemented.
- The academic literature shows that, compared to decentralised platforms (DEX), the centralised ones (CEX) enjoy higher liquidity in most cases. Yet, decentralised platforms may reduce the trading cost of large orders. The literature has also uncovered arbitrage opportunities raised from price discrepancies among crypto-currency pairs on different trading platforms, pointing to potential inefficiency issues in the crypto-currency market.

2. Introduction

Currently, there are more than 500 crypto-currency trading platforms worldwide, and these crypto platforms were, until very recently, receiving increasing amounts of trading volume in crypto-currencies. Their lack of transparency and regulatory oversight, together with the extreme volatility associated with the crypto market and, in the last months, the various cases of crypto-platforms collapsing, has sparked questions and concerns regarding the market quality and stability offered by these markets. Regulators are looking closely at how they should be regulated so that innovation is not constrained, investors are protected, and potential future threats to financial stability are addressed.²

In this context, and as part of its mission to ensure that technology is an enabling, effective, and powerful force for good in the financial markets, the WFE is conducting a two-stage research project to improve our understanding of the crypto-market infrastructure and contribute to the discussion around its benefits and risks.

In this report, which corresponds to the first stage of this research project, we focus on the structure and the quality of the markets crypto-trading platforms provide and assess how market infrastructures and the regulatory environment are evolving as a result of the introduction of distributed ledger technologies (DLTs). This is done in three parts. The first part provides an overview of the current setup and operation of the crypto-trading platforms. More specifically, we contrast the Central Limit Order Book (CLOB) model used by most centralised platforms (CEX) with the Automated Market Making (AMM) models that characterise the decentralised platforms (DEX), and we assess the implications each of these structures has in terms of liquidity provision, customer access, asset custody, and security. To complete the picture, we review what academic research has found about the market microstructure of crypto-currency platforms and the pricing of crypto-currencies.

In the second part, the report presents the results of the survey that the WFE conducted in 2022 among its members and affiliates to capture how crypto-trading platforms are evolving in different jurisdictions, how demand for crypto-related products and services is changing, and how regulated exchanges³ are responding to the opportunities and challenges posed by these technologies,

² In the U.S., for example, the SEC is pushing for stronger regulation of crypto-currencies and has also urged increased enforcement of financial regulations for stablecoins and other crypto-tokens (see <https://www.sec.gov/news/speech/gensler-remarks-crypto-markets-040422>).

In the EU, the Markets in Crypto Assets (MiCA) Regulation proposal has four general and related objectives: to provide legal certainty; to support innovation; to instil appropriate levels of investor protection and market integrity; and to ensure financial stability.

(<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0593>).

The MiCA was formally adopted by the European Council in May 2023, and will start applying (after a transitional period) in 2024. After the collapse of FTX, the framework has been under further scrutiny ([EU crypto framework under scrutiny by policymakers after FTX collapse](#), Financial Times, November 20, 2022).

³ Throughout the paper, we reserve the name of “exchanges” to denote traditional regulated exchanges (e.g., NYSE) and refer to unregulated marketplaces for trading crypto-assets (e.g., Binance) as “platforms”.

including with the creation of regulated crypto-trading exchanges or the provision of crypto-related services.

In the third part, we discuss the implications of the difference in crypto-trading structures regarding three fundamental pillars of financial markets regulation: anti-money laundering and countering the finance of terrorism, prudential regulation and financial stability, and investor protection. We also assess how, around the world, crypto-currencies are being increasingly regulated despite the inherent aim of many DEX to keep users' information out of the reach of central authorities.

While our paper focuses on crypto-trading platforms, it relates to other recent papers that investigate different aspects of crypto platforms in general. For example, (IOSCO 2022) provides an overview of decentralised finance, (Bains, et al. 2022) discusses unbacked crypto assets, and (Aspris, et al. 2022) examine the market landscape for digital assets.

3. Crypto-trading platforms

Crypto-trading platforms are digital marketplaces that facilitate the match of buyers and sellers of crypto-assets and allow them to transact crypto-assets for other crypto-assets or for fiat currencies.⁴ The most popular crypto-trading platforms are the crypto-*currency* trading platforms, where traders transact crypto-currencies (e.g., Bitcoin) using either fiat currencies (e.g., U.S. Dollar) or other crypto-currencies (e.g., Ether). Many of these platforms offer, in addition to spot trading, trading in derivatives on crypto-assets (futures, options, and perpetuals), which can be cash-settled or can involve physical delivery of the underlying crypto-asset.⁵ Note that, by referring to crypto-*trading* platforms, we are focusing on the marketplaces having a price discovery function, implemented through some trading mechanism. There are other crypto platforms where crypto assets can be exchanged, lent, or deposited but do not involve trading or a price discovery process. This would be the case, for example, of platforms used for settlement of security and cash tokens;⁶ platforms where crypto-currencies are used to buy digital assets (e.g., NFTs); or staking platforms, which pay rewards on deposits of crypto-currencies to be used as stake in a Proof of Stake (PoS) validation context. While these platforms are often linked to a crypto-trading platform, they are not considered here as a crypto-trading platform.

Currently, there are more than 500 crypto-currency trading platforms worldwide.⁷ According to The Block's estimations, the total value traded value of USD-crypto trades across these platforms jumped from an average of less than USD 64 billion per month in 2020 to an average of more than USD 460

⁴ For general definitions of DLT, blockchain and smart contracts and their application in the context of securities trading and settlement, see, for example Aspris et al. (2022), Bech et al. (2020), or Benos et al. (2019).

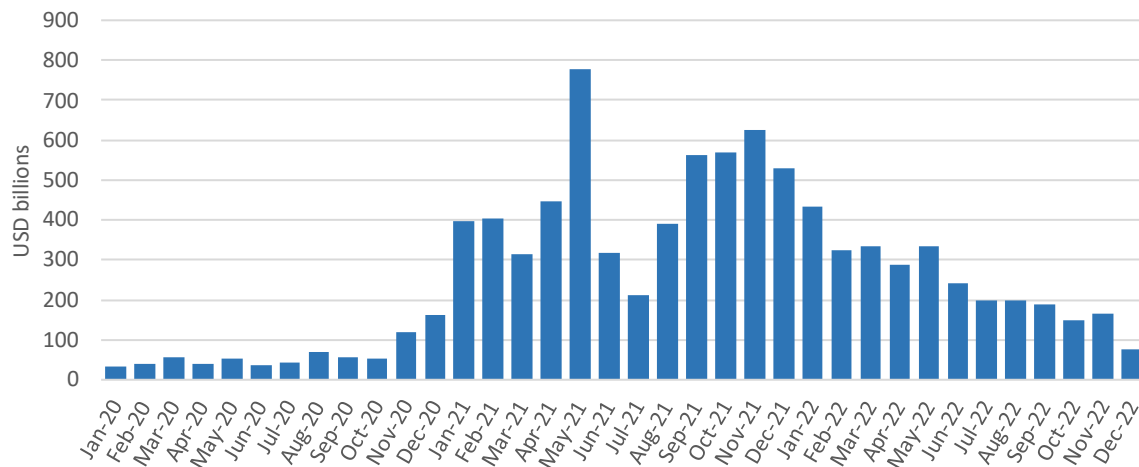
⁵ Note that, under the above definition, a platform that only offers trading of derivatives on crypto-currencies with cash settlement *in fiat currency* is not considered here as a crypto-trading platform.

⁶ A security token is a token that has the characteristics of a security but exists in the ledger. This would include tokenised securities, where tokenisation is understood as "the process of recording claims on real or financial assets that exist on a traditional ledger onto a programmable platform" (Inaki, et al. 2023).

⁷ As of July 2022, this was the number of crypto-platforms listed by CoinMarketCap (<https://coinmarketcap.com/rankings/exchanges/>). However, despite the abundance of crypto-currency trading platforms, trading volume and liquidity concentrate on a handful of platforms.

billion per month in 2021, before slowing down to USD 245 million in 2022 (**Figure 1**). The value traded peaked in May 2021, reaching more than USD 770 billion.⁸ Still, this value is dwarfed by the value traded in the equity market where, for example, the U.S. stock exchanges collectively handled close to USD 11 trillion during the same month, more than ten times the value for USD-crypto trading in all crypto platforms.

Figure 1 . Monthly USD-crypto currency value traded



The figure shows the monthly value traded of spot crypto-currency trades with USD support.

Source: The Block

3.1 Centralised (CEX) vs decentralised (DEX) trading platforms

One of the underpinning goals often espoused for the use of DLT in finance is the disintermediation of financial services by offering a decentralised and universally accessible service without the need for a trusted central entity and outside the boundaries of authority oversight. Yet, the DLT’s decentralisation goal seems to be at odds with the centralised nature of the order book used by exchanges, which allows for all-to-all, continuous and fully transparent trading;⁹ and attempts to replicate a central limit order book (CLOB) in a blockchain have faced different challenges. The consensus-based validation processes that characterise DLT find it difficult to mimic some of the CLOB features, including the pre- and post-trade transparency, the instant order matching, or the ability to handle a large number of orders. For example, even in the most basic setting, hosting the CLOB in the blockchain means that every order posted and every trader action (e.g., cancellations and

⁸ See <https://www.theblock.co/data/crypto-markets/spot>. These figures correspond to trades with USD support. If we consider all crypto trades the total traded value handled by crypto-currency spot trading platforms jumped from an average of USD 203 billion per month in 2020 to more than USD 1 trillion monthly average in 2022, reaching a peak of USD 4.42 trillion in May 2021. according to The Block data. See

<https://www.theblock.co/data/crypto-markets/spot/cryptocurrency-exchange-volume-monthly>. In addition, (Hougan, Kim and Lerner 2019) reports that up to 95% of the crypto platforms’ reported trading volume might not represent economically meaningful trades or might even be fake.

⁹ Limit order books are often used in combination with other tools to enhance liquidity, such as designated market makers for specific instruments or periodic auction processes.

modifications) requires to go through the blockchain validation process and get copied and stored in all the nodes in the network, making the process extremely costly in terms of time (high latency, due to the validation process)¹⁰ or gas fees (e.g., the transaction fees paid to validators in the case of the Ethereum blockchain). Moreover, in the case of competing blocks, some transactions or data may not be recorded in all versions of the blockchain due to connection speed and physical distance. Although these lost transactions can be retransmitted and included in the final version of the blockchain, it may require additional fees or processing time as they will need to be validated by the network again. Because of these challenges, platforms operating an on-chain CLOB are much less popular.¹¹

To offer the level of efficiency and transparency of a CLOB, many platforms opted to rely on an off-chain CLOB operated by a central entity (or consortium of entities) for quote display and order execution and use the blockchain only for the purposes of settlement and custody. This arrangement also means that traders would not interact directly with the blockchain but only with the central entity (or entities) that provides the CLOB and controls the digital wallets to access the blockchain. In this way, gas fees only apply when orders are settled, and lower latencies can be achieved. Crypto-trading platforms with this type of arrangement are called centralised platforms (CEX). See the left panel in **Figure 3** for a schematic representation of this arrangement.

Such an arrangement, however, is not appealing to users who want to avoid having a central entity controlling their assets, or who want to fully benefit from instant and atomic settlement.¹² To allow users to have more control over their assets, other setups were introduced where only the matching happens off-chain. For example, a third party (called a *relayer*) offers the display of orders, the *makers* (providers of liquidity) submit their orders to be displayed, and the *takers* (consumers of liquidity) are responsible for finding the right order to match. When a match is found, the taker and the maker then countersign the limit order and submit the completed transaction to a smart contract in the network for execution and settlement.¹³ Although this type of setup does not offer the full benefits of a CLOB and leads to sub-optimal price formation, the participants control their funds and execute their orders. An example of this setup is the 0x platform Schar (2021).

The situation started to change in the last six years or so with the development of protocols implemented with smart contracts, which allowed a price formation process happening directly on

¹⁰ For instance, it takes, on average, 10 minutes to add a new block on the Bitcoin blockchain and about 15 seconds on the Ethereum blockchain. This frequency is not sufficient to accommodate the recording frequency on the CLOB, which could be thousands of orders and trades in less than a second.

¹¹ According to THE BLOCK, in December 2022 only 1.4% of DEX platforms were using an on-chain CLOB, 76% were using a constant function AMM protocol and 22.6% were using a hybrid protocol. An example of a platform implementing an on-chain order book is Serum, which is built on the Solana blockchain (a competitor of Ethereum). Solana uses ‘proof-of-history’ consensus mechanism, which appears to allow for faster operation, as nodes do not need to communicate to validate a block. Since its launch in 2020, Solana has experienced several outages.

¹² Atomic settlement refers here to the simultaneous settling of trades at execution. See Lee, Martin, and Muller (2022).

¹³ Smart contracts are pieces of computer code that trigger certain actions without third party intervention after the predetermined conditions are met. The smart contract runs on the blockchain and works as a digital agreement that is enforced by a pre-specified set of rules, which are replicated and executed by all network nodes all over the blockchain. They are neither “smart” nor are they “contracts”.

the blockchain. In particular, the introduction of Automated Market Makers (AMMs) protocols provided a mechanism to determine the price of assets within the blockchain.¹⁴ We discuss in detail the AMM protocols below.

In summary, currently we can broadly identify two dominant types of crypto-trading market structures:¹⁵

- The **centralised platforms (CEXs)**, which are owned and operated by a central entity (or consortium of entities) intermediating access to the blockchain (or distributed ledger) where the crypto-assets exist. They typically rely on an off-chain CLOB to display and match the buy and sell orders and execute trades and they utilise the blockchain to store, over its user nodes, the order and transaction data as well as settlement records. Some of the largest cryptocurrency CEXs are Binance, Coinbase, and Kraken.
- The **decentralised, permissionless platforms (DEXs)**, where there is no central entity operating the platform, participants directly control their assets in the blockchain, and trading and execution happens in the blockchain (in addition to settlement and record keeping), usually using the AMM protocols.¹⁶ Some of the largest DEXs are Uniswap, Bancor, and Balancer.

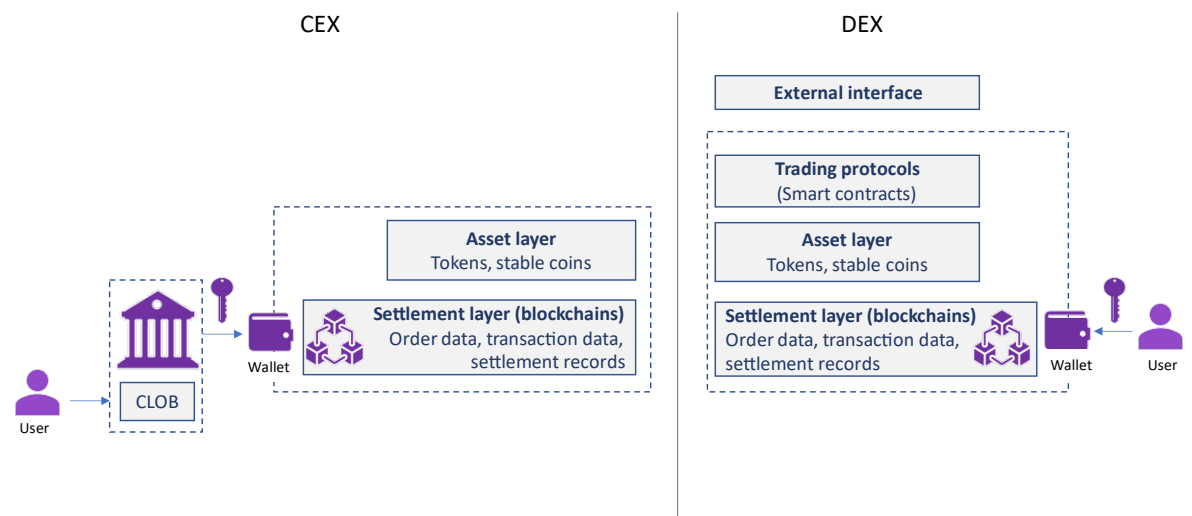
Both CEX and DEX are built following a layered architecture: they both have a settlement layer (first layer) consisting of the blockchain or distributed ledger, where the native asset sits and which stores the settlement, ownership, and trade data information, and an “asset layer” (second layer) consisting of assets (e.g., coins and tokens) issued on top of the settlement layer. In DEXs, a third layer would provide smart contracts, where AMMs and other trading protocols operate, while the final layer manages the interaction with off-chain data and provides user interfaces (Schar (2021); CPMI-IOSCO (2021)). In contrast, CEX requires a separate entity to manage the CLOB and to provide access to the blockchain (see **Figure 2**). In general, CEXs allow fiat-to-crypto and crypto-to-crypto transactions, while DEXs only allow crypto-to-crypto transactions.

¹⁴ Bancor, launched in August 2018, is considered a pioneer in the use of AMM model for a full decentralised platform. Uniswap went live in November 2018.

¹⁵ Some authors also consider a third type of structure: DEX Aggregators. These are blockchain-based applications that enable users to access liquidity pools from multiple DEXs; a function like that of smart order routing (SOR) technology employed by exchanges and brokers in traditional financial markets (Aspris, et al. 2022).

¹⁶ According to The Block, in February 2023 only 1% of DEX volumes corresponded to platforms using CLOB, 86% to platforms using AMM, and 13% to platforms using some hybrid approach.
<https://www.theblock.co/data/decentralized-finance/dex-non-custodial/dex-mechanism-volume-share>

Figure 2. Typical CEX and DEX architectures

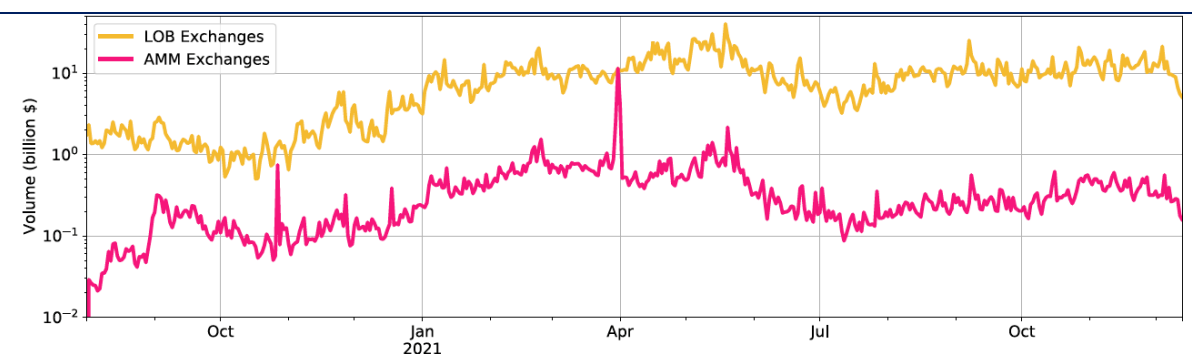


Source: WFE Research

According to data on CoinMarketCap’s website, out of the more than 500 existing crypto-currency platforms, about 60% are centralised, and about 40% are decentralised.

Figure 3 plots the evolution of the average daily trading volume for the two types of crypto-currency platforms. The figure shows that in 2021, on average, the CLOB platforms handled around USD 10 billion of trading volume. In contrast, the DEX platforms handled lower trading volume (around 100 million USD to one billion USD). In addition, we can see that the average trading volume has been increasing over time since late 2020.

Figure 3. Trading volumes of platforms using CLOB and platforms using AMM



The figure presents traded volumes for both the AMM-based and CLOB-based platforms averaged across three platforms of the largest exchanges in each category, namely, Binance, Kraken, and Coinbase, for CLOB; and Uniswap, PancakeSwap, and SushiSwap for AMM. The displayed traded volume is the summation of the volume for all the trading pairs listed on each exchange. The vertical axis uses log-scale. Source: Figure 1 of Barbon and Rinaldo (2021)

In addition to trading and custody services, crypto-currency CEXs also offer other services, analogous to those provided by traditional market infrastructures and financial intermediaries. For instance, some CEXs provide crypto-collateralised loans, where users can take out loans denominated in fiat currencies using cryptocurrencies as collateral. On top of that, many CEXs also offer a range of cryptocurrency-related instruments such as futures, options, and leveraged tokens.

In the next sections, we discuss what are the implications of the difference in structures in terms of price discovery and custody of assets.

3.2 Liquidity provision and price discovery

Centralised platforms (CEX)

Following our previous discussion, centralised crypto-trading platforms (CEX) typically rely on an electronic CLOB to match and execute user orders. The CLOB is separated from the blockchain, where the crypto-assets sit, and is operated and maintained on a computing system or server owned by the central entity acting as the platform administrator or provider.

In a CLOB, liquidity is generated by the continuous interaction between buyers and sellers. Traders submit their buy and sell orders using different order types, including market orders and limit orders. The CLOB system matches these orders on a 'price time priority' basis and aggregates the unmatched orders in the limit order book. Such a matching system distinguishes liquidity demand from liquidity supply according to incoming orders. More specifically, market orders or marketable limit orders¹⁷ are matched against the prevailing limit order book and executed immediately; therefore, they demand liquidity. At the same time, non-marketable limit orders¹⁸ are not matched nor executed but instead added to the limit order book, therefore supplying liquidity. Liquidity suppliers, such as market makers, profit from the bid-ask spread, after compensating for their market-making costs, by completing round-trip trades (George et al. (1991); Huang and Stoll (1997)).

In the crypto markets, in addition to the participation and the interaction of different traders, the presence of a fiat-currency leg in a transaction can also affect liquidity. For instance, fiat-to-crypto transactions (e.g., using USD to buy Bitcoin) tend to be more liquid than the crypto-to-crypto transaction, as the latter requires the investors to hold both cryptocurrencies in their account.

Decentralised platforms (DEX) and AMM protocols

In contrast with CEXs, in decentralised, permissionless platforms (DEXs), there is no central entity (or consortium of entities) that controls the flow of funds, the access to the network, the trading process, or the validation of transactions. The problem of enabling price discovery in an all-to-all fashion without relying on a central limit order book but maintaining higher levels of decentralisation has been addressed in DEX, to some extent at least, through the implementation of the Automated Market

¹⁷ Marketable limit orders are buy orders with a limit price equal to or greater than the best bid or sell orders with a limit price equal to or less than the best bid at the time of order receipt.

¹⁸ Non-marketable limit orders are buy orders with a limit price less than the best bid or sell orders with a limit price greater than the best bid at the time of order receipt.

Maker (AMM) protocols. These protocols allow permissionless, public, on-chain trading and are based on smart contracts that set the prices depending on the liquidity provided by the market participants.

In an AMM market, the traders trade against a liquidity pool consisting of at least two cryptocurrencies. First, on the liquidity supply side, to add liquidity (reserve) into the liquidity pool, the liquidity providers (LPs) need to deposit all currencies proportional to the composition of the current liquidity pool. In other words, the ratio between the currency pairs in the liquidity pool remains unchanged before and after the liquidity provision. In return, the liquidity provider receives a proportional amount of a liquidity token, which could be a token different from the tokens in the liquidity pool. This token represents the liquidity provider's share of the pool, and the liquidity provider can redeem the liquidity token at any time to exchange for a payout in the equal value of all currencies in the pool.

On the liquidity demand side, a trader fulfils her trades in the liquidity pool by depositing one currency, extracting another currency, and paying a fee. In particular, the quoted price of the currencies is determined by the ratio of the quantities in the liquidity pool. Moreover, the AMM employs conservation functions¹⁹ to compute the transaction prices based on the liquidity available on the platform for certain pairs of currencies. The most used conservation function by the DEXs is the **constant product function**,²⁰ which takes the form $xy = constant$. More specifically, without adjusting for trading fees, the product of the post-trade quantities remains unchanged from the product of the pre-trade quantities of the currencies. Worth noting that the trading fee adds to the liquidity pool and changes the constant term, which will serve as the new constant of the liquidity pool.

More formally, consider a liquidity pool consisting of x amount of token X and y amount of token Y and let $f \geq 0$ represent a trading fee, which is expressed as a percentage of the trading volume. Taking the token X as the base currency (numeraire), the quoted price for the token Y is

$$P_y = \frac{x}{y}$$

This is the slope of the point (y, x) , see Panel B in **Figure 4**.

To buy Δy amount of token Y , the liquidity demander needs to deposit Δx amount of token X , so that the following relation holds (assuming a constant product function)

$$xy = k = (x + \varphi\Delta x)(y - \Delta y)$$

where $\varphi = 1 - f$ and $k > 0$ is a constant. Therefore, with Δx amount of X , the buyer gets

$$\Delta y = y - \frac{xy}{x + \varphi\Delta x} = \frac{\varphi\Delta x}{x + \varphi\Delta x}y$$

¹⁹ A conservation function f encodes an invariant property of a system by expressing it in the form $f(x, y, z, \dots) = k$, where k is a constant.

²⁰ The constant product function is used, for instance, in Uniswap. There are also other conservation functions used for AMMs, such as the constant sum function (implemented in the MStable protocol), the constant mean function, and hybrid functions combining constant sum and constant product formulas, as in the Curve(v1) protocol.

Accordingly, the transaction price for the buyer is

$$P_{\Delta y} = \frac{\Delta x}{\Delta y} = \frac{x + \varphi \Delta x}{\varphi y}$$

After the trade, the liquidity pool receives Δx amount of token X , pays Δy amount of token Y to the buyer, and updates the reserve to

$$\begin{aligned} x' &= x + \Delta x \\ y' &= y - \Delta y \end{aligned}$$

Then the post-trade quoted price is

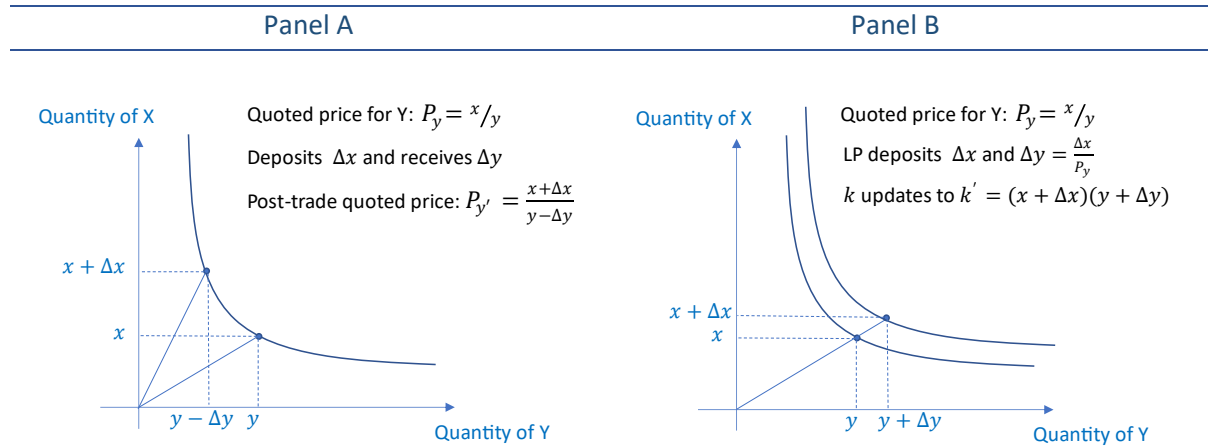
$$\begin{aligned} P'_{yx} &= \frac{x'}{y'} = \frac{x + \Delta x}{y - \Delta y} = \frac{x + \Delta x}{\left(\frac{xy}{x + \varphi \Delta x}\right)} \\ &= \frac{(x + \Delta x)(x + \varphi \Delta x)}{xy} \end{aligned}$$

Similarly, the addition of the fee to the liquidity pool updates the constant k to

$$\begin{aligned} k' &= x'y' = (x + \Delta x)(y - \Delta y) = (x + \Delta x) \left(\frac{xy}{x + \varphi \Delta x}\right) \\ &= k \times \frac{x + \Delta x}{x + \varphi \Delta x} \geq k, \quad \text{for } \varphi \leq 1 \end{aligned}$$

The formula shows that, after a purchase of token Y , the post-trade constant is not less than the pre-trade constant, given a non-negative trading fee.

Figure 4 . Price adjustment with constant product function



Panel A illustrates the price adjustment after a liquidity demander buys token Y (zero-fee case). Panel B illustrates the adjustment of the curve when a liquidity provider (LP) deposits proportional amounts of tokens X and Y .

Going back to the liquidity provider, we can also derive her payoffs by comparing her pre-trade and post-trade values. As mentioned above, the liquidity provider deposit both token x and token y according to the existing ratio in the liquidity pool in exchange for liquidity tokens that represent her share of the pool ($\phi \in (0, 1]$). So, the value of her initial investment is

$$v_0^{LP} = \phi(x + yP_{yx}) = 2\phi x$$

After the purchase of Δy from the trader, the position of the liquidity trade becomes $\phi x'$ of token x and $\phi y'$ of token y (which worth P'_{yx} now). Thereby, the value of the liquidity provider's investment becomes

$$v_1^{LP} = \phi(x' + y'P'_{yx}) = 2\phi(x + \Delta x)$$

With a buying trade of token y (i.e., $\Delta x > 0$), the liquidity provide gains a positive return

$$r^{LP} = \frac{v_1^{LP} - v_0^{LP}}{v_0^{LP}} = \frac{\Delta x}{x} > 0, \quad \text{for } \Delta x > 0$$

However, if the liquidity provider held her initial position in her own wallet, without adding it to the liquidity pool, she would have ϕx and ϕy units of the two tokens respectively with the price of P'_{yx} . Then, the value of her position is

$$v_1^{LP'} = \phi(x + yP'_{yx}) = \phi \left(x + \frac{(x + \Delta x)(x + \phi \Delta x)}{x} \right)$$

Comparing $v_1^{LP'}$ with v_1^{LP} , it is easy to show that

$$v_1^{LP'} > v_1^{LP}, \quad \text{if } \frac{\Delta x}{x} > \frac{f}{1-f}$$

In other words, with a small enough trading fee ($\frac{f}{1-f} \rightarrow 0$ as $f \rightarrow 0$) and a non-trivial order size ($\Delta x > 0$), the liquidity provider would be better off if she held the tokens in her own wallet without depositing them to the liquidity pool. This potential loss in value is also called *impermanent loss*, which could discourage liquidity supply in the AMM systems.²¹

To better illustrate the trading in the AMM liquidity pool, in **Box 1** we provide a numerical example.

Box 1: Automated Market Maker-a numerical example

We provide a numerical example of the AMM to better illustrate how it operates and we use the same notations as the mathematical derivation for consistency. Let us consider a liquidity pool of two crypto currencies, 900 Ethereum (ETH) and 90 Token Y (denoted as Y). We take ETH as the base currency (numeraire), and it corresponds to the Token X in the above mathematical derivation. The current ratio between the two crypto currencies is 900 ETH to 90 Y, that is, 10 ETH to 1 Y. The liquidity pool also charges a 0.3% fee for transactions (i.e., $f = 0.003$; $\phi = 1 - f = 0.997$).

²¹ The term “impermanent” reflects the fact that the loss will only be realised if the liquidity provider exits the position and it may revert if the prices move back to their original value,

When a liquidity provider wishes to add liquidity to this pool, she needs to put both ETH and Y according to the 10:1 ratio. For example, she adds 100 ETH and 10 Y to the pool and, in turn, gets 100 liquidity tokens, which represents her share of the liquidity pool (i.e., $\phi = 10\% = \frac{100}{900+100}$).

After the addition, the liquidity pool has 1000 ETH and 100 Y, and the ratio remains the same (10:1). The quoted price of Y is

$$P_y = \frac{x}{y} = \frac{1000}{100} = 10 \text{ ETH}$$

Now a liquidity demanding trader wishes to purchase Token Y using 10 ETH (i.e., $\Delta x = 10$), he pays $f * \Delta x = 0.03 \text{ ETH}$ in fess and gets Δy units of Y. The relationship must satisfy the constant product function with $k = 100 \times 1000 = 100,000$

$$xy = k = (x + \phi\Delta x)(y - \Delta y)$$

The trader gets

$$\Delta y = \frac{\phi\Delta x}{x + \phi\Delta x} y = \frac{0.997 \times 10}{1000 + 0.997 \times 10} \times 100 = 0.9872$$

The trading price for this transaction is

$$P_{\Delta y}^T = \frac{\Delta x}{\Delta y} = \frac{10}{0.9872} = 10.1301 \text{ ETH}$$

In order words, the liquidity demanding trader pays in total 10.1301 ETH in exchanges for 0.9872 units of Token Y. The trading fee of 0.03 ETH is also added to the liquidity pool. After the transaction, the new quantities of ETH and Token Y are updated to

$$\begin{aligned} \text{ETH: } x' &= x + \Delta x = 1010 \\ \text{Token Y: } y' &= y - \Delta y = 99.0128 \end{aligned}$$

Therefore, the post-trade quoted price is

$$P'_y = \frac{x'}{y'} = 10.2007 \text{ ETH}$$

And the updated constant k is

$$k' = x'y' = 100,002.9704$$

After the purchasing trade, if the liquidity trader redeems share of the liquidity pool, he will receive $\phi x'$ and $\phi y'$ units of the two tokens, whose value will be

$$v_1^{LP} = \phi(x' + y'P'_y) = 202.0 \text{ ETH}$$

If the liquidity provider kept her tokens in her wallet instead of providing them to the liquidity pool, the value of her position would be

$$v_1^{LP'} = \phi(x + yP_y') = 202.0070 \text{ ETH}$$

In this case, the liquidity provider incurs an impermanent loss of $v_1^{LP'} - v_1^{LP} = 0.007 \text{ ETH}$.

Liquidity provision is a key difference between an AMM and a CLOB protocol. In an AMM, liquidity relies heavily on the liquidity providers' willingness to add tokens to the liquidity pools. However, there are some hurdles to liquidity provision. First, the liquidity provider must possess both tokens to be able to supply liquidity. Second, as discussed above, the liquidity traders face the risk of impermanent losses, which may disincentivise their participation in the market.²² Thereby, the AMM markets for non-mainstream crypto pairs may suffer from a lack of liquidity.

Another shortcoming of AMM is the existence of slippage.²³ While there is little or no slippage in a CLOB (without considering price impact), when exchanging token pairs there is always some slippage, which is measured by the slope of the conservation function used (Bluhm (2022)).

Regarding the price discovery process, the liquidity provision in an AMM is determined by the ratio of token quantities in the liquidity pool and, therefore, is uninformed and does not contribute to the price discovery. The price discovery in an AMM market relies heavily on arbitrageurs, who take advantage of the price discrepancies among different platforms (both DEXs and CEXs) to correct the prices on the DEXs markets.

The market microstructure of crypto-currency trading

The academic literature on the setup of crypto market infrastructure has mainly focused on trading and market microstructure issues of crypto-currencies, which include liquidity, price efficiency, comparison between centralised (CLOB) and decentralised (AMM) crypto-currency trading platforms, and price discrepancies (and therefore the possibility of arbitrage) among crypto-trading platform pairs.

Building upon well-known results of the impact of liquidity on pricing, multiple studies investigate the liquidity condition and liquidity provision in crypto-currency markets. Brauneis et al. (2021), relying on trading and quote data of Bitcoin and Ethereum, compare the accuracy of different low-frequency liquidity measures. More specifically, they benchmark the low-frequency measures against high-frequency ones, such as quoted spread, effective spread, price impact, and the cost of a round trip trade. The authors find that, regarding the low-frequency measures, the Corwin and Schultz (2012) and Abdi and Rinaldo (2017) estimators best capture the *time-series variation* in cryptocurrency liquidity, and the Amihud (2002) and Kyle and Obizhaeva (2016) estimators best measure the *level* of

²² It is sometimes argued that the risk of impermanent loss also exists in CLOB, under the name of inventory risk (Bluhm 2022). However, this assumes market makers in the CLOB do not manage the risk.

²³ Slippage refers to the difference between the expected price of a trade and the execution price.

liquidity. The authors suggest that, despite the lack of a universally best liquidity estimator for the crypto-currencies, there exist several well-performed low-frequency measures.

Related to the provision of liquidity several studies focus on comparing the CLOB employed by the centralised platforms with the AMM employed by the decentralised platforms. In a theoretical study, Aoyagi and Ito (2021) build upon Glosten and Milgrom (1985) and model the coexistence of the two forms of liquidity supply in the crypto-currency space. In their paper, informed traders, uniformed liquidity traders, and market makers endogenously choose their trading platforms in a two-period setup. Firstly, the market makers provide liquidity in their chosen platforms. Then, in the second period, two types of shock could occur. On the one hand, an information shock that could affect the price of the security is only known to the informed traders. On the other hand, a liquidity shock that only affects the trading of the liquidity traders without affecting the value of the security can take place. At the end of the game, informed traders and liquidity traders choose their trading platforms and trade according to the shock they perceived, and the payoffs are realized. Solving the model through backward induction, the authors argue that liquidity in the AMM market complements that in the limit-order market. Also, Capponi and Jia (2021) model the liquidity supply in an AMM platform and find that that liquidity providers experience value losses when volatility is high, and the AMMs are more suitable for adoption when the securities possess high personal use-value or when the crypto-currency pairs are highly correlated.

Empirically, relying on an intraday quote and transaction data, Barbon and Ranaldo (2021) compute and compare the transaction costs for both types of crypto-trading platforms. The authors take the sum quoted half spread and trading fees (also gas fees for the AMM) as the transaction cost and compute this measure for different trade sizes (**Figure 5**). They find that the transaction costs are generally lower on the centralised platforms (Binance and Kraken) than on the decentralised one (Uniswap). In most cases, Binance offers the lowest transaction costs, which are lower than ten bps for smaller orders and between 100 and 1000 bps for large orders. The decentralised platform, yet, might become favourable for large orders (e.g., trade size larger than one million USD). The authors also explore the arbitrage bounds of crypto-currencies based on the no-arbitrage relations of triplet exchange pairs and find that the no-arbitrage conditions are more relaxed for the AMM, which experiences larger deviations from the theoretically efficient price. Similarly, Lehar and Parlour (2021) study the liquidity provision of AMM, and they find that returns on liquidity provision are, on average, positive. The authors also document the liquidity provision patterns that, for large pools, an increase in liquidity inflows leads to future liquidity withdrawals, and high past returns lead to future inflows. Confirming the implications of Aoyagi and Ito (2021), these papers support the coexistence of both CLOB and AMM platforms.

Figure 5. Transaction Costs



The figure presents transaction costs, computed at the hour-frequency for the 6 currency pairs, for different trade sizes, then averaged over the period from January 2021 to September 2021. The vertical axis is in log-scale and reported in basis points units. Source: Figure 5 of Barbon & Rinaldo (2021)

Furthermore, several studies investigate the arbitrage opportunities and price discrepancies among multiple crypto-trading platforms. In Hautsch et al. (2018), the authors model the stochastic dynamics of the crypto-asset prices, taking into account the stochastic latency of settlement, derive the theoretical arbitrage boundaries, and show that they increase with expected latency, latency uncertainty, spot volatility, and risk aversion. Empirically, Makarov and Schoar (2020) rely on the limit-order-book data for various crypto-trading platforms and formulate an arbitrage index, which is the ratio of the maximum price to minimum price over a one-minute interval. Comparing the arbitrage index across jurisdictions, they find that the price discrepancies are large across countries and relatively smaller between crypto-currencies. The authors also advocate for capital controls for the movement of arbitrage capital. Similarly, Krückeberg and Scholz (2020) focus on the arbitrage opportunity in Bitcoin and find that the market inefficiency increases over time. It is worth mentioning that arbitrage is captured as price discrepancies among different platforms in these empirical studies without considering the feasibility of implementing and profiting from the arbitrage, such as trading fees, trading time, and short-selling restrictions.

Crypto-currency pricing

Besides the market microstructure issues, the research literature also investigates the pricing of crypto-currencies. More specifically, the Efficient Market Hypothesis (EMH) (i.e., price reflects the past

information) (Fama 1970) for crypto-currencies has attracted a lot of attention. Urquhart (2016) applies five tests to assess the randomness of Bitcoin returns and concludes that the Bitcoin market is not efficient over the full sample. However, the results also show some degree of market efficiency in a more recent subsample, suggesting that the Bitcoin market could become more efficient over time. A follow-up study by Nadarajah and Chu (2017) shows that a power transformation of Bitcoin return can be weakly efficient. Consistent with their results, Brauneis et al. (2018) show that, among others, Bitcoin is the most efficient crypto-currency, with its efficiency positively correlated with liquidity (i.e., turnover ratio) and size (i.e., market capitalization).²⁴

Besides studying the crypto-currency market as a standalone market, several studies investigate the return correlation with other assets. For instance, Liu and Tsyvinski (2021) find that crypto-currency returns have low exposures to traditional asset classes. On the one hand, the nature of crypto-currency is not driven by its function as a future benefit of blockchain technology like a stock, a medium of exchange like a currency, or a store of value like a precious metal commodity. On the other hand, two crypto-currency-specific features, namely the time-series momentum effects and investor attention proxied by Google searches and Twitter posts (Da et al. (2011)), strongly predict the returns of crypto-currencies. Moreover, Liu et al. (2022) find that three cryptocurrency-specific return-based factors, market, size, and momentum, capture the cross-sectional variation in expected cryptocurrency returns. They first identify nine long-short strategies from a “zoo” of factors (Feng et al. (2020)) that could generate excess returns. They further developed a three-factor model akin to the equity factor model to explain the excess returns of all nine strategies.

While investor sentiment and market-related factors have a significant impact on the pricing of crypto-currencies, blockchain features, such as electricity and computing power, can also be the key determinants of price, as they reflect the cost of operating blockchains (Easley et al. (2019); Pagnotta (2022)). Bhambhwani et al. (2021) use computing power (hashrates) to capture the resources expended for mining and find that cryptocurrency prices are cointegrated with the hashrates and with the number of users in the network.²⁵

At the same time, Zhang et al. (2021) analyse the risk profile of crypto-currencies as the crypto-currency market suffers greater volatility and downside risks than the stock market. The authors use metrics of downside risk, such as value-at-risk, expected shortfall, downside beta, and hybrid tail risk, to highlight the positive cross-sectional relationship between downside risk and future returns in the crypto-currency market.

In addition, several authors study the correlation among crypto-currencies and traditional assets using techniques, such as conditional value-at-risk, principal component analysis, or variance decomposition. The results are mixed; for example, Borri (2019) finds that crypto-currencies are not exposed to the U.S. equity market or to gold. Panagiotidis et al. (2019) find a significant interaction

²⁴ Authors adopt Urquhart’s choice of tests and derive results for 73 currencies.

²⁵ Liu and Tsyvinski (2021) construct proxies to capture the supply, i.e., mining a cryptocurrency. The main production proxies are the cost of electricity in the U.S. and China, and the prices of Bitmain Antminer, a common Bitcoin mining equipment. However, the returns are not clearly exposed to any of the proposed proxies.

between Bitcoin and the traditional stock market, while only finding a weak interaction with the foreign exchange market and the macroeconomy. Corbet et al. (2018) show that crypto-currencies may offer diversification benefits over short investment horizons.

3.3 Custodial vs self-custodial crypto-wallets

To make crypto transactions or trade on crypto platforms, users need crypto wallets to “store” their crypto assets. Technically, crypto assets are not stored in the crypto wallets but instead saved on the blockchain in the form of a wallet address. The crypto wallets contain the user’s public and private keys needed to store and transact with the crypto assets. Operations with the crypto wallet are protected through the use of private/public-key cryptography. The owner authorizes the transaction with her private key, which only she knows, proving ownership of the funds stored at her wallet address. The public key is derived from the private key and is used to store information of digital signatures of a transaction so that the network can verify that the private key was used to sign the transaction. In this way, the private key does not need to be revealed when the transaction is broadcast to the network. These keys could be stored in various forms, on a piece of paper (as a string of digits or in a 2D barcode), on a software-based wallet, or in a hardware wallet device.²⁶ What is crucial is that the private key needs to be kept in the most secure form, since the person who controls the private key owns the assets in the wallet address.

Depending on who holds (custodies) the private keys, crypto-wallets can be characterised as *custodial* or as *self-custodial* (see **Figure 1**).²⁷

Custodial wallets

Another consequence of CEXs’ centralised structure is that they operate with *custodial* (also called *hosted*) crypto wallets, an arrangement in which the customer assets are held by a third-party (usually the central administrator of the platform) acting as a custodian, who holds and manages the private keys on the customer’s behalf.²⁸ The users do not have the keys and can only deposit funds or sign transactions through an application provided by the platform provider. This way, the platform provider keeps the private keys, and the owner only keeps the platform’s login information.

Under this arrangement, the customer does not possess full control of the funds nor the ability to sign transactions. In other words, custodial wallet users might not be the legal owners of the assets. The custodian might even commingle the holdings of various customers in a single omnibus crypto wallet controlled solely by the custodian (Levitin 2022), which presents additional investor protection issues.

²⁶ Hardware wallets are usually like a USB thumb-drive. Together with paper wallets, they are characterised as ‘cold’ since they are held offline and therefore have lower (or zero) risk of being hacked. In software wallets private keys are stored and encrypted in the application itself, which is kept online (they are ‘hot’), offering more flexibility but posing a higher risk of malicious access.

²⁷ There is also the less common case of “staged wallets”, where two entities are involved: the investor purchases cryptocurrency via one entity, which tracks the investor’s holdings on its own books but holds the cryptocurrency in its own wallet held at a separate entity. Such arrangements multiply the credit risk for the investor (Levitin 2022).

²⁸ We provide more information about crypto wallets and keys in Section 3.3.

On the other hand, the presence of a third party that provides access to the platform offers some advantages. First, it is easier to trace and identify illegal behaviours---when users set up custodial wallets to sign up on the crypto-trading platform, they can be subject to the KYC process and have their identity verified. Second, as the private keys are stored with the custodian, users do not have to worry about keeping their keys safe. They can retrieve lost access if they lose the passwords. In addition, the custodial wallet allows crypto assets to be transferred, as further KYC would be required at the point of transfer of ownership. In the case of inheritance transfers of crypto-assets, for example, the transfer could be impossible for self-custodial wallets if the private keys are not shared in advance. Even when private keys are shared, there is a risk they are not declared, and there is a potential loss of inheritance tax for governments who institute this type of tax, particularly as there is no way of knowing if someone possesses a self-custodial wallet. Though, it should be noted that this risk also exists for cash.

To the extent that the crypto-trading platforms acting as custodians are unregulated or are not subject to the same standards as in the regulated markets, customers of CEX platforms are exposed to credit risk arising from custodial wallet arrangements. Concerns raised regarding the custodial wallets include the stability and the trustworthiness of the custodians---depending on the legal framework in each jurisdiction, users might lose their crypto-assets when the custodian files for bankruptcy.²⁹ In their recent SEC 10Q filing, for example, Coinbase stated that *“because custodially held crypto assets may be considered to be the property of a bankruptcy estate, in the event of a bankruptcy, the crypto assets we hold in custody on behalf of our customers could be subject to bankruptcy proceedings and such customers could be treated as our general unsecured creditors. This may result in customers finding our custodial services more risky and less attractive and any failure to increase our customer base, discontinuation or reduction in use of our platform and products by existing customers as a result could adversely impact our business, operating results, and financial condition.”*³⁰ In July 2022, crypto broker Voyager Digital Ltd. filed for Chapter 11 bankruptcy protection in the U.S., and Voyager customers might not be able to retrieve their crypto holdings.³¹ Similarly, in the case of FTX’s bankruptcy in November 2022 (one of the most dramatic collapses of a CEX platform), there is still uncertainty on whether investors will recover their assets.³² Such cases confirm Levitin’s observation that there is a serious moral hazard problem with unregulated CEX platforms. These platforms have every incentive to engage in riskier behaviour because they gain all of the upsides from their risky ventures, while the downsides are externalised on their customers (Levitin 2022). All this is in stark contrast with what happens in traditional finance, where there are strict regulations to protect customers from custodial credit risk, including guaranteeing that client assets are segregated and that they are kept bankruptcy-remote.

²⁹ This would most probably be the case under U.S. bankruptcy law (Levitin 2022)

³⁰ Coinbase 10Q filing, May 10, 2022, page 83. Filing available at https://www.sec.gov/Archives/edgar/data/1679788/000167978822000048/coin-20220331.htm#i6ff81ac294904d009a3ab35125a1d5f6_187

³¹ For more information, see https://www.wsj.com/articles/crypto-firm-voyager-seeks-to-honor-customer-withdrawals-from-custodian-bank-11657922435?mod=article_relatedinline

³²See <https://edition.cnn.com/2022/11/14/business/ftx-customer-money-bankruptcy/index.html>

Self-custodial wallets

As recent examples have shown, it could be very costly for the user if the CEX platform provider was hacked, lost the private keys, or went bankrupt.³³ For this reason, CEXs might not sound appealing to traders who value the notion of “*not your keys, not your coins*” and might also fail to appeal to those individuals that seek anonymity or want to avoid any type of regulatory oversight. In these cases, self-custodial wallets and DEX platforms would be more attractive.

With *self-custodial* wallets (also called *non-custodial* or *non-hosted* wallets), the owner of the wallet possesses and controls the private keys and can make transactions directly from the wallet without an intermediary. Although, in some cases, the decentralised crypto-platforms may accept transfers to or from wallets hosted by a centralised platform, in general, to participate in a DEX, a self-custodial wallet is required. In most cases, self-custodial wallets do not require verification of the identity of the owners, providing them with anonymity. This feature creates two major concerns. First, as we discuss in more detail in **Section 5**, illegal behaviours, such as money laundering or illicit transactions, can hide behind anonymity. Second, the self-custodial wallet owner may lose access to her funds if she loses access to the wallet. If access to the wallet is protected by a password (or by an encrypted passphrase), then losing or forgetting the password implies losing the keys. Some self-custodial wallets allow for a limited number of access attempts, and after that, the password would be encrypted, and the wallet (and the keys) would be impossible to access.³⁴

The fact that self-custodial wallets do not have the same custodial risk as custodial wallets, does not mean that they are risk-free. In DEX, investors are still exposed to hackers, code vulnerabilities, and misleading claims.³⁵ Self-custody is the equivalent of stuffing dollars under the mattress; yes, the investor is in control of her money but is also at risk that someone breaks into the house and steals it all. Since, in the crypto-world, individuals are unlikely to have security equivalent to that of trusted institutions in traditional finance, some of these trusted institutions, like exchanges, are offering or will start offering custody services.

4. Crypto-related developments at exchanges

Parallel to the development of the crypto-trading platforms, several regulated exchanges have introduced crypto-related products and services, such as custodial services and trading of crypto ETFs or derivatives on crypto-currencies. To get a better picture of how crypto-trading platforms are evolving in different jurisdictions, and how exchanges are reacting to these developments, including their views on the future opportunities or challenges in relation to crypto markets, the WFE conducted

³³ For stories about cyberattacks on cryptocurrency, see <https://www.bbc.co.uk/news/technology-59549606> .

³⁴ For some colourful stories of lost passwords, see for example, <https://www.nytimes.com/2021/01/12/technology/bitcoin-passwords-wallets-fortunes.html> <https://www.bbc.co.uk/news/technology-55645408>

³⁵ One notorious example was the Ethereum DAO hack in 2016, where USD 150 million worth of Ether were stolen and, when the blockchain was hard forked to restore the funds, disagreement between participants resulted in the split of the network (<https://ethereum.org/en/history/#dao-fork>). A more recent case is the USD 40 billion collapse of Terra stable coin in May 2022 ([Luna crash sends a chill through decentralised financial market](#), Financial Times, June 3, 2022).

between May and July 2022 a survey among its member and affiliate exchanges. There were 29 respondents to the survey, most of them from the EMEA region (55%), followed by the Americas (24%) and the Asia-Pacific (21%) regions. In the following subsections, we summarise and discuss the survey results.

4.1 Supply and demand for crypto-related products at exchanges

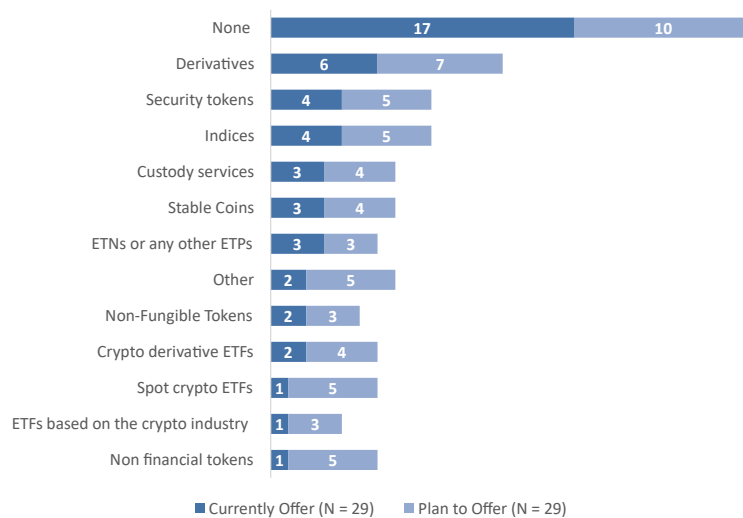
When examining the supply of crypto-related products and services by exchanges, we find that twelve exchanges in the survey are already offering crypto-related products or services (**Figure 4**). Also, 41% (7/17) of the exchanges with no current offerings are planning to offer crypto-related assets and services in the future. In addition, three of the twelve exchanges currently offering crypto-related products or services accept crypto-currencies (e.g., stablecoins) as a medium of exchange. In other words, traders may use cryptocurrencies as a payment method to trade exchange-listed products.

To capture which specific products or services are the most offered, in the survey we classified crypto-related products and services into eleven categories: security tokens, indexes on crypto-related products, custody services, stablecoins, derivatives on crypto-assets, ETNs, non-fungible tokens (NFTs),³⁶ ETFs that track one or more crypto-assets or derivatives on crypto-assets, and non-financial tokens. *Figure 6* also shows the number of exchanges currently offering or planning to offer any of these products or services. While derivatives, security tokens and indices are the most offered crypto-related products, there seems to be similar interest across all types of products.³⁷

³⁶ Non-Fungible Tokens (NFTs) record ownership of a unique tangible or intangible object such as a song, digital art, or collectibles.

³⁷ “Staking” services were not included in the survey. In a staking operation, participant A obtains a yield from lending her crypto-assets to participant B, who uses those assets to increase his stake in a Proof-of-Stake consensus process. B gains from higher probability of participating in the validation process. Interest in staking services has grown after Ethereum moved from Proof-of-Work to Proof-of Stake in September 2022.

Figure 6: Crypto-related products and services offered or planned to be offered by exchanges



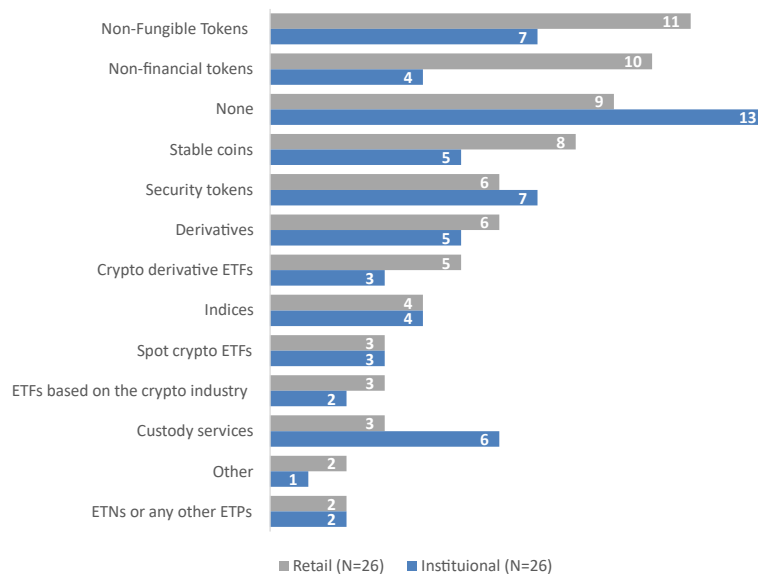
Multiple answers allowed. N is the total number of respondents. Source: WFE Survey

Exchanges also engage in different initiatives to promote their crypto-assets or services. Eleven respondents have established (or plan to establish) working groups dedicated to crypto-related assets or services, and five have published (or plan to publish) related articles.

As for the demand of crypto products, it is interesting to distinguish between retail and institutional investors. According to the respondents' perceptions, retail investors and institutional investors show a slight divergence in the type of products they demand. As shown in **Figure 7**, in general, retail demand for crypto products is greater than institutional demand, except for security tokens and custody services. More specifically, respondents observed that the most demanded products by retail investors are Non-Fungible Tokens (NFTs), non-financial tokens (e.g., utility tokens that grant access to future services), and stablecoins. Yet, for institutional investors, the most demanded products are NFTs, security tokens, and custody services.³⁸ The higher demand of custody services from institutional investors suggests that, at least at the time of the survey, retail customers were perhaps less aware of the lack of investor protection surrounding unregulated crypto-platforms.

³⁸ See the previous footnote.

Figure 7. Retail and institutional investor demand for crypto products



Multiple answers allowed. N is the total number of respondents. Source: WFE Survey

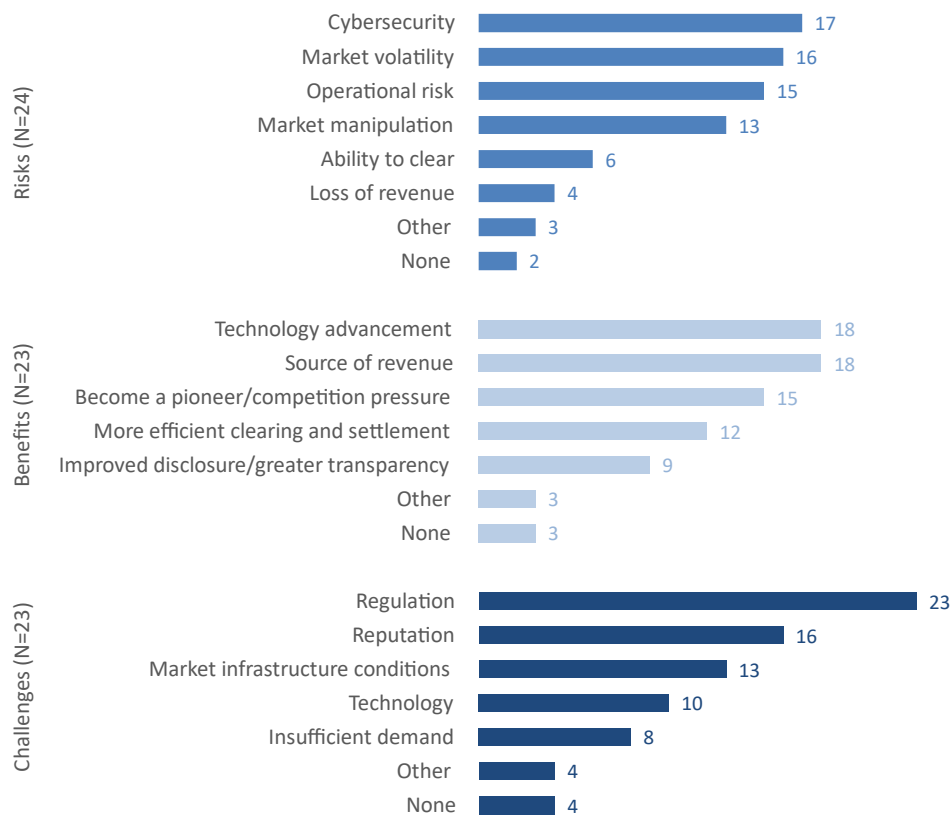
4.2 Opportunities, concerns, and risks ahead

To get a complete picture of how the exchanges envisage the future of crypto-related products and services, we further asked them about the challenges of introducing crypto-related products, as well as about the risks and benefits of offering crypto-related assets. The question was structured as a multiple choice with predefined options.

As shown in **Figure 8**, the most notable risks associated to offering crypto-assets are cybersecurity, market volatility, and operational risk, with 33% of exchanges highlighting all three at the same time. When asked about benefits, technological advancement, new sources of revenue, and technological leadership were the most common choices, with about a quarter (26%) of the exchanges choosing these three at the same time. With regards to the challenges associated with the introduction of crypto-related products, the most significant challenges at this stage centred on regulation, reputation, and the market infrastructure conditions, with 26% of the exchanges coinciding on the three. It is worth noting that, for all of the 23 exchanges that responded to this question, regulation was perceived as a challenge. Of these, 15 exchanges were from the EMEA region, accounting for 65% (15/23) of respondents.

In addition to the above, respondents also mentioned industry readiness, market education, the lack of custody solutions, and investor protection as challenges to the introduction of crypto-related products. On the other hand, increasing investor choice, increasing exposure to new clients, and offering new funding options for issuers were cited as benefits of offering crypto-related products.

Figure 8 . Risks, benefits, and challenges



Multiple answers allowed. The question was structured with predefined options. N is the total number of respondents. Source: WFE Survey.

When asked whether they expected crypto assets to become mainstream in the near future (less than five years), 26% (5/19) of the respondents gave a positive response.

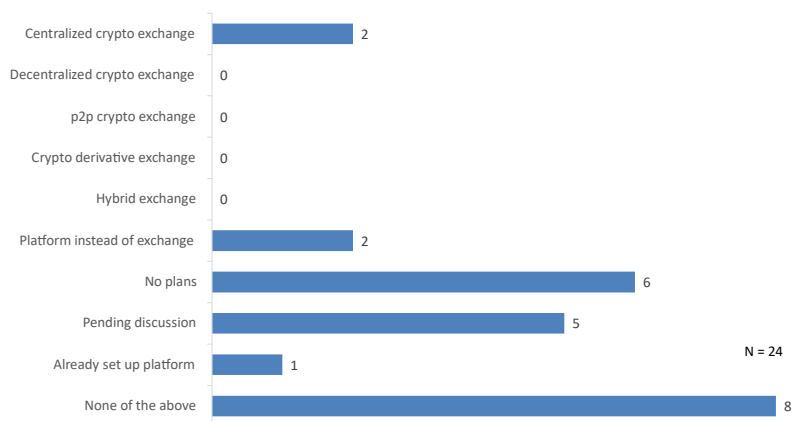
With regards to regulatory activity, 18 exchanges indicated that their jurisdictions have established (or plan to establish) licensing regimes for the operation of digital asset exchanges or custodial services, and 12 exchanges indicated that their jurisdictions allow the issuance of company shares through blockchain networks. In both cases, the jurisdictions in the EMEA region appear as the most active and welcoming to the implementation of crypto-related products or services. Of the 18 respondents reporting that their jurisdictions were positive in terms of licensing regimes, 72% (13/18) were from EMEA; and of the 12 jurisdictions allowing issuance via blockchain, 58% (7/12) were from EMEA. Two respondents from the Americas region and three respondents from the APAC region reported that their jurisdictions were positive on both questions.

With regards to central bank digital currencies (CBDC), 12 exchanges in the survey reported that central banks in their jurisdictions are also actively promoting crypto-currencies or developing projects to issue CBDC, and 12 exchanges indicated that their central banks have issued (or planned to issue) digital currencies.

4.3 Exchanges' digital solutions

As highlighted above in **Figure 4** twelve exchanges in the survey currently offer crypto-related products and services, such as crypto-related securities (e.g., NFTs, crypto ETFs, and derivatives on crypto-assets) or the listing of security tokens. The survey further asked about the exchanges' plans for setting up crypto-asset exchanges in the future. As shown in Figure 9, five (21%) respondents are establishing either new centralised exchanges/platforms dedicated to the trading or listing of crypto assets ³⁹ or they had already set up a platform. Currently, none of the respondents plans to create, within five years, a decentralised crypto exchange, a p2p crypto exchange, a hybrid exchange, or a crypto derivative exchange. In addition, the survey results shows that five (21%) respondents are internally discussing the establishment of a crypto-asset exchange and six (25%) respondents do not have any plans.

Figure 9. Exchanges' plans for offering crypto-asset exchanges or platforms



Multiple answers allowed. The question was structured with predefined options. N is the total number of respondents. Source: WFE Survey.

Among the exchanges that indicated their plans to establish a new exchange or platform or provided information on their current implementation, in **Box 2**, we list and describe some of their digital solutions.

The WFE survey also asked our members about the existing platforms operating in their jurisdiction. Based on the survey responses, the majority of respondents reported having crypto-asset platforms operating in their jurisdictions, which may not be domiciliated or registered in these jurisdictions. Exchanges take the view that platforms should be licensed and regulated to the same standards as exchanges – *same activity, same risk, same regulation*.

³⁹ Here, “platforms” refer to marketplaces prior to being registered as an “exchange” by the corresponding regulators.

Box 2: Exchange's digital solutions: some examples

Securities Official List (SOL) by the Luxembourg Stock Exchange

In January 2022, the Luxembourg Stock Exchange (LuxSE) started to admit security tokens to be registered onto the Securities Official List (SOL),⁴⁰ which is part of the LuxSE's Official List. This service allows qualified issuers to list security tokens on a distributed ledger. LuxSE's SOL listing service intends to enhance the visibility of both the issuer and the security token as well as the dissemination of indicative prices. At the current stage, the issued tokens are not admitted to trading in either the regulated Bourse de Luxembourg market (BdL) or the Euro MTF, as the current European Union regulatory framework does not allow DLT financial instruments to be admitted for trading on these markets.

For the time being, the only accepted security tokens are debt financial instruments. These instruments are priced in fiat currency and are directly issued and exist on a distributed ledger. Moreover, the SOL plans to admit existing securities via tokenization, a method to convert existing rights to an asset into a digital token, representing the ownership of the asset on DLT.

SIX Digital Exchange

In September 2021, the SIX Swiss Exchange (SIX)'s SIX Digital Exchange (SDX)⁴¹ formally received the Swiss Financial Market Supervisory Authority (FINMA)'s regulatory approval to operate a stock exchange and a central securities depository for digital assets in Switzerland. This authorization enables SDX to offer DLT-based services, including trading, settlement, and custody. UBS launched the world's first native digital bond with intended dual listing and trading on SIX Digital Exchange and SIX Swiss Exchange in November 2022.⁴² In January 2023 the city of Lugano issued its first native digital bond on SDX.⁴³

The SDX operates the trading system using an auction model. During the trading period, or the Open Order Book period, executable orders are not matched directly but rather enter an auction for matching and execution. If an order cannot or can only be partially executed after the auction call, the remaining portion will remain in the order book. In addition, short-selling is not permitted on SDX.

SDX recently launched via its SDX Web3 Ltd (under consolidated supervision of FINMA) self-custodial staking of ETH for institutional clients in August 2022 and introduced institutional custody service for crypto assets in October 2022.⁴⁴

In 2022 SDX built as a joint venture the AsiaNext, a new digital asset exchange in Singapore for crypto and securities tokens. This partnership allows SDX to provide services into the Asian market as well as open up the trading channel between Europe and APAC.⁴⁵

⁴⁰ For more information, see <https://www.bourse.lu/admitting-security-tokens-on-sol> .

⁴¹ For more information, see <https://www.sdx.com/>.

⁴² <https://www.ubs.com/global/fr/media/display-page-ndp/en-20221103-digital-bond.onlycontent.html?caasID=CAAS-ActivityStream> .

⁴³ <https://www.sdx.com/news/benvenuta-lugano/> .

⁴⁴ <https://web3.sdx.com/> .

⁴⁵ <https://www.asianext.com/> .

Cboe Digital⁴⁶

In May 2022, Cboe Global Markets (Cboe) completed the acquisition of Eris Digital Holdings, LLC (ErisX),⁴⁷ which was an operator of a U.S.-based digital asset spot market, a regulated futures exchange, and a regulated clearinghouse. The acquisition of ErisX allowed Cboe to enter the digital asset spot and derivatives marketplaces through a digital-first platform developed with industry partners to focus on robust regulatory compliance, data, and transparency. In addition to the current services, Cboe intends to develop and distribute a wider range of digital asset data products.

Bolsa de Santiago (SantiagoX)

SantiagoX has implemented a security lending platform on a permissioned distributed ledger, where lending transactions and short sells are recorded. This platform allows reducing the processing time from four days to around four minutes. The DLT nodes are the participants (e.g., brokers and institutional clients), the regulator, and the exchange (who acts as the platform central authority). The ledger is built on Hyperledger Fabric, and the nodes validate the information through the consensus protocol RAFT.

Nasdaq U.S.

Nasdaq is reportedly looking at Q2 2023 for the release of its custody services for Bitcoin and other cryptocurrencies. The exchange group is pushing ahead to get all the necessary technical infrastructure and regulatory approvals in place.⁴⁸

5. Regulation

As it is often pointed out, the goals of financial regulation of crypto-assets are not different from those of traditional assets. They be grouped into three categories: combating the use of funds for illicit activities; protecting consumers and investors; and ensuring the integrity of markets and overall financial stability (Auer and Claessens 2018).

In this section, we discuss CEX and DEX crypto-trading platforms from these three perspectives. First, the application of Know Your Customer (KYC) standards, which are designed to protect financial institutions against fraud, corruption, money laundering, and terrorist financing. We then focus on how global regulatory bodies are approaching the regulation of crypto-assets and platforms. Finally, we discuss investor protection.

5.1 Anti-money Laundering (AML) and Know Your Customer (KYC)

Anti-money laundering (AML) and countering the finance of terrorism (CFT) regulations are fundamental to ensure the integrity of the financial industry. Their aim is to prevent and detect

⁴⁶ <https://www.cboedigital.com>

⁴⁷ For more information, see <https://ir.cboe.com/news-and-events/2022/05-02-2022/cboe-global-markets-completes-acquisition-erisx-entering-digital-asset-market-0>.

⁴⁸ [Nasdaq eyes crypto custody launch by end second quarter](#), by Anna Irrera, Bloomberg 24 March 2023

financial operations arising from illegal activities like smuggling, illegal arms sales, or drug trafficking, and to protect financial institutions against those activities. At the global level, the AML/CFT international standards are set by the **Financial Action Task Force (FATF)**, an independent inter-governmental body leading global action to tackle money laundering, terrorist financing, and the financing of proliferation of weapons of mass destruction.⁴⁹ The FATF Recommendations (FATF (2022)) set out a comprehensive AML/CFT framework, which is regularly updated and which national authorities should implement through measures adapted to their particular circumstances. Although the international standards developed by the FATF are not legally binding, they aim at a coordinated global response to prevent illicit financial activities, and most jurisdictions tailor their national regulations to align with the Recommendations.

One of the key elements of an AML/CFT framework is customer due diligence, also referred to as the Know-Your-Customer (KYC) process. KYC serves as the client identification step to support AML/CFT regulation and sanction screening around the world. It involves establishing the customer's identity, as well as understanding the nature of customers' activities, qualifying the legitimacy of funding sources and assessing the money laundering risks associated with the customers (FATF (2022)). In countries abiding by the FATF standards, financial institutions, such as banks and brokers, are obliged by law to identify their customers and to understand the nature of the business in which the customers are involved before conducting any activity with them. For instance, banking customers are required to submit identification documents, including government-issued photo ID and proof of address, when opening an account before utilizing any of the bank's services. In addition to verifying the customers' identity, financial institutions may also conduct further KYC measures, which can include risk assessments, background checks, and verification of the source of funds. Moreover, financial institutions are required to monitor their customer information continuously and ensure that the KYC information is up to date.

In recent years, regulators around the globe have expanded or clarified the scope of the existing AML and KYC requirements to ensure they apply to crypto platforms and crypto-wallet providers. In 2019, the FATF explicitly clarified that the FATF Recommendations also apply to financial activities involving crypto-assets and introduced the definition of virtual assets (VA) and virtual asset services providers (VASP) – see **Box 3**. In particular, the FATF Recommendations establish that *“To manage and mitigate the risks emerging from virtual assets, countries should ensure that virtual asset service providers are regulated for AML/CFT purposes, and licensed or registered and subject to effective systems for monitoring and ensuring compliance with the relevant measures called for in the FATF Recommendations.”*⁵⁰

⁴⁹ For more details, see <http://www.fatf-gafi.org/>.

⁵⁰ See §15 of the Recommendations (FATF 2022).

Box 3: Crypto platforms and the FATF definitions

The FATF Recommendations (FATF 2022) define **virtual assets** as “a digital representation of value that can be digitally traded, or transferred, and can be used for payment or investment purposes”. It further clarifies that “virtual assets cannot be merely digital representations of fiat currencies, securities and other financial assets that are already covered elsewhere in the FATF Recommendations, without an inherent ability themselves to be digitally traded or transferred and the possibility to be used for payment or investment purposes”.

On the other hand, a **virtual asset service provider (VASP)** is any natural or legal person who, on behalf of another natural or legal person, conducts one or more of the following activities or operations:

- i. exchange between virtual assets and fiat currencies
- ii. exchange between one or more forms of virtual assets
- iii. transfer of virtual assets
- iv. safekeeping and/or administration of virtual assets or instruments enabling control over virtual assets; and
- v. participation in and provision of financial services related to an issuer’s offer and/or sale of a virtual asset.

After the FATF 2019 Recommendations update, virtual assets were also included in the ‘travel rule’ (which requires financial institutions to pass on information to the receiving financial institutions during wire transfers).

In **Box 4**, we provide some examples of how regulators around the globe have imposed KYC requirements on the crypto-trading platforms operating in their jurisdiction to ensure KYC requirements are the same as those applicable to other financial institutions. Some of these specific crypto-related KYC regulations date back to ten years ago, and most of them have been focusing on crypto-currencies.

In the recent years, the increase in the application of tax and AML/CFT laws has been noticeable: whereas in 2018 a U.S. Library of Congress report found that only 33 jurisdictions regulated cryptocurrencies in these areas, with only five of them applying both tax and AML/CFT laws, in a November 2021 update, 103 jurisdictions were identified as applying these laws, most of which apply both).⁵¹

⁵¹ For details of the 2021 report, please see <https://www.loc.gov/item/2021687419>.

Box 4: AML/KYC requirements across regions⁵²

Across jurisdictions, AML requirements are being applied to crypto-platforms (mainly for crypto-currencies) using different approaches. In some cases, specifically designed regulations have been drafted; in others, the preference is to use AML/KYC policies already in place. We present here some examples of the different approaches adopted.

In March 2013, the **U.S. Financial Crimes Enforcement Network (FinCEN)**, a bureau of the United States Department of the Treasury, issued guidance regarding virtual currencies, stating that currency “exchangers and administrators” must comply with AML/CFT rules by record-keeping, reporting, and registering with FinCEN.⁵³ In June 2014, the **Government of Canada** amended its Proceeds of Crime (Money Laundering) and Terrorist Financing Act to include virtual currencies in its anti-money laundering law. As a result, crypto-currency platforms, including those that operate outside of Canada but provide direct services to persons or entities in Canada, must keep and retain prescribed records and report suspicious or terrorist-related property transactions. In **Mexico**, the central bank (Banxico) requires crypto-trading platforms to prove the legitimacy of all customers and corporations involved in each trade.

In February 2022, the **Colombian** government mandated the reporting of crypto-currency transactions to the country’s AML watchdog. Also, in **El Salvador**, from August 2021, after Bitcoin was declared legal tender, KYC verification is required for all customers, as mandated by the central bank.

In Europe, the **EU’s Fifth Money Laundering Directive (AMLD5)** introduced amendments to include virtual currencies and custodian wallet providers in its KYC/AML mandate. The directive was approved in 2018 and required EU Member States to transpose it into law by 2020 (it is up to the individual Member States to devise their own laws on how to reach the goals expressed in the directive). For example, **Italy’s Ministry of Economy and Finance (MEF)** requires registration with relevant documents from cryptocurrency platforms and investors. The **Commission de Surveillance du Secteur Financier (CSSF) of Luxembourg** has implemented a rigorous vetting process and requires all VASPs (as defined in the FATF Recommendations) to register and to comply with professional obligations and the conditions described in the AML/CFT Law. Similarly, in January 2020, the **UK Financial Conduct Authority (FCA)** required businesses carrying out crypto-asset activities in the UK to register and comply with the AML policies, including records of all crypto-asset public keys and wallet addresses. In 2021, the European Commission proposed implementing the Travel Rule on virtual assets, making crypto transactions traceable.

Yet, the process has not always been smooth. For instance, in May 2021, after a local exchange took the matter to court, the Netherlands regulator, **De Nederlandsche Bank (DNB)**, reversed the requirements it had introduced in 2020, which required clients to upload screenshots of their wallets and provide reasons for their crypto purchases.⁵⁴

⁵² Unless otherwise stated, information on the evolution of AML regulation was obtained from the WFE Survey and from Nasdaq’s [Crypto Currency Regulation Summary](#).

⁵³ For more information, see: <https://www.fincen.gov/sites/default/files/guidance/FIN-2013-G001.pdf>

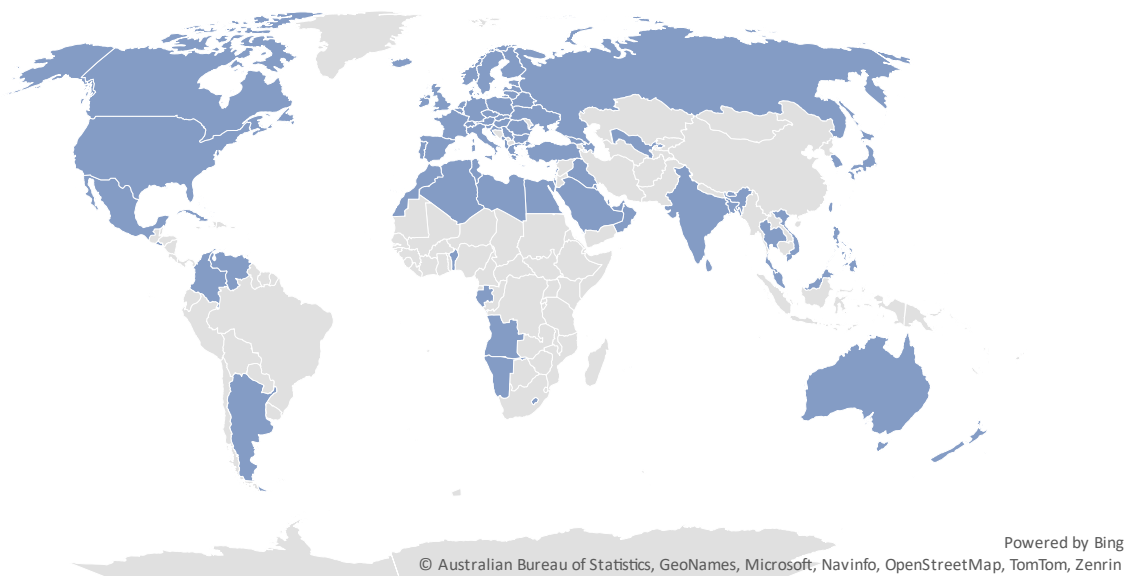
⁵⁴ [Dutch Central Bank revokes strict verification rules for crypto exchanges](#), NewsBitcoin.com

In **Turkey**, crypto-asset service providers have been included among the parties obliged to comply with the local AML/CFT regulation.

In the Asia-Pacific region, the **Reserve Bank of India (RBI)** has suggested that crypto-trading platforms and other financial institutions ensure the legitimacy of crypto transactions, especially concerning fraudulent activities and tax evasion. The **Monetary Authority of Singapore (MAS)** and the **Financial Services Agency (FSA) of Japan** have mandated proper KYC/AML verifications for crypto-platforms operating in their jurisdictions. In **Taiwan**, in 2021, the **Financial Supervisory Commission (FSC)** enacted the "Regulations Governing AML and CTF for Enterprise Handling Virtual Currency Platform and Transaction" to meet the FATF's international standards.

Seychelles has updated the AML Act to include FATF recommendations for VASPs including crypto platforms. In **Botswana**, there is no specifically defined regulation for cryptos, but the generic AML / KYC policies are being applied. **South African** policymakers have proposed that an amendment to the Financial Intelligence Centre Act (FIC Act) is made to add Crypto Assets Service Providers (CASPs) to the list of accountable institutions. Once CASPs are added to the list of accountable institutions, the full ambit of the FIC Act obligations will apply to them, including AML and CTF provisions.

Figure 10. Applicability of AML and antiterrorist finance laws for crypto-currencies



The map shows the application of anti-money laundering and counter-financing of terrorism laws (AML/CFT laws) to crypto-currencies across the world. Shaded regions correspond to 95 countries where these laws apply to crypto-currencies. Non-shaded countries either do not apply AML/CFT laws to crypto currencies or the information was not available.

Source: Law Library of Congress (2021) and WFE Research.

CEX, DEX, and the FATF Recommendations

From the FATF definition of virtual-asset service providers (see **Box 3**), it follows that CEXs are VASPs (either as a provider of trading services, brokerage services, or custodial wallet services), and they should, therefore, meet the FATF standards and conduct KYC to the same standards as in regulated markets. This is explicitly indicated in the Updated Guidance (FATF (2021)).⁵⁵

However, in the case of DEX, the absence of a clearly defined legal entity or person behind the decentralised, permissionless distributed ledger and the fact that participants trade directly on the blockchain (on their own behalf, with no intermediation), brings the question of how KYC requirements should be enforced on these unregulated platforms. This concern is particularly important, given that decentralised, permissionless platforms allow customers to remain anonymous and keep their personal information private from central authorities, which makes DEXs platforms particularly attractive for potential money laundering or terrorist financing activities.

The opaqueness of DEXs is addressed to some extent in the Updated Guidelines, where The FATF acknowledges that, despite the software program supporting the DEX is not a VASP under the FATF standards (i.e., the Standards do not apply to the underlying software or technology), *“creators, owners and operators or some other persons who maintain control or sufficient influence in the platform arrangements, even if those arrangements seem decentralized, may fall under the FATF definition of a VASP where they are providing or actively facilitating VASP services.”*⁵⁶

Still, the Updated Guidance recognises that there may be cases of DEX where it is not possible to identify the legal or natural person possessing the control or sufficient influence over the platform and, therefore, doesn't meet the definition of a VASP. In these cases, the Guidance recommends monitoring emergent risks and considering mitigating actions (for example, requiring that a regulated VASP be involved in the DEX arrangements).⁵⁷

There is an additional consideration to be made about the applicability of KYC to DEX. Although anonymity can be ensured through a decentralised, permissionless distributed ledger, there is the problem of how to acquire crypto-currency in the first place. If one only receives crypto as a reward from mining, for example, one can remain anonymous and operate without any external oversight. Yet, users that acquire crypto-currency using fiat money (a process called *on-ramping*) might be subject to some degree of control at the on-ramping stage. Different ways of on-ramping include buying crypto through a CEX, using an on-ramping platform that interacts with a DEX, acquiring crypto-currency through NFTs, or even using Bitcoin ATMs. through NFTs, All these cases fall within the FATF definitions of VASPs, and therefore should be subject to the FATF standards.⁵⁸

⁵⁵ See §70 of (FATF 2021)

⁵⁶ See §67 of FATF (2021)

⁵⁷ See §69 of FATF (2021)

⁵⁸ See §69 and §71 of FATF (2021)

Poor KYC compliance and enforcement

In its July 2022 report, three years after issuing its Recommendations for the implementation of AML/CFT standards for VASPs, the FATF noted that of the 98 jurisdictions that responded to its March 2022 survey, only 29 jurisdictions have passed relevant Travel Rule laws, with only a small subset of these jurisdictions starting enforcement. And from 53 jurisdictions sampled, only 12 were rated as largely compliant with FATF Recommendation 15, and none was rated as fully compliant. (FATF; 2022b).

Although, in principle, platforms that offer on-ramping (including CEX) should fully comply with KYC processes, the reality is that unregulated platforms, either because of lack of awareness or enforcement, tend to be less strict in implementing their KYC measures. For instance, the initial identification verification may take place *after*, instead of *before* or *during*, account opening. As a result, crypto-trading platform users are able to access some services before being identified. Also, unverified users, despite being subject to withdrawal limits, can often trade crypto-assets on these platforms. Furthermore, the KYC process conducted in practice sometimes only involves the verification of identity without requiring further information, such as proof of address and funding sources.⁵⁹ To evade KYC regulations, it is common for unregulated crypto-trading platforms to operate in various jurisdictions, without a formally registered headquarter.⁶⁰ The less strict application of KYC measures by unregulated crypto-trading platforms has provided opportunities for malicious participants to evade conventional AML/CFT controls. According to Chainalysis, illicit transactions totalled USD 14 billion in 2021, up 79% from USD 7.8 billion in the previous year. As of 2022, it is estimated that around USD 10 billion in crypto-currency is held in illegal addresses.⁶¹

The KYC measures are now a must for crypto-trading platforms looking to offer services in jurisdictions such as the U.S., the U.K., Australia, or Turkey. Several crypto platforms have acknowledged the importance of KYC in eliminating financial fraud, despite arguing that KYC practices are complex and time-consuming.⁶² **Table 1** Error! Reference source not found. lists the KYC and AML market surveillance technology used in several centralised platforms that typically perform at least some level of KYC because they deal with fiat currencies.

⁵⁹ See, for example, a KYC comparison provided by Binance (as of July 25, 2022).

<https://www.binance.com/en/blog/community/kyc-in-crypto--a-comparison-421499824684904092>.

⁶⁰ For example, annual and quarterly report filings with the SEC of Coinbase Global, which is a publicly listed company in the U.S., put “Not Applicable” as its address and telephone number, stating that “We are a remote-first company. Accordingly, we do not maintain a headquarters. For purposes of compliance communications required to be sent to our principal executive offices may be directed to the email address set forth in our proxy materials and/or identified on our investor relations website.” In addition, the company’s filings reveal that the platform only verifies the users’ email address, phone number, or a self-custodial wallet’s username, despite required to perform KYC/AML measures.

⁶¹ For more information, see <https://blog.chainalysis.com/reports/2022-crypto-crime-report-introduction/>.

⁶² For instance, see Binance’s statement on their website. <https://academy.binance.com/en/glossary/know-your-customer>

Table 1. Comparison of Fiat-to-Crypto Platforms by KYC Measures (as of August 2022)

Platform	KYC	Verifier	AML/CFT
Coinbase	KYC upon account activation	Jumio	Active market surveillance team and program since 2018
Gemini	KYC upon account activation	In-house	Nasdaq’s SMARTS surveillance technology
Kraken	Five KYC tiers with usage limits	Unknown	Claims 25% of the workforce deals with compliance
Bitfinex	Four KYC tiers; higher tiers needed to trade fiat currencies	Unknown	Irisium’s market surveillance technology
Bitstamp	KYC needed to trade	Onfido	Irisium’s market surveillance technology
Binance	KYC needed to trade	Refinitiv	Chainalysis’s AML compliance and investigation solution
Bittrex	KYC needed to trade	Jumio	IdentityMind’s Digital Identities Platform

Source: WFE Research

5.2 Market integrity and financial stability

Regulators are broadly in agreement that the crypto world is currently not large enough or sufficiently interconnected with mainstream finance to threaten the stability of the financial system. Nevertheless, crypto markets are growing rapidly; regulators, and prudential regulators in particular, are encouraged to continuously monitor for financial stability risk to avoid a bubble similar to the ones seen in the financial world in the past and are considering whether these activities and entities should be brought within the regulatory perimeter; and, if so, how.⁶³

At a global level, regulatory bodies have taken different initiatives to promote and coordinate the regulation around crypto markets. In 2020, for example, IOSCO published a report on crypto-asset trading platforms (CTPs), which describes the issues and risks associated with the trading of crypto-assets on CTPs.⁶⁴ While noting that many of its members did not have regulatory authority over much of the crypto world, in the report IOSCO suggested a toolkit for regulators where crypto-assets fell into their remit. IOSCO pointed to risks with regard to access, safeguarding, financial resources of the crypto-trading platform, conflicts of interest, disclosure, market abuse and manipulation, resiliency, and efficient price discovery.

⁶³ See, for example, [Reflections on DeFi, digital currencies and regulation](#) - speech by Jon Cunliffe, Warwick Business Schools’s Gilmore Centre Policy Forum Conference on DeFi & Digital Currencies, 21 November, 2022

⁶⁴ <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD649.pdf>

In June 2022, the Basel Committee on Banking Supervision published a second public consultation on the prudential treatment of banks' crypto-asset exposures.⁶⁵ A month later, the Financial Stability Board (FSB) published a risk assessment of crypto-assets,⁶⁶ outlining its concerns about the risk they bring and stating that crypto-assets and markets must be subject to effective regulation and oversight commensurate to the risks they pose, both at the domestic and international level. The FSB report highlights the risk that the failure or the misconduct of a market player could generate potentially large losses on investors, threaten confidence in the markets, and spill over to the traditional financial markets. The report recognises also that an effective regulatory framework must ensure that crypto-asset activities posing risks similar to traditional financial activities are subject to the same regulatory outcomes, while taking account of novel features of crypto-assets and harnessing their benefits.

In a follow-up to the assessment, the FSB noted that the spillover effects remain "limited." Noting in particular that "though the recent turmoil in crypto-asset markets resulted in a sharp and wide depreciation in crypto-asset market values and the failure of some service providers, this turmoil has not yet transmitted significant financial stability concerns to the wider financial system."⁶⁷

In a later report,⁶⁸ published after the FTX bankruptcy, the FSB reiterates the view that the interlinkages with traditional finance are still limited, "as shown by the modest impact of the May/June 2022 crypto-asset market turmoil and the November 2022 FTX collapse". It alerts, however, that if the crypto market becomes mainstream, the vulnerabilities inherent in decentralised finance (DeFi) could pose potential threats to financial stability (through interconnection with traditional finance) and therefore require careful monitoring as the ecosystem grows and evolves.

Another problem, which became even more evident with the demise of FTX, is that crypto-trading platforms frequently carry out further activities that would not be permitted, or would be closely regulated, in a traditional trading environment. They often also serve (i) in a role similar to a traditional broker-dealer, representing traders and executing trades on their behalf; (ii) as custodians, of their customers' assets, a role traditionally performed by Central Security Depositories (CSDs); (iii) as money-transmitters, transferring virtual and fiat currency and converting it from one form to another; (iv) as owners of large virtual currency holdings; and, in some cases, (v) as issuers of a virtual and tradable currency listed on their own and other platforms, with a direct stake in its performance. They may also offer lending and borrowing services, and some will even trade on their own account.⁶⁹

⁶⁵ <https://www.bis.org/bcbs/publ/d533.htm>

⁶⁶ See <https://www.fsb.org/2022/07/fsb-statement-on-international-regulation-and-supervision-of-crypto-asset-activities/>

⁶⁷ <https://www.fsb.org/wp-content/uploads/P111022-3.pdf>

⁶⁸ <https://www.fsb.org/wp-content/uploads/P160223.pdf>

⁶⁹ In June 2023, the US SEC sued Coinbase alleging it had been operating as an unregistered broker through its exchange platform, depriving investors of critical protections. The day before, the SEC had filed a complaint against Binance for mixing customers funds with those of a trading firm owned by Coinbase CEO. Gary Gensler, the SEC chair, commented "These trading platforms, they call themselves exchanges, are commingling a number of functions which [we don't see] in traditional finance," [SEC sues Coinbase in widening crackdown on crypto exchanges](#), Financial Times, June 6, 2023.

On the other hand, allowing functions like clearing, trading, or lending to be managed by software protocols, as is the case in DEX, carry its own risks; for example, the risk that automated liquidation of collateral assets could lead to triggering or amplifying fire sale dynamics.

Given the risks, the conflicts of interests, the poor governance structures, and the lack of investor protection that such comingling of services tend to generate, it is perhaps not surprising that some crypto platforms' models and market structures are evolving to offer more traditional services, with a traditional separation of functions (trading, custody, financing, margin trading, etc.).⁷⁰

Regulatory approaches

The WFE Survey asked exchanges to report which crypto-assets fell within the regulatory perimeter in their jurisdictions. The responses reveal differences across jurisdictions in regulatory approach to crypto-platforms and in the set of crypto-assets currently captured within the regulatory perimeter. This should not be surprising. First, crypto markets are at different stages of development in different jurisdictions. Second, the crypto markets are still evolving, with new services and products being created, and there is a perception that, at this stage, it may be too early to develop too specific or too restrictive rules, as they may become quickly outdated and may stifle innovation. Moreover, regulations on crypto-trading platforms are contingent on how crypto-assets are defined and classified, an area where there are still diverging views.

Results from the survey show that, in some jurisdictions, no crypto-assets are currently captured within the regulatory perimeter, while in others a decision has been taken that allows the inclusion of some (or all) crypto-assets and markets within the perimeter of current financial regulation and supervision.⁷¹ While in some cases no crypto-specific regulation is being planned at this stage, in others it may already be underway or may have already been enacted. The regulatory outcome largely depends on how the crypto-asset is defined. If the asset is deemed to have the features of a security, it would often be subject to the corresponding regime for trading securities and the supervision of the relevant authority. This is consistent with the basic principles of technology-neutrality and of "same activities, same risks, same rules". Finally, in some jurisdictions, there is a ban on crypto-assets. The ban can be explicit or implicit (for example, banning payments in crypto-currency).

Of particular interest is the regulatory framework designed in the **European Union: the Markets in Crypto Assets regulation (MiCA)**, formally adopted in May 2023, will bring crypto-assets, crypto-assets issuers, and crypto-asset service providers (CASPs) under a single regulatory framework.⁷² From the perspective of this analysis, two things are worth highlighting: First, the framework will only apply to crypto-assets that are not already captured as financial instruments under the second Markets in Financial Instruments Directive (MiFID II). Hence, trading platforms where *security tokens*

⁷⁰ One example is Coinbase Prime.

⁷¹ It is worth noting that, in a consultative report published in October 2021, the BIS and CPMI-IOSCO provided guidance on the application of the PFMI to systematically important stablecoin arrangements, including entities integral to such arrangements. While recognizing the new features that characterize stablecoins arrangements, the underlying assumption is that the PFMI should also apply.

⁷² <https://www.consilium.europa.eu/en/press/press-releases/2022/06/30/digital-finance-agreement-reached-on-european-crypto-assets-regulation-mica/>

are traded, should be already captured within MIFID II. Second, MiCA will apply whenever there is a natural or legal person providing or controlling the services provided, even if it is indirectly, or when only part of such activities is decentralised. Hence, CEX platforms trading any of the crypto-assets captured by the MiCA fall within the definition of a CASP. As in the case of FATF, this means that CEX in the EU will generally require prior authorization and will have to comply with a broad set of general and service specific rules for CASPs, including governance requirements (Art 61), prudential requirements (Art 60), safe-keeping of client assets (Art.63), segregation of client assets (Art. 67) ,and regulations to prevent market abuse (Title IV).⁷³ CASPs are also required to inform about adverse environmental and climate-related impacts of the consensus mechanism they use. For issuers of the stablecoin variants EMTs and ARTs, MiCA includes stricter rules due to related concerns about financial stability. However, where crypto-asset services are provided in a fully decentralised manner they do not fall within the scope of the MiCA regulation (recital 12a). In other words, fully decentralised, permissionless platforms (DEX) are outside of the scope of MiCA (see **Box 5**).

MiCA also includes specific requirements on pre- and post-trade transparency. The requirements are modelled on those applied to continuous order book trading protocols (Art 68). For example, authorized CASPs shall make public, during the trading hours on a continuous basis, any bid and ask prices and the depth of trading interests at those prices which are advertised for crypto-assets through the systems of the trading platform. They shall also make public, as close to real-time as is technically possible, the price, volume and time of the transactions executed.

Moreover, CASPs are required to make such pre- and post-trade information available to the public “on a reasonable commercial basis and ensure non-discriminatory access to that information.” That information shall be made available free of charge 15 minutes after publication in a machine-readable format and remain published for at least 2 years.

Box 5: CEX and DEX under EU MiCA

The MiCA defines a **crypto-asset** as *a digital representation of a value or a right which may be transferred and stored electronically, using distributed ledger technology or similar technology.*

A **crypto-asset service provider (CASP)** means a *legal person or other undertaking whose occupation or business is the provision of one or more crypto-asset services to third parties on a professional basis* (Art. 52). Crypto asset services comprise:

- a) the custody and administration of crypto-assets on behalf of third parties
- b) the operation of a trading platform for crypto-assets
- c) the exchange of crypto-assets for funds
- d) the exchange of crypto-assets for other crypto-assets
- e) the execution of orders for crypto-assets on behalf of third parties
- f) placing of crypto-assets
- g) providing transfer services for crypto-assets on behalf of third parties
- h) the reception and transmission of orders for crypto-assets on behalf of third parties

⁷³ See Titles V and VI.

- i) providing advice on crypto-assets
- j) providing portfolio management on crypto-assets

MiCA introduces three sub-categories of crypto-assets:

- Electronic money tokens (EMTs) are crypto-assets that aim to maintain a stable value by referencing to the value of one official currency (Art. 3 (1) No. (4)). For example, stablecoins like Tether (backed by USD) or USDC.
- Asset-referenced tokens (ARTs), which aim to maintain a stable value by referencing to any other value or right or a combination thereof, including one or more official currencies (Art. 3 (1) No. (3)). For example, PaX Gold, an asset-backed token backed by physical gold.⁷⁴
- All other crypto-assets that are not EMTs or ARTs, (e.g., cryptocurrencies and utility tokens).

Guided by the principles of ‘same activities, same risks, same rules’ and of technology neutrality, MiCA does not apply to crypto-assets captured by existing financial services legislation (Recital 6(a)). In particular, it does not apply to crypto-assets that qualify as financial instruments under MiFID II. In layman’s terms, that would mean MiCA would not apply to a tokenised security for example. And it does not apply to Non-Fungible Tokens (NFTs) (Art. 2 (2a)). However, NFTs that are issued "in a large series or collection" may be considered fungible and thereby covered by MiCA (Recital 6(c)).

In **Box 6**, we provide some examples of the different regulatory approaches that exchanges reported in the survey.

Box 6: Crypto-assets under regulatory perimeter

The WFE Survey revealed that in some cases, like **Pakistan**, no crypto assets are currently considered within the regulatory perimeter. Other respondents indicated that, while currently in their jurisdiction no crypto-assets are under regulatory perimeter, the drafting of specific crypto-asset regulation is underway. This was the case, for example, reported by **Cape Town Stock Exchange**, the **Johannesburg Stock Exchange (JSE)**, the **Latin American Stock Exchange**, and **Dubai Gold and Commodities Exchange**. Accordingly, these jurisdictions have yet to formulate standards for crypto-asset transactions.

In **Turkey**, crypto-assets are not currently subject to any regulation and supervision mechanisms nor to overseeing from a central regulatory authority. However, according to the Regulation on the Disuse of Crypto Assets in Payments issued on April 16, 2021, by the Central Bank of the Republic of Turkey (CBRT), the use of crypto assets in payments either directly or indirectly has been banned.

In the **European Union**, until the MiCA enters into force, EU countries have relied on MiFID II and local legislation. In **Luxembourg**, for example, the MiFID II Implementation Act regarding infrastructures together with Luxembourg securities laws is currently the main framework applicable to crypto-assets. Crypto-assets that qualify as financial instruments (under the Law of 5 April 1993 on the financial sector), electronic money (under the Law of 10 November 2009 on

⁷⁴ See <https://paxos.com/paxgold/>

payment services) and other virtual assets (under a specific supervisory regime⁷⁵) are included in the perimeter of the **Commission de Surveillance du Secteur Financier (CSSF)**.⁷⁶ Similarly, in **Poland**, if the token has the features of a financial instrument, it would be subject to the regime for trading in financial instruments and the supervision of the Polish Financial Supervision Authority. In **Switzerland**, regulation captures all crypto-assets, including cryptocurrencies and stablecoins. In assessing ICOs, the Swiss Financial Market Supervisory Authority (FINMA) focuses on the economic function and purpose of the tokens.

In **Japan**, cryptocurrency exchange service providers that handle cryptocurrencies come under the regulatory scope of the Japan Financial Services Authority (FSA). Japanese laws specify crypto-assets as a category and not specific types of crypto-assets. In **Korea**, the regulatory authority perceived assets traded in virtual asset platforms as virtual assets in the Act on Reporting and Use of Certain Financial Transaction Information. Security Token Offerings (STOs) are regulated under securities Law (Financial Investment Services and Capital Markets Act. In **Taiwan**, STOs are defined as securities and must comply with the applicable provisions of the Securities and Exchange Act. Other virtual currencies and any derivatives thereof are not financial products approved by the Financial Supervisory Commission (FSC).

In the **United States**, the Securities and Exchange Commission (SEC) regulates digital assets deemed securities and the Commodity Futures Trading Commission (CFTC) regulates derivatives on digital asset commodities. The SEC uses the "Howey Test"⁷⁷ to determine whether a virtual currency is a security. All ICOs are treated as securities, except Ether and Bitcoin.⁷⁸

In **Nigeria**, the Securities Exchange Commission (SEC) has included all digital assets, subject to the reporting standards set by the SEC and the Central Bank. In **Mexico**, in addition to stablecoins and tokens, NFTs have been included in the regulation. The central bank (Banxico), the finance ministry (SHCP), and the market regulator (CNBV) are the institutions that approve and regulate the issuance of any digital asset. The law that establishes the regulatory perimeter is called FinTech Law ("Ley Fintech").

⁷⁵ <https://www.cssf.lu/en/registration-virtual-asset-service-provider/>

⁷⁶ It is worth noting that the implementation of EU Directives is done by Member States. who can interpret bits differently. Hence some discrepancies.

⁷⁷ The "Howey test" refers to SEC v. W.J. Howey Co., a case heard in the Supreme Court in 1946 regarding the existence of an investment contract. The Supreme Court has established a test for such purposes: investment of money in a common enterprise with a reasonable expectation of profits to be derived from the efforts of others. As a result, it is used to determine if a transaction qualifies as an investment contract and is therefore considered a security and subject to disclosure and registration requirements under the Securities Act of 1933 and the Securities Exchange Act of 1934. For more information on Howey Test, see <https://www.sec.gov/corpfin/framework-investment-contract-analysis-digital-assets>

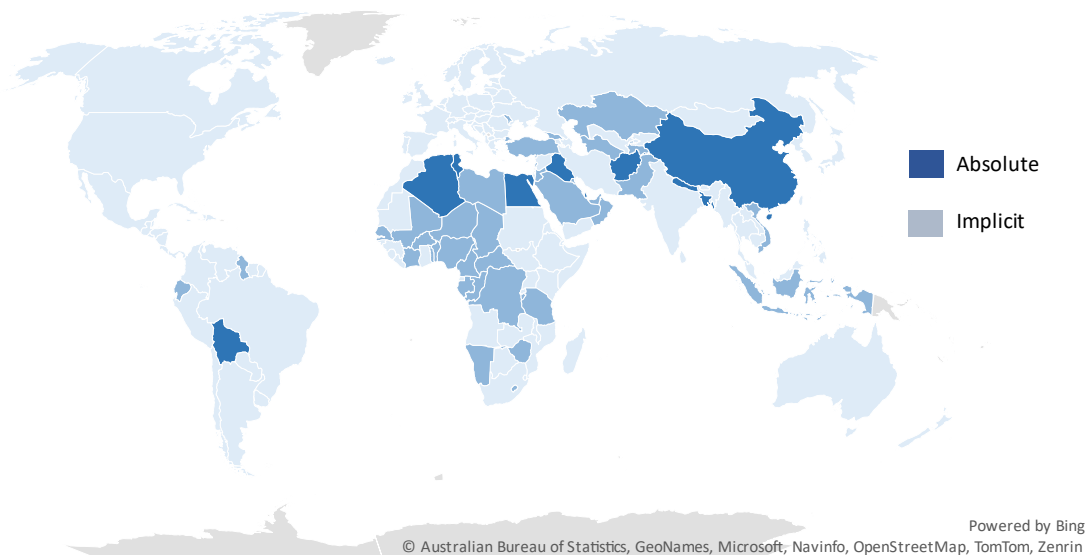
⁷⁸ At the time of writing, it is unclear who will regulate crypto assets in the future and numerous bills are waiting to go through congress.

In January 2023, **Israel’s** financial authority proposed that cryptocurrencies should be included in existing securities legislation. As such, the regulator will directly supervise operations with bitcoin and altcoins. It will also place the asset class into the category of “financial instruments,” together with securities, marketing, and joint investments. Later in the year, the **Tel Aviv Stock Exchange** published a draft for public comments for approval of the expansion of the authorized activities of non-banking Members (NBMs) to include trading in cryptocurrencies. Under this scheme, NBMs customers will deposit fiat money that is designated for investment in crypto-currency and withdraw monies originating from those currencies.⁷⁹

The legal status of crypto-currencies

Over the years, there has been a trend of increasingly strict regulation of crypto-currencies around the world. In 2018, the U.S. Law Library of Congress’s report⁸⁰ on the regulation of crypto-currencies around the world indicated that eight jurisdictions had in place an absolute ban, and 15 jurisdictions had established an implicit ban (e.g., by banning banks and other financial institutions from engaging in crypto-currency transactions, or providing relevant services to individuals/businesses, or by banning crypto-currency exchanges). At the end of 2022, there were ten countries issuing absolute crypto-currency bans and 42 with implicit bans; see **Figure 11**.

Figure 11. Legal status of crypto-currencies



The map shows the countries that either explicitly or implicitly ban cryptocurrencies. Countries with absolute bans are Afghanistan, Algeria, Bangladesh, Bolivia, China, Egypt, Iraq, Nepal, Qatar, and Tunisia.

Source: Law Library of Congress (2021) and WFE Research.

⁷⁹ See <https://maya.tase.co.il/reports/details/1507925>

⁸⁰ For details of the 2018 report, please see <https://www.loc.gov/item/2018298387>.

Auer and Classens (2018) have shown that, while crypto-currencies are often thought to operate outside the reach of national regulation, in reality their valuation, trading volume, and user base have been significantly affected by local regulatory actions, and the impact depends on the specific type of action. General bans on crypto-currencies or their status under securities law tend to have the most negative effect, followed by AML/CFT regulations, as well as restrictions to the interaction between crypto-currencies and regulated markets. Conversely, the creation of specific legal frameworks designed for crypto-currencies coincides with substantial market gains. Because of their cross-border nature, local regulations might not only affect crypto-currencies in the local jurisdiction but also have an impact beyond its borders. For instance, when China suggested the implementation of the stringent regulations on Bitcoin in January 2017, there was a significant shift in Chinese Yuan-denominated Bitcoin trades towards other Asian currencies-denominated trades (Auer and Claessens (2018)).

5.3 CEX, DEX, and investor protection

Many of the aforementioned regulations lean away from privacy and toward investor protection, which is essential due to the opaque, under-regulated, and highly volatile nature of the crypto-asset markets.

As discussed in Section 3.3, to the extent that the crypto-trading platforms acting as custodians are unregulated or are not subject to the same standards as in the regulated markets, customers of CEX platforms are exposed to credit risk arising from custodial wallet arrangements. In these unregulated platforms, customers may lose their assets if, for example, the custodian makes use of custodial holdings or in the event of the custodian's bankruptcy (Levitin 2022).⁸¹ The case of FTX is another reminder of the importance of having investor protection safeguards and adequate governance arrangements in place. Therefore, it is not a surprise to see that crypto-custody services by a trusted and regulated entity (such as a regulated exchange or a central security depository) are one of the more demanded services, according to the WFE survey. Or that some platforms are offering regulated, segregated services, as in traditional finance, including the choice of an independent custodian.⁸² Such demand reflects the concerns around the legal uncertainty and lack of protection surrounding the custodial arrangements offered by those crypto-trading platforms in which a third-party (usually the same, unregulated legal entity that runs the platform) custodies the customer's assets.⁸³

⁸¹ In addition, some custodial solutions offer omnibus wallets and not segregated accounts, which could lead to investor protection issues.

⁸² For example, TP-ICAP Fusion Digital Assets, a wholesale spot crypto-asset platform led by a traditional finance institution. Introduced in May 2023 and regulated by the UK FCA, it allows participants to choose an independent, third-party custodian of their choice. Its segregated operational structure aligns with that of traditional financial markets, with independent providers performing different functions (trade execution, custody and settlement). See <https://tpicap.com/digitalassets/trade-spot-cryptoassets>.

⁸³ It is worth noting that, in February 2023, the U.S. Securities and Exchange Commission (SEC) published a proposal to update its custody rule (a rule aimed to protect client funds and securities from investment adviser insolvency and to prevent client assets from being lost). The proposed amendment will require SEC-registered investment advisers to put all of their clients' assets, including some crypto-assets, into "qualified custodians", a category that does not include crypto trading platforms. See <https://www.sec.gov/rules/proposed/2023/ia-6240.pdf>.

Moreover, while it is often argued that the investor can avoid custody risk when operating with a DEX, there are other sources of risk, especially for retail investors. Initial coin offerings, for example, often lack the levels of disclosure required in the regulated markets. While CEX may perform a vetting process, DEX has no screening process to prevent scams or duplicates. As we pointed out before, DEXs are also subject to failure or hacking, in which case the investor has no one to recourse to.⁸⁴

Another problem that is exacerbated in DEX is the lack of transparency. Although the DEXs claim that DLT brings transparency by making their operation visible to everyone, this notion can be misleading. For example, the fact that the code in smart contract is *visible* to everyone, does not mean that its operation is *transparent* to everyone. Auditing the code or paying someone to audit the code may be challenging for a retail participant. As the Dao Fork showed (see footnote 79), it may also bring surprises to the more sophisticated programmers. One potential consequence of the lack of transparency is the creation of a two-tier market, where professional investors make profits at the expense of retail participants.

Anonymity in DEX could also encourage market manipulation. Without being able to identify the identity behind accounts, it is not possible to detect, for example, collusion to manipulate the prices.

Moreover, removing intermediaries that perform important gatekeeping functions and operate under the existing investor and market protection regime can leave retail investors without access to intermediaries who help screen potential investments for quality and legitimacy.

All these issues associated with the crypto trading platforms are in stark contrast with the traditional, regulated setting, where exchanges and custodians must adhere to strict regulatory standards and provide additional security measures to ensure the safety of assets and the integrity of markets, all of which provide protection for investors and create trust in the system.

Box 6: Investor's access to crypto assets

In the survey, we asked WFE members about the restrictions on investors' access to crypto-assets in their jurisdictions. In many cases, such as in **Nigeria, South Africa, Panama, Poland** or **Switzerland** (which applies a technology-neutral approach), there were no specific legal restrictions.

In other cases, like **Taiwan**, the regulator does not restrict investor access to legitimate crypto-related assets; however, only professional investors are allowed to participate in security token offering (STO) fundraising and trading. In countries like Botswana, investors may only access crypto-trading platforms through a licence-holder intermediary.

In **Luxembourg**, the restrictions depend on the type of crypto-related assets:

1. **Crypto-currencies:** While there is no blanket restriction on access, the Luxembourg financial sector regulator (the CSSF) has issued several warnings related to the risks associated with crypto-currencies.

⁸⁴ See, for example, [Hackers siphon \\$600m in digital tokens, crypto network says](#), Financial Times, August 10, 2021.

Financial instruments: with respect to crypto assets that are qualified as financial instruments, the CSSF takes a very cautious approach, in particular when those are targeting retail investors. The CSSF has not imposed any express restrictions but determines on a case-by-case basis whether the relevant asset meets the applicable investor protection standards. Public offer prospectuses for financial instruments taking the form of tokens have been approved in the past by the CSSF.

In the **U.S.**, existing federal securities laws and various types of state laws apply to crypto assets in some form and can restrict investors' access to those assets in different ways.

KYC/AML can also limit investors' access to crypto-assets. In **Korea**, for example, investors wanting to participate in currency-to-token market need to open a designated bank account with their real name and make transactions based on such account.

6. Concluding remarks

The results of the survey conducted amongst WFE member exchanges shows a dynamic landscape, with regulated exchanges actively responding to a growing demand for crypto products and services and where crypto-related innovations are seen as an opportunity to advance technology development and increase investor choice, with almost half of the respondents already offering some crypto-related product or service (with derivatives, financial tokens, and indexes being the most common products).

However, when considering the option of entering the crypto-markets, there are also concerns, notably around the lack of uniform regulatory standards, the high volatility observed in these markets, and the risk of cybersecurity threats.

Regarding regulatory standards, in many jurisdictions crypto-trading platforms have been operating without the high standards required from established financial markets and with very little regulatory oversight. As these markets continue to grow, it is clear that this may have negative consequences for AML/CFT, for market integrity, and for investor protection. The various failures of high profile crypto-trading platforms in 2022 (both CEX and DEX) are a point in case and have been a wake-up call for regulators to increase the regulatory focus.

The risks that unregulated crypto-trading platforms bring are compounded by the fact that they frequently carry out further activities that would not be permitted, or would be closely regulated, in a traditional trading environment.

From a market structure perspective, while the current AMM protocols built on smart contracts do not offer the same levels of pre- and post-trade transparency and efficiency as an order book, they remain an active area of innovation and we can expect them to develop further. However, because in these protocols liquidity and price discovery are driven by algorithms, it is critical to fully understand how these automated mechanisms operate, especially in extreme market conditions (for example, when liquidity providers withdraw or when there is a run to the exit), what incentives they create, and whether they can guarantee market integrity and stability, and offer fair and transparent markets to their users.

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Appendix A. Survey participants

WFE Members

Americas	Asia-Pacific	EMEA
Bolsa Mexicana de Valores	Japan Exchange Group	Amman Stock Exchange
CME Group	Korea Exchange	Baku Stock Exchange
Cboe Global Markets	The Stock Exchange of Thailand	Borsa İstanbul
Intercontinental Exchange, Inc.	Taipei Exchange	Cyprus Stock Exchange
Nasdaq	Taiwan Futures Exchange	Deutsche Börse AG
TMX Group Limited	Taiwan Stock Exchange	Dubai Gold and Commodities Exchange
		Johannesburg Stock Exchange
		Luxembourg Stock Exchange
		Nigerian Exchange Group
		SIX Group
		Tel-Aviv Stock Exchange
		Warsaw Stock Exchange

WFE Affiliates

Americas	Asia-Pacific	EMEA
Latin American Stock Exchange		Botswana Stock Exchange
		Cape Town Stock Exchange
		MERJ Exchange Limited
		Pakistan Stock Exchange