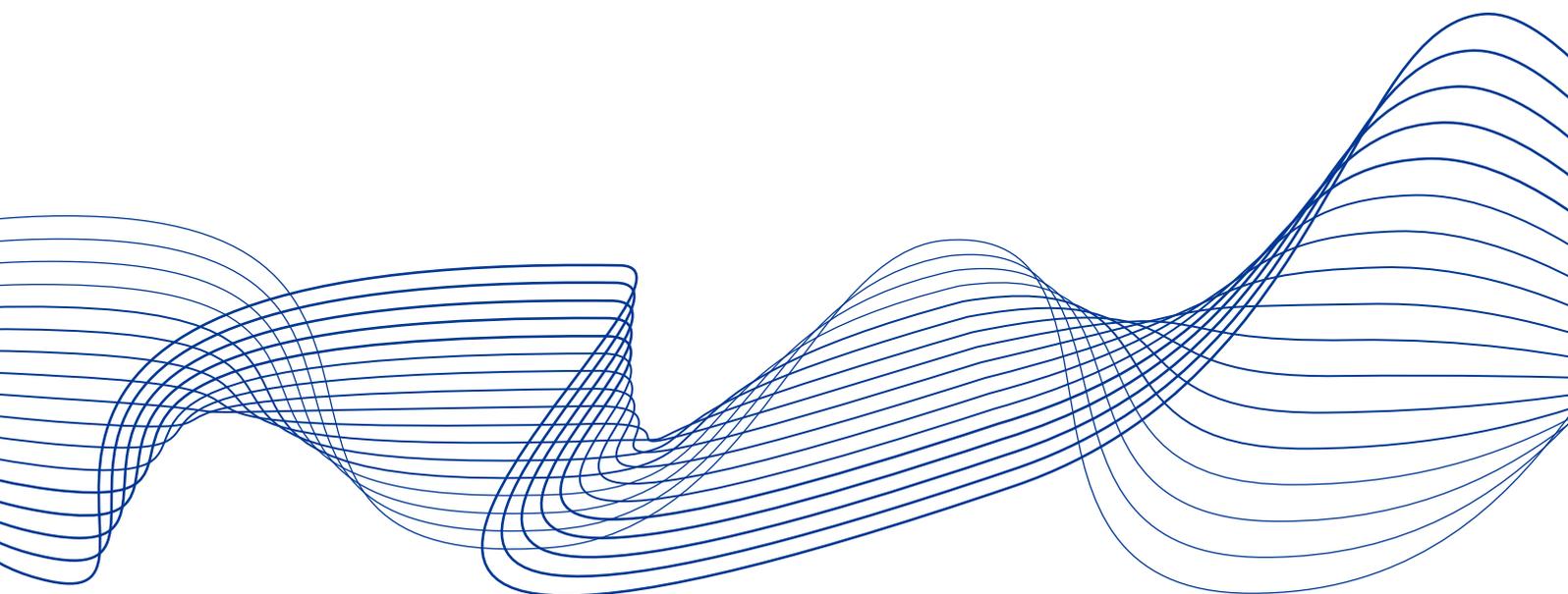


Crypto-assets and decentralised finance

May 2023

Systemic implications and
policy options

by
ESRB Task Force on Crypto-Assets and Decentralised Finance



ESRB

European Systemic Risk Board

European System of Financial Supervision

Contents

Executive summary	2
1 Introduction	6
2 Systemic implications	10
2.1 Market developments	10
2.2 Identifying the investors in crypto-asset markets	20
2.3 Linkages between crypto-assets and traditional finance	24
2.4 How might crypto-assets become systemic?	27
3 Policy options	30
3.1 Methodological approach	31
3.2 Priority 1: Strengthen monitoring capacity	31
3.3 Priority 2: Identify and assess risks from crypto-asset conglomerates and leverage using crypto-assets, and suggest policy options to mitigate identified risks	36
3.4 Priority 3: Monitor market developments to ensure potential risks to financial stability and the effectiveness of macroprudential policy can be identified, assessed and mitigated	42
4 Conclusion	49
Annex	
A.1 Speculative scenarios of potential systemic risk	51
A.2 Overview of the key features of MiCA	58
A.3 Valuation of crypto-assets	64
A.4 Glossary	67
References	70
Imprint and acknowledgements	76



Executive summary

In June 2022 the High-Level Exploratory Group on Crypto-Assets and Decentralised Finance (HLEG) established by the European Systemic Risk Board (ESRB) delivered a report outlining its findings on the scope and priorities for the analysis of crypto-assets and decentralised finance (DeFi) from a financial stability perspective. The report concluded that while potential systemic implications stemming from crypto-assets, service providers and DeFi applications appeared limited, systemic risks could arise quickly and suddenly. If the rapid growth trends observed in recent years were to continue, crypto-assets could pose risks to financial stability.

The ESRB General Board welcomed the report and established the Task Force on Crypto-Assets and Decentralised Finance (CATF). The General Board asked the CATF to submit a report at its meeting in the first quarter of 2023, focusing on two priority areas:

Priority 1: Policy options

Consider the role of financial stability and macroprudential policy for crypto-assets, their service providers and DeFi applications.

Priority 2: Systemic implications

Identify systemic implications of the crypto-asset market, its service providers and DeFi applications in the EU.

This report by the CATF notes the rapid growth of crypto-assets and DeFi in recent years, which has attracted increasing attention among academics, central banks, regulators and policymakers, including with respect to the role of the ESRB in this area.¹ Since the latest peak in November 2021, crypto-asset markets have contracted sharply (with a rebound in 2023). Numerous corporate failures have been reported, and there is an increasing perception of fundamental issues concerning corporate governance, conduct, market abuse and business models. Policy discussions on how to approach the regulation of crypto-asset markets have progressed in jurisdictions around the world, with a focus on consumer and investor protection² and the need to ensure crypto-assets and DeFi are not used to launder money or facilitate illicit activity. But the broader financial stability implications remain unclear.

The ESRB has therefore considered the systemic implications of crypto-asset markets and DeFi applications for the stability of the EU financial sector. Notwithstanding important consumer and investor protection issues, and from a macroprudential perspective, the report takes into account ongoing efforts in various jurisdictions to address challenges arising from the growth of crypto-assets and DeFi. In addition, the report identifies areas in which the ESRB, with its broad European membership, could best complement and deepen ongoing policy work at the EU and international level.

¹ See McGuinness (2021).

² See European Securities and Markets Authority (2022).



Given the vast scope of the crypto-asset universe, the report distinguishes among the specific areas that concern financial stability. The report first defines the three distinct types of crypto-assets considered from a financial stability perspective: (i) native tokens, (ii) reserve-backed stablecoins, and (iii) algorithmic stablecoins³. The report also provides a description of the DeFi ecosystem. There are significant warnings about the interpretation of the terminology adopted in the crypto-asset universe. Therefore, caveats on the availability and quality of data are important, in particular since most of the data are gathered from commercial sources.

Turning to market developments, the report focuses on reported prices, market capitalisation, price volatility, trading volumes and participants in the system. Prices for native tokens have dropped drastically since their peak in November 2021, more than for global equities during the same period, but are rising again in 2023. When considering market capitalisation, concentration is stark, with the top ten native tokens accounting for 75% of total crypto-asset market capitalisation. Yet the crypto-asset market remains only a fraction of the size of the global capital market.⁴ Prices for native tokens are quite volatile, whereas for reserve-backed stablecoins volatility is limited yet still not zero as it should be. To get a more informative picture, the report considers trading volume data in comparison with market capitalisation: reported trading within the crypto-asset space is much higher on a daily basis than in equity markets. Finally, using the limited means available to measure the size of DeFi, the report concludes that it is currently very small and exclusively serves the crypto-asset world, with no significant connection yet to traditional finance.

In the absence of dedicated regulatory data, it is difficult to identify investors in crypto-asset markets and the direct bearers of risks. On-chain data suggest growing use by retail investors, sizeable cross-investments among crypto-asset providers and some investment by traditional finance, especially alternative investment funds (AIFs). But both bank sector and fund sector exposures remain de minimis at present. From a geographical perspective, estimates using on-chain data show the EU with roughly the same trading volume as the United States, although off-chain trading involving fiat currency is dominated by USD.

Linkages between crypto-assets and the traditional financial system could be an important channel of shock transmission and require specific attention to understand any systemic risks that may emerge from a growing crypto-asset universe. First, an estimate of the value of the crypto-asset world shows it is just 0.8% of the size of the EU financial sector⁵. Second, there is only sporadic correlation between the booms and busts of crypto-assets and traditional finance. Furthermore, including crypto-assets in a portfolio of equities, bonds and gold would not appear to lead to an improvement in the risk-return profile. Finally, EU banks' engagement in crypto-asset activities is very limited. The report nevertheless emphasises the clear and growing connections

³ Section 5.2 provides an overview of the terminology applied in the EU's MiCA regulatory framework and a mapping of the concepts.

⁴ It is tempting to liken the size of the crypto-asset market to that of the US subprime mortgage market in 2007. Prior to the financial crisis, the latter accounted for less than 1% of global capital market capitalisation. Such a comparison would be misleading since there is a critical difference. Not only was the quality of the subprime mortgages and mortgage pools opaque, traditional financial intermediaries were exposed. But both the scope and depth of that exposure were unknown. As a result, when the quality of subprime mortgages came into question, so did the creditworthiness of a broad range of counterparties. By contrast, we know both the quality of crypto-assets – they have no fundamental value – and the fact that traditional intermediaries are not now significantly exposed. So, the analogy does not hold.

⁵ Sources: 2023 ESRB Non-Bank Financial Intermediation Risk Monitor and ESRB calculations.



between crypto-assets and traditional finance: reserve-backed stablecoins themselves, and the use of traditional intermediaries by crypto-asset players.

From the perspective of the ESRB, the central issue is how the crypto-asset market could become systemically relevant. Crypto-asset markets, especially after collapsing since November 2021, are not systemic in size and interconnections. Since they may expand again in the future (as evidenced by their behaviour in early 2023) and have in the past demonstrated their potential for staggering growth dynamics, this report considers conditions under which crypto-asset markets could become systemically relevant. In this regard, it is difficult to estimate the time required for the sector to reach systemic proportions, which calls for caution in using current observations to guide policy. Three scenarios are discussed: (i) a run on a stablecoin, (ii) greater integration between the crypto-asset and traditional finance worlds, and (iii) a major expansion in transacting with crypto-assets instead of traditional means of payment. These scenarios illustrate the risks of the potential evolution of crypto-asset markets.

The report also considers potential policy implications, taking into account the extent to which existing policy measures, including the EU's Regulation on Markets in Crypto-assets (MiCA),⁶ are sufficient to mitigate financial stability and macroprudential risks. These considerations are based on a comprehensive review of crypto-asset market developments, the analysis of the revised text for the proposed European legislation, as well as regulatory initiatives in key third countries and at the international level (e.g. proposed by the Basel Committee on Banking Supervision, BCBS, and the Financial Stability Board, FSB). Given the strong cross-border nature of crypto-asset markets, the success of implementing the regulatory and supervisory framework will depend on the level of coordination and cooperation among the competent regulatory and supervisory authorities in EU Member States, as well as between the EU and third-country bodies.

The findings of this report suggest that it is necessary to improve the capacity of public authorities, including in the EU, to monitor potential contagion channels between the crypto-asset sector and the traditional financial sector, as well as within the crypto-asset sector.

MiCA will subject issuers and crypto-asset service providers to requirements designed to safeguard consumers, market integrity and financial stability. The applicable legal framework should provide authorities with access to data useful in identifying potential risks to financial stability posed by the crypto-asset sector and mitigating them. Moreover, it will be beneficial to carry out assessments of risks posed by (i) crypto-asset conglomerates⁷ (i.e. entities and groups carrying out combinations of significant crypto-asset-related activities, such as issuance and exchange), taking account of market developments following the application of MiCA; and (ii) leverage using crypto-assets, and to identify potential additional actions to mitigate observed risks. Furthermore, the report endorses the continued exchange of knowledge between public authorities in the EU on market developments, focusing on several areas where potential risks may emerge, notably regarding (i) operational resilience, (ii) DeFi, and (iii) crypto-asset staking and lending. Finally, the principle of

⁶ Following a provisional political agreement in June 2022, the European Parliament and Council formally adopted the final text in April and May 2023 respectively, which paves the way for publication in the EU's Official Journal and entry into force shortly.

⁷ Where reference is made to crypto-asset conglomerates in the report, it is not meant as an equivalent to any definition of conglomerate within EU law (i.e. Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2020).



proportionality should be given due consideration as well as the need to ensure a harmonised EU reporting framework.



1 Introduction

The past year has been tumultuous for crypto-asset markets. With prices falling by as much as 75% from their peaks in late 2021, bankruptcies followed. Exchanges, lenders, hedge funds, trading firms, asset managers and mining firms went into various forms of administration. Over the past year, notable failures include Voyager, Three Arrows Capital, Babel Finance, Celsius, FTX, BlockFi, Core Scientific and Genesis Global Holdco, as well as the collapse of TerraUSD and Luna.⁸ In the context of the March 2023 collapse of Silicon Valley Bank (SVB), the stablecoin USD Coin (USDC) came under pressure and temporarily broke its US dollar peg on the news that managing company Circle held USD 3.3 billion of USDC reserves with SVB. In the following three days, Circle processed USD 3.0 billion in net redemptions⁹. None of these failures directly affected the traditional financial sector, with the exception of Silvergate Bank and Signature Bank in the United States, hitherto the main bankers to the crypto-asset sector. Linkages between the traditional finance and crypto-asset sectors remain minimal, albeit increasing.

To date, the crypto-asset world has had few links with and provided few services to, the real economy, none of them vital. It is unknown whether what has been dubbed the “crypto winter” will turn into an ice age, or if the current thaw will bring crypto-assets roaring back. Even though the crypto-asset sector might not be systemic today, authorities should be able to understand the developments of the sector and their potential implications for financial stability.

Regulation of crypto-asset markets, most notably the Regulation on Markets in Crypto-assets (MiCA) in the EU¹⁰, is aimed at establishing standards known from traditional finance.

These important measures may result in some crypto-asset market participants exiting the market due to sub-standard governance and risk management practices. Regulatory standards could thereby eliminate the competitive advantage of some crypto-asset market participants, who may rely on weaker regulation to attain a lower cost of service provision than in the traditional financial sector.

Moreover, trustless mechanisms based on proof of work (like the one underpinning bitcoin) will continue to be extremely expensive. Those using proof of stake (as now used by Ethereum) are vulnerable to attack and to sudden slowdowns. Rather than flocking to these permissionless blockchains, there is some evidence that non-crypto-asset firms are abandoning them.¹¹

That said, the underlying technologies may at some stage become integrated with the more traditional financial sector. Despite the implicit or explicit promise of stability, significant volatility in crypto-asset instruments has been observed in practice (given the widespread use of the term “stablecoins”, this report uses it simply to facilitate reading). Issuance activities could become substantial, as could associated service provision such as the operation of trading platforms.

⁸ FT Alphaville gives a fairly **comprehensive list** as of 14 March 2023.

⁹ See Circle (2023) or Howcroft (2023).

¹⁰ Following a provisional political agreement in June 2022, the European Parliament and Council formally adopted the final text in April and May 2023 respectively, which paves the way for publication in the EU's Official Journal and entry into force shortly.

¹¹ See, for example, stories about the **Australian stock exchange** (Kaye, 2022), as well as **Maersk and IBM** (Moller, 2022).



The following analysis of the current state of the crypto-asset world underscores findings by international standard-setters that currently the crypto-asset sector is too small and insufficiently integrated with the traditional financial system to pose any systemic risks. But crypto-asset markets may expand in the future and have in the past demonstrated their potential for growth dynamics that could lead to them becoming systemically relevant at some point in the future.

In terms of effective regulation, the EU is set to implement MiCA, which creates a comprehensive framework for the regulation of crypto-asset service provision and crypto-asset issuance in the EU. This includes stablecoins, which in MiCA language are referred to as asset-referenced tokens (ARTs)¹² and e-money tokens (EMTs)¹³. Financial stability is not a main theme of MiCA, however, and this report offers a number of important considerations for further action from the perspective of the European Systemic Risk Board (ESRB).

At the outset, it is important to highlight the approach taken in this report to nomenclature and to acknowledge issues with data availability and quality.

On the first, terminology used in the crypto-asset ecosystem often relies heavily on language that is well established in the traditional financial system, and primarily in the context of marketing materials.¹⁴ Therefore, it is necessary to exercise caution in its interpretation. This report avoids the term “currency” in favour of using crypto-assets¹⁵ or tokens. A currency is money underpinned by a legal system that is generally accepted in payment of debt. Money, in turn, is something broadly accepted as a payment for goods and services or repayment of debt, acts as a unit of account and serves as a store of value. Neither unbacked tokens nor reserve-backed stablecoins¹⁶ have the accepted properties of money. That said, reserve-backed stablecoins have value traceable to the traditional financial assets backing them. By contrast, even though they lack fundamental value in a conventional sense, unbacked tokens may have some of the properties of standard financial assets insofar as those with claims on them can be identified and the holders may derive economic benefits by converting them into fiat currency in order to purchase conventional goods or services. Unbacked tokens can therefore have economic value with prices that are determined in markets where they trade.

¹² Under MiCA, ARTs aim to maintain a stable value by referencing to any other value or right, or combination thereof, including one or several official currencies. This sub-category covers all crypto-assets (other than EMTs) whose value is backed by assets.

¹³ Under MiCA, EMTs are crypto-assets that to stabilise their value by referencing only one official currency. The function of such crypto-assets is very similar to the function of electronic money, as defined in Article 2, point 2, of Directive 2009/110/EC of the European Parliament and of the Council. Like electronic money, such crypto-assets are electronic surrogates for coins and banknotes and are likely to be used for making payments.

¹⁴ For an investigation into the claimed benefits offered by crypto-assets and the associated risks and costs, see Chapter 8 in Executive Office of the President of the United States (2023).

¹⁵ Even the term “crypto-assets” requires caution. The term “assets” often denotes something that is valuable, but crypto-assets cannot commonly be defined as something with a clear intrinsic value.

¹⁶ Relative price stability may not be the case for all stablecoins. This is due to the various ways in which they are pegged, the nature of reserve assets (if any) and their governance structure. The use of “coins” in stablecoins can be misleading as well, since coins are associated with money, and stablecoins cannot be considered actual money.



Section 2 examines three distinct types of crypto-assets. First, there are native tokens. These are integral to any permissionless blockchain¹⁷ as they are the reward for the miners or validators adding to the chain, including clearing and settling transactions. Every blockchain has one. Examples include bitcoin, Dogecoin and ether. Second, there are reserve-backed stablecoins, which are “backed” by traditional assets with equal or greater nominal value in one or more fiat currencies. The largest currently are Tether, USD Coin and Binance USD. Third, there are on-chain collateralised stablecoins (e.g. DAI) and algorithmic stablecoins (e.g. FRAX), which aim to maintain their peg without corresponding reserve assets, instead relying on an on-chain algorithm and/or smart contract that manages the supply of tokens in circulation. A common feature is a set relationship to a second crypto-asset token, wherein trading between the stablecoin and second token is intended to offer arbitrageurs profitable opportunities to return the stablecoin to its peg.

There are important caveats regarding the understanding of what these crypto-assets purport to be. Native tokens, as well as some algorithmic stablecoins, are unbacked by financial assets, bearing little resemblance to traditional financial instruments or currencies. In the language of traditional finance, they have no fundamental value, so their price is driven entirely by sentiment. Reserve-backed stablecoins are different: the issuer uses the fiat currency proceeds from the sale of their tokens to purchase traditional financial assets, such as sovereign debt instruments. In contrast to money market funds (MMFs), the issuers of reserve-backed stablecoins promise redemption of their tokens at par. This makes them economically equivalent to bank demand deposits, albeit without the government safety net afforded by deposit insurance or central bank lender of last resort liquidity facilities.

The report refers to “decentralised finance” (DeFi), which is a set of financial markets, products and systems that operate using crypto-assets and “smart contracts” built using distributed ledger or similar technology. This technology is a means of holding information in a distributed ledger, i.e. a repeated digital copy of data available at multiple locations. A smart contract is a piece of code that resides on the blockchain (which is a form of distributed ledger) and executes deterministically when requested.¹⁸

Despite their name, DeFi protocols can never be fully decentralised.¹⁹ They need mechanisms for making strategic decisions, adapting to changes and correcting errors. Governance, operation and maintenance always have a significant degree of centralisation.

A range of activities – mostly occurring off the blockchain – are linked to DeFi. These include asset management, automated trading bots and supply of data, which are required inputs into conditional smart contracts, and blockchain governance arrangements. The suppliers of external

¹⁷ A form of distributed ledger in which details of transactions are held in the ledger in the form of blocks of information. A block of new information is attached to the chain of pre-existing blocks via a computerised process (commonly called a consensus mechanism) by which transactions are validated (by participants in the network). Such technology enables new forms of communication that allow a user to enter and automatically perform transactions without knowing the identity of the other party.

¹⁸ There is a sense that the mechanics of DeFi and smart contracts are ubiquitous in finance and have been for a long time. Most people in the advanced world use automated methods to make recurring payments. Take the case of electricity bills. Meter readings are taken (possibly automatically over a cellular network), the information is sent to the customer's bank, and on a pre-specified date, a payment is sent to the electricity company. Using DeFi terminology, there is a smart contract – the bank's code that makes the payment – and an oracle (or possibly two) – the company sending the information and the clock that determines the date.

¹⁹ See Aramonte, Huang and Schimpf (2021).



data (i.e. asset prices) are known as “oracles”.²⁰ There is also a range of other off-chain providers – including exchanges and app developers – who combine many of these activities to facilitate retail and wholesale access to the DeFi system.

Turning to data, there are weaknesses.²¹ This report relies primarily on information from various public sources. While the data largely match across sources, variations occur. For pricing and trading information on crypto-assets, aggregates are based on selected crypto-asset exchanges that fulfil the criteria of the Crypto Coin Comparison Aggregate Index (CCCAGG), reviewed monthly. Despite the somewhat selective sample, data issues persist. There are no data compiled by the official sector from trusted sources. This can be improved with comprehensive and recurring monitoring of the engagement of traditional financial firms (Section 3).

Second, it is important to interpret information on prices and market capitalisation with caution. The primary difficulty is the increasing evidence of price manipulation. This can lead to short-term volatility arising from pump-and-dump schemes and longer-term price inflation from interested-party market participation and self-dealing. Furthermore, there can be a large difference between quoted “market capitalisation” and what is commonly known as “fully diluted market capitalisation”. The former is the market price times the number of tokens that are known to have been publicly issued. The latter is all the tokens that were created, including those still held by the initial issuer. XRP, the native token on the Ripple-maintained (proprietary) blockchain is an example. On 10 March 2023 XRP’s reported market capitalisation was USD 18.6 billion on a circulating supply of 51 billion tokens.²² Ripple has sold only about half of the XRP tokens to users of its clearing service, so the fully diluted market capitalisation is twice the market capitalisation. While it is impossible to know what would happen if XRP holders were to sell substantial quantities, a significant negative price impact is likely.

Third, information on trading volume cannot be guaranteed. One reliable estimate puts the amount of wash trading at over 70% of the volume of transactions reported on unregulated crypto-asset exchanges.²³

²⁰ A third-party service enabling smart contracts to access external data used as an input for the smart contract’s functionality.

²¹ EUR figures/data were used to the extent possible throughout the report. Given the nature of the crypto-asset market and the data availability, however, the majority of references are in USD.

²² See [CoinMarketCap](#).

²³ See Cong, Li, Tang and Yang (2022). There are also reports of wash trading in DeFi protocols; see Shevchenko (2020).



2 Systemic implications

In order to identify EU systemic implications of the crypto-asset market, its service providers and DeFi applications, this section considers market developments and interconnectedness between the crypto-asset and traditional finance sectors. The report assesses the current importance of the crypto-asset sector and what would need to happen for the sector to become systemic. It concludes that the sector is not yet systemic (a conclusion shared by the Financial Stability Board (FSB) and other international standard-setters).²⁴ Nevertheless, past exponential growth dynamics demonstrate the need to monitor developments in the sector closely to identify and address potential risks to financial stability that may arise.

2.1 Market developments

2.1.1 Reported prices and market capitalisation

The prices of native tokens have experienced considerable fluctuation over the last two years. Chart 1 reports the price history for the largest tokens considered in this section. Starting with the native tokens in panel a), it is clear that after peaking in November 2021, prices declined significantly. The two largest by market capitalisation (Chart 2) are bitcoin (BTC in blue) and ether (ETH in yellow). After peaking at prices of USD 67,549 and USD 4,811 respectively, as of 10 March 2023 they are now trading at USD 20,208 and USD 1,432 respectively. That is a decline of roughly 70%. While this occurred during a wider market downturn, the decline was far larger than the roughly 20% drop for global equities.

Comparing the shifts in native token prices with a US stock index highlights the greater degree to which the former reacts to uncertainty. In the six months beginning mid-June 2022, as FTX and BlockFi were failing and the entire system was coming under increasing regulatory scrutiny globally, bitcoin's price fluctuated between USD 26,587 and USD 15,760, i.e. by around 50%. By contrast, the S&P 500 index peaked at 4,305 (in mid-August) and bottomed out at 3,577 (in mid-October) – a range of closer to 20%.

On the other hand, given their nature, reserve-backed stablecoins should in principle experience no change in price. Indeed, panel b) of Chart 1 shows that USD reserve-backed stablecoins display far less volatility. This is as it should be, as these stablecoins are backed by traditional safe assets, some of whose issuers publish audited financial statements – as for USD Coin (in blue). For Tether (in yellow), the case is slightly different. While Tether claims transparency, its reports display far less detail than, for example, those of USDC, which reports the US Treasury securities it holds in detail.

Similar in nature, algorithmic stablecoins also display a relatively stable price, but issues of depegging have been experienced in the past. Panel c) of Chart 1 shows the collapse of

²⁴ See Financial Stability Board (2022b).

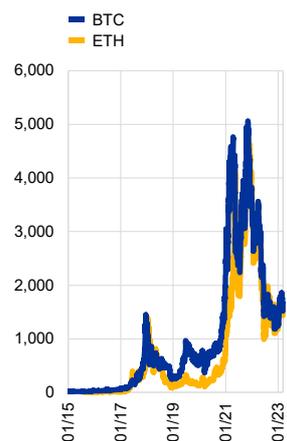


TerraUSD in May 2022, when the algorithmic stablecoin, with a market capitalisation of over USD 18 billion, collapsed within days.

Chart 1
Prices of selected crypto-asset instruments

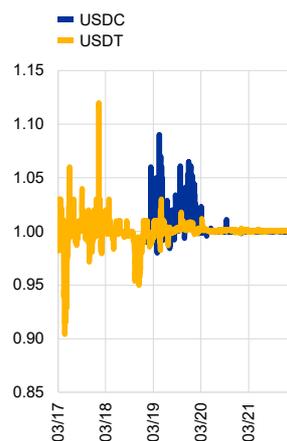
a) USD price of native tokens

(USD, 1 Jan. 2015-10 Mar. 2023)



b) USD-referenced reserve-backed stablecoins

(USD, 5 Mar. 2017-10 Mar. 2023)



c) Algorithmic and on-chain collateralised stablecoins

(USD, 1 Jul. 2021-10 Mar. 2023)



Sources: CryptoCompare and CoinGecko.

Notes: Crypto-asset prices as aggregated within the CCCAGG. BTC stands for bitcoin; ETH stands for ether; USDC stands for USD Coin; USDT stands for Tether; DAI stands for Dai; FRAX stands for Frax; UST stands for TerraClassicUSD (formerly TerraUSD – switch in data on 27 May 2022); LUSD stands for Liquity USD. Panel c: the DAI line is hidden by the FRAX line as they have a similar price range.

Turning to market capitalisation, the system remains extremely concentrated (Chart 2). As of early March 2023 bitcoin accounted for 44% of the total, ether for 20%, and the top ten native tokens for 75%.



Chart 2

Share of bitcoin and selected native tokens in total crypto-market capitalisation

(percentages, 1 Aug. 2015-10 Mar. 2023)



Sources: CryptoCompare and ESRB calculations.

Notes: Based on the price of crypto-assets as in the CCCAGG and current supply data as provided by CryptoCompare. BTC stands for bitcoin; ETH stands for ether; DOT stands for Polkadot; XRP stands for Ripple. ADA stands for Cardano; LTC stands for Litecoin; LINK stands for Chainlink; DOGE stands for Dogecoin; BNB stands for Binance Coin; BCH stands for Bitcoin Cash; UNI stands for Uniswap. The category "Rest" covers all other altcoins, stablecoins and fiat currencies as covered by CryptoCompare. Some lines are covered by other lines, since their share of market capitalisation is very similar and small compared with bitcoin.

Looking at the overall crypto-asset world, the value has fallen markedly from its November 2021 peak of roughly USD 2.9 trillion. As of 10 March 2023 the total value is just over USD 890 billion, a decline of over two-thirds. In the third quarter of 2021, around the peak of the global crypto-asset market capitalisation, it accounted for only 1.5%²⁵ of the value of the EU's financial system alone, which was estimated at around €105 trillion²⁶.

USD-referenced reserve-backed stablecoins experienced a much less pronounced decline in market capitalisation over the past year. As depicted in Chart 3, Tether fell from USD 83 billion in May 2022 to USD 72 billion in early March 2023. Similarly, USD Coin market capitalisation peaked at USD 56 billion at the end of June 2022 and stood at USD 43 billion in March of this year.

Similarly, algorithmic stablecoins have shown a relatively smooth decline in market capitalisation, with one clear exception to date. The collapse of TerraUSD, once estimated to have the largest market capitalisation of all algorithmic stablecoins, and its associated sister crypto-asset token Luna, wiped out almost USD 400 billion from the crypto-asset market.²⁷ The mechanism for this type of algorithmic stablecoin (allowing newly minted crypto-asset tokens to support the dollar peg) magnifies the potential for instability: as a loss of investor confidence

²⁵ ESRB calculations.

²⁶ See European Systemic Risk Board (2022).

²⁷ See Chow (2022).

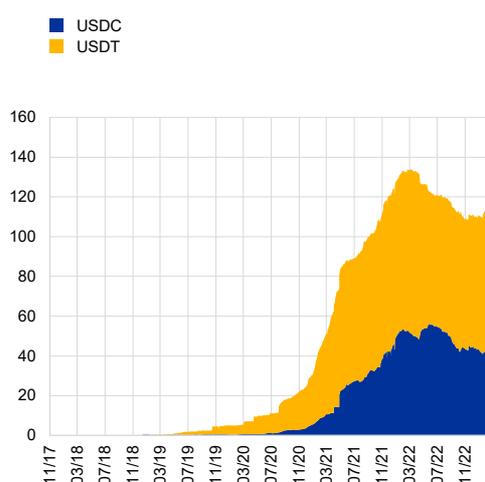


depresses the price of the associated token (in this instance, Luna), even more of that token can be minted for each unit of algorithmic stablecoin (TerraUSD) that is exchanged. The resulting plunge in the associated token's price can lead to an ever-larger supply, accelerating the move toward zero.

Chart 3
Market capitalisation of stablecoins

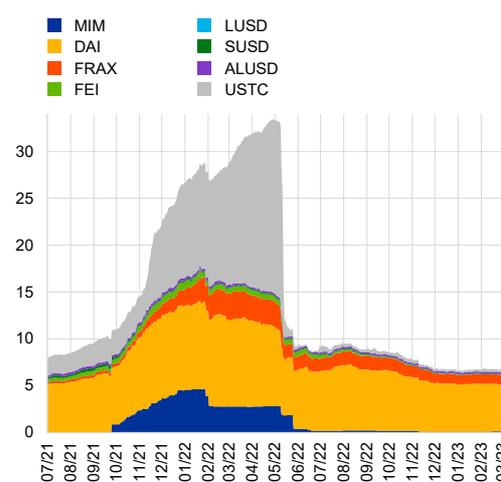
a) Market capitalisation of USD-referenced reserve-backed stablecoins

(USD billions, 28 Nov. 2017-10 Mar. 2023)



b) Market capitalisation of algorithmic on-chain collateralised stablecoins

(USD billions, 1 Jul. 2021-10 Mar. 2023)



Sources: CryptoCompare, CoinGecko and ESRB calculations.

Notes: USDC stands for USD Coin; USDT stands for Tether; MIM stands for Magic Internet Money; DAI stands for Dai; FRAX stands for Frax; FEI stands for Fei Protocol; LUSD stands for Liquity USD; SUSD stands for sUSD; ALUSD stands for Alchemix USD; USTC stands for TerraClassicUSD (formerly TerraUSD – switch in data on 27 May 2022). LUSD and SUSD are not visible because they overlap with ALUSD.

When measured against traditional finance, the market capitalisation of crypto-assets appears fairly small.

The total reported market capitalisation for all crypto-assets of USD 890 billion (as of the beginning of March 2023) – including the USD 130 billion in reserve-backed stablecoins and the USD 80 billion in bitcoins for which private keys are thought to be lost – equates to around 0.8% of the EU financial sector, about the size of Amazon and roughly the same size as the 15th largest bank in the EU (UniCredit SpA).

**Box 1
Circle, USD Coin, BlackRock and the Federal Reserve System**

USD Coin is a dollar-referenced reserve-backed stablecoin issued by Circle that, as of mid-March 2023, had a market capitalisation of USD 36.3 billion and a unit price of USD 0.9999. Since the inception of USD Coin in October 2018, Circle has published monthly attestation reports audited by Grant Thornton. These list the CUSIP number²⁸, quantities of US Treasury securities and amount

²⁸ An identification number assigned to all stocks and registered bonds by the Committee on Uniform Securities Identification Procedures.



deposited in chartered banks along with the names of the banks. In mid-2021 Circle announced its intention to become a chartered bank. At the time of writing, it had not done so.

On 1 September 2022 BlackRock Funds published a prospectus for Circle Reserve Fund. This is a government money market fund (MMF) – it can hold only US Treasury securities – that is open only to Circle Internet Financial LLC. Total operating expenses are 0.17% of assets per year. Since this is a registered MMF, it provides daily disclosures.

Looking at the disclosures, on 16 March 2023 Circle Reserve Fund had assets of USD 29.6 billion. Circle deposited more than three-quarters of the assets backing USD Coin in this MMF, which holds only US Treasury securities. In other words, USD Coin is operating as if it were a narrow bank (but unregulated), holding only government bonds. The portion of USD Coin reserves not held at Circle Reserve Fund appears to be deposited in banks, with the bulk of it at Silicon Valley Bank (SVB). On 11 March 2023 it became known that Circle had USD 3.3 billion deposited in SVB, which had been shut down on 10 March. USD Coin immediately de-pegged and fell to 0.8774, then recovered quickly to its peg when the US authorities announced that all deposits in SVB would be guaranteed and available from the opening of business on Monday, 13 March. During the period of uncertainty, Circle processed USD 3.0 billion in net redemptions. Coinbase and Binance stopped USD Coin conversions, and Tether rose to 1.026.

Since the September 2022 announcement of the creation of Circle Reserve Fund, USD Coin's daily closing price has been between 0.9715 and 1.0007. The lowest price observed over this period was 0.8774, and the median coefficient of variation was 0.0006.

In early January 2023, there were news reports that BlackRock had applied for Circle Reserve Fund to become a reverse repo counterparty at the Federal Reserve Bank of New York. Seven BlackRock funds are already on the reverse repurchase (RRP) counterparty list. If this application were accepted, BlackRock would be able to reverse repo up to USD 160 billion of the assets of Circle Reserve Fund with the Federal Reserve System.

Several EUR-referenced reserve-backed stablecoins emerged in early 2021, but they have an extremely small market presence. Only two exceed €100 million in market capitalisation (Chart 4). By comparison, as of early March 2023, the two largest USD-referenced stablecoins (USDT and USDC) have a combined market capitalisation of USD 116 billion; the respective value is €383 million (around USD 410 million) for the three largest EUR-referenced reserve-backed stablecoins (EURT, EURS and CEUR).

The overall magnitude of reserve-backed stablecoins is small relative to the total size of the MMF sector. In the United States, MMFs currently have total assets of just over USD 5 trillion, while euro area MMFs have assets of roughly €1.4 trillion. In other words, current levels of reserve-backed stablecoins are less than 2.5 and 0.03% the size of their traditional finance counterparts in the United States and EU respectively. Put slightly differently, ranking Tether and USDC alongside

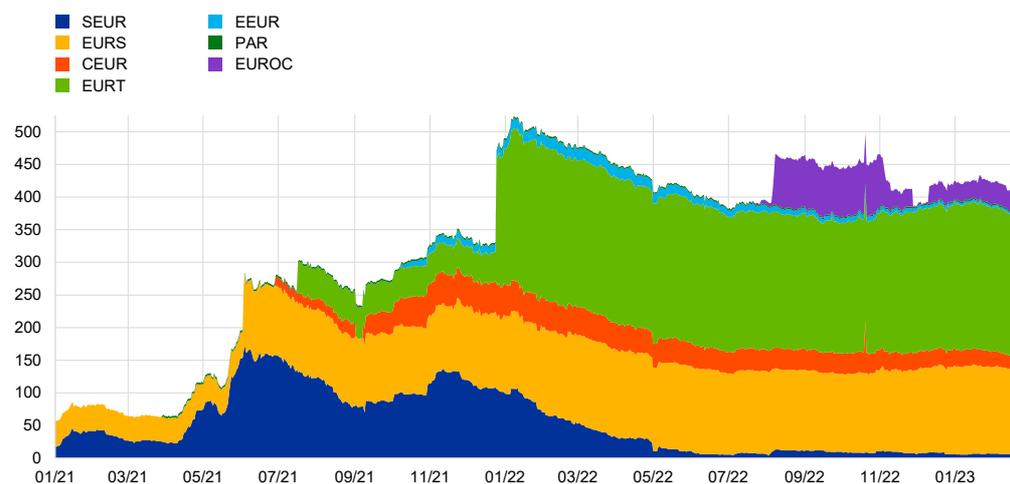


US MMF providers, they would be ranked 18th and 20th. That is, there are 17 US MMF managers with more MMF assets than the market capitalisation of the biggest stablecoin.²⁹

Chart 4

Market capitalisation of euro-referenced reserve-backed stablecoins

(EUR millions, 13 Jan. 2021-10 Mar. 2023)



Source: CoinGecko.

Note: SEUR stands for Synth EUR; EURS stands for Stasis EUR; CEUR stands for Celo EUR; EURT stands for Euro Tether; EEUR stands for E-Money EUR; PAR stands for Parallel; EUROCC stands for Euro Coin.

2.1.2 Price volatility and trading volume

Turning to an additional measure of crypto-asset market dynamics, trading volume, it is again pertinent to note the limitations of data availability and quality. It is standard for potential customers to look at volume to infer the depth of a financial market in deciding where to route trades. The crypto-asset trading platforms know this, which is why they engage in wash trading to improve their ranking. Given the degree to which these markets are subject to manipulation, volume data may also misrepresent the true nature of the market.

The trading volume of reserve-backed stablecoins outpaces that of native tokens. In Chart 5, 24-hour transaction volume data are reported for off-chain trading of native tokens, USD-referenced reserve-backed stablecoins and EUR-referenced reserve-backed stablecoins. Starting with native tokens, bitcoin’s trading volume is clearly the largest, with its current 24-hour volume in the range of USD 22 billion – it was over USD 50 billion in May 2021. Trading in USD-referenced reserve-backed stablecoins (panel b) is even larger, as other coins are typically traded against stablecoins – with a typical daily volume of over USD 20 billion and a peak of over USD 100 billion in late 2021.

²⁹ See the [Office of Financial Research’s U.S. Money Market Fund Monitor](#). Fidelity is the largest MMF manager, with total assets of USD 1 trillion.

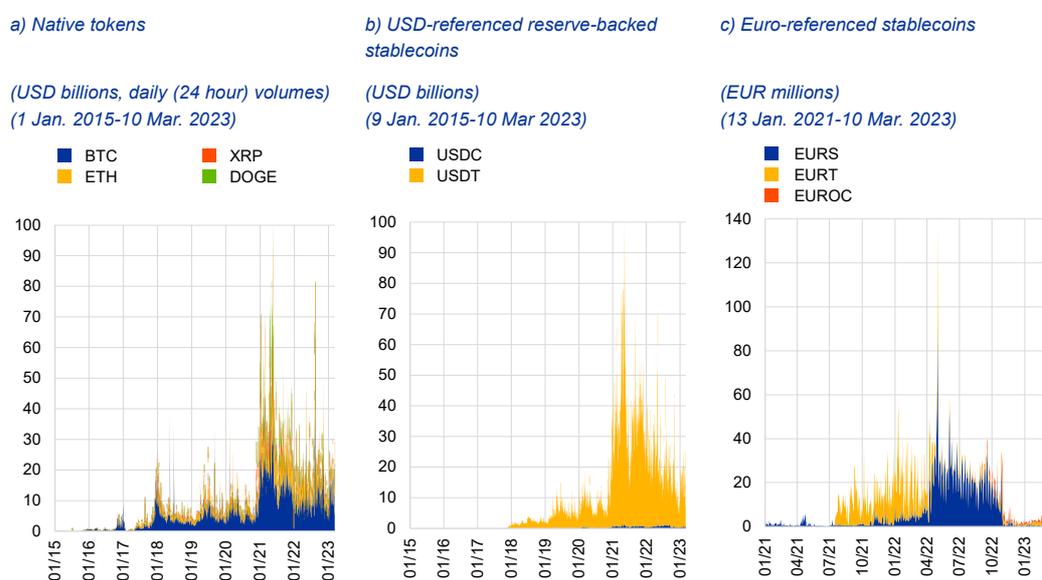


By contrast, EUR-referenced reserve-backed stablecoins, because they are so much smaller, have far less trading – with a peak trading volume of just over €90 million.

Comparing trading volume with market capitalisation, a clearer picture emerges of recorded trading in crypto-assets. The Chicago Board Options Exchange estimates the USD volume of daily US equity trading at over USD 450 billion.³⁰ Typical trading volumes in crypto-assets appear to be less than 10% of those in the US equity market. While that may seem small, it is very large relative to market capitalisation. As a reminder, the crypto-asset system has a market capitalisation of between USD 800 billion and USD 1 trillion. This means that the daily turnover of USD 40 billion represents between 4 and 5% of the market capitalisation. By contrast, US equity markets have a total market capitalisation over USD 40 trillion, so the daily turnover is closer to 1%.

Chart 5

Trading volume for selected crypto-assets



Sources: CryptoCompare, CoinGecko and ESRB calculations.
 Notes: Based on the trading volumes of crypto-assets as in the CCCAGG. Trades from and to selected crypto-assets are considered. Daily observations. BTC stands for bitcoin; ETH stands for ether; XRP stands for Ripple; DOGE stands for Dogecoin; USDC stands for USD Coin; USDT stands for Tether; EURS stands for Stasis EUR; EURT stands for Euro Tether; EUROC stands for Euro Coin.

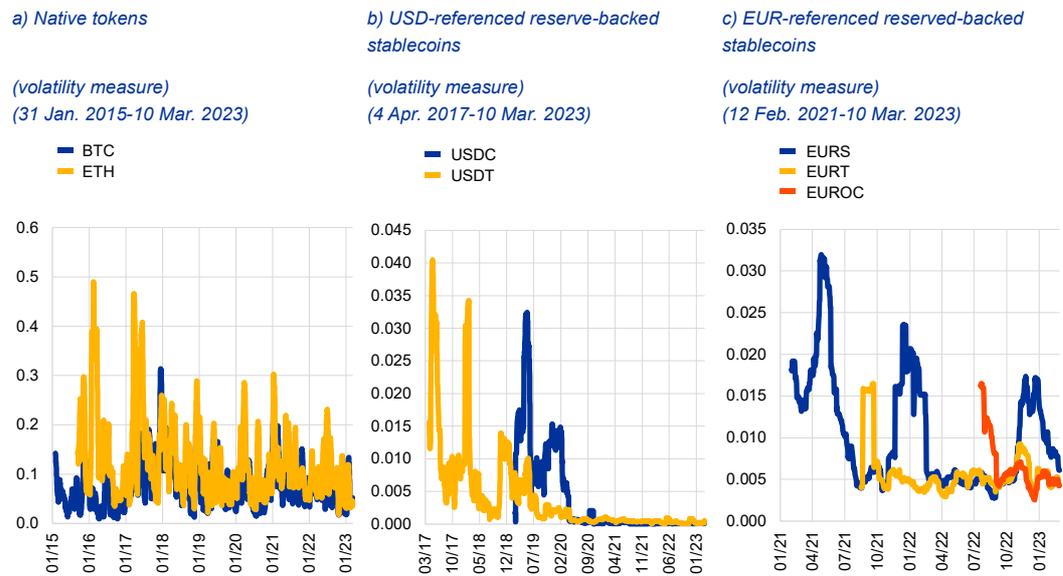
Looking at a measure of volatility, native tokens experience a greater degree of volatility than a European stock index. Panel a) of Chart 6 displays price volatility measured as the 30-day coefficient of variation of the price series. This metric can be thought of as a measure of return volatility, so a number such as 0.40 means that the standard deviation of the return to holding the token is 40% per month. While it may not be apparent in the chart, the volatility of ether is higher than that of bitcoin by about 50%. To give a sense of scale to the numbers, the equivalent measure for the Stoxx Europe 600 index over the same 2015-22 period ranges from 0.005 to 0.15, and for

³⁰ See Chicago Board Options Exchange, “U.S Equities Market Volume Summary”.



gold from 0.005 to 0.05. So the native token prices (shown in panel a) are quite volatile – the median bitcoin 30-day coefficient of variation is four times that of the Stoxx Europe 600 index, while for ether it is six times higher.

Chart 6
Price volatility for crypto-asset instruments



Sources: CryptoCompare, CoinGecko and ESRB calculations.

Notes: Volatility is calculated as 30-day lagging coefficient of variation. Based on the trading volumes of crypto-assets as in the CCCAGG. Trades from and to selected crypto-assets are considered. Daily observations. BTC stands for bitcoin; ETH stands for ether; XRP stands for Ripple; DOGE stands for Dogecoin; USDC stands for USDCoin; USDT stands for Tether; EURS stands for Stasis EUR, EURT stands for Euro Tether; EUROC stands for Euro Coin (EUROC).

The volatility in stablecoins is less than for native coins, as expected. But these numbers should be zero if there were to live up to their claims of stability. Deviation from a price of one comes from a lack of trust in the issuer and information provided on the backing of the token – classic counterparty risk. Looking at panel b), the only USD-referenced reserve-backed stablecoin that has had material volatility since mid-2020 is Tether.³¹ The fact that there is any volatility at all is concerning. Panel c) shows that EUR-referenced reserve-backed stablecoins have experienced a greater degree of volatility in recent years compared with their USD equivalents, albeit the volatility is relatively low and is almost surely a consequence of bid/ask bounce at times of low liquidity.

2.1.3 Decentralised finance

Measuring the size of DeFi is difficult, since there are neither common definitions nor comprehensive measures of activity, but the most common proxy for the size of DeFi is

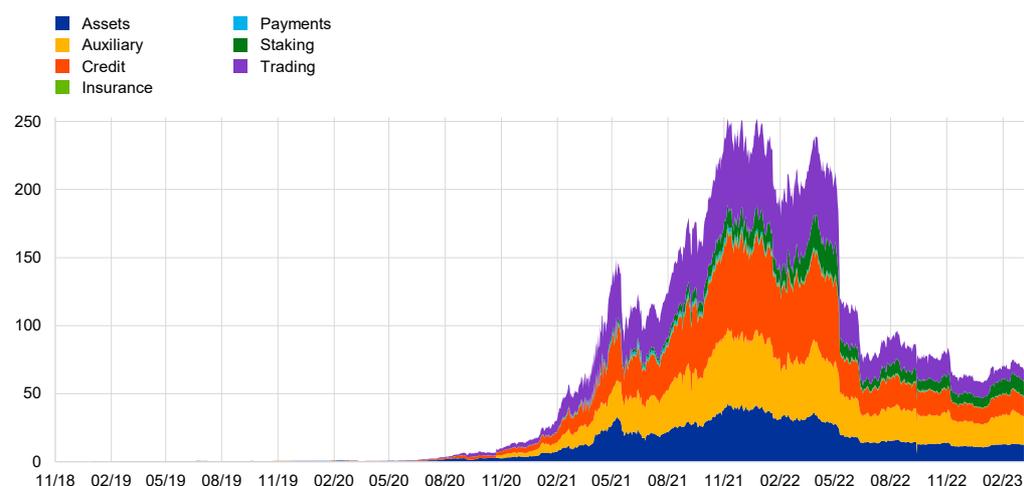
³¹ As previously mentioned, the stablecoin USDC temporarily broke its US dollar peg following the news that managing company Circle held USD 3.3 billion of USDC's reserves with SVB, which was on the brink of collapse at the time.



“total value locked” (TVL).^{32 33} In Chart 7, TVL is plotted by activity. The largest categories of the DeFi ecosystem are protocols providing auxiliary services to help facilitate services across networks. These include platform interfaces, the provision of third-party information on protocols through oracles, and blockchain bridges that enable crypto-asset interoperability from one network to another, such as wrapped bitcoin.³⁴

Chart 7
Total value locked in DeFi protocols by category

(USD billions, 3 Nov. 2018-10 Mar. 2023)



Sources: DefiLlama and ESRB calculations.

Notes: TVL represents the sum of all assets deposited in DeFi protocols earning rewards, interest, new coins and tokens, fixed income, etc. The categories include (i) asset protocols, including derivatives, synthetics, options, indices, algorithmic stablecoins and protocols that mint their own stablecoins or launch new projects and “coins”; (ii) auxiliary protocols that allow users to bet on future results, that bridge tokens from one network to another or allow for the interoperability among different blockchains, and that support DeFi services (including gaming and NFT mining); (iii) credit protocols that allow users to borrow and lend assets and that pay a reward for the liquidity provision or aggregate yield from various protocols, as well as protocols that use reserves of assets to issue and back their native tokens; (iv) insurance protocols that offer coverage against losses caused by events typically in the DeFi ecosystem, such as hacking, malfunctioning of exchanges or smart contracts; (v) payment protocols that allow users to pay/send/receive crypto-assets; (vi) staking protocols that reward staked assets with crypto-assets; and (vii) trading protocols that allow users to swap and trade crypto-assets. TVL might be overestimated due to token re-usage. The “Payments” series scale is too small to be observed on the chart.

Following a peak in late 2021, TVL fell especially for prominent categories such as lending and trading. After rising somewhat in early 2022, TVL dropped markedly during the crypto-market turmoil in spring. The sharp drop in May 2022 is associated with the collapse of TerraUSD. After peaking at USD 250 billion, TVL is now closer to USD 65 billion. Prominent services such as lending and trading protocols had dominant positions in the ecosystem until recently. But for

³² TVL measures the value of crypto-assets or other tokens that have been transferred to the smart contracts underlying a DeFi protocol. Given that these protocols differ in design, TVL is not a standardised measure, and reported values for specific protocols can vary substantially.

³³ Each dollar that goes into DeFi can be looped through several services, which increases the price of the respective tokens. Higher prices increase their value as collateral, which enables more borrowing. This token price and TVL loop builds leverage in the system automatically.

³⁴ Wrapped bitcoin is an Ethereum token that is intended to represent bitcoin on the Ethereum blockchain. It is backed with bitcoin on a 1:1 basis. See Makarov and Schoar (2022).



various reasons, including the failure of a number of centralised crypto-asset intermediaries such as Celsius Network, Voyager Digital Holdings, BlockFi, FTX Trading and Genesis Global Holdco (footnote 7), there have been large outflows since spring 2022.

Turning to the organisation and contestability of the market, there are many entities participating, and protocols are constantly being added, but the market remains highly concentrated. Since networks are central, individual service areas tend to display high concentration. For example, MakerDAO, the largest single DeFi protocol with a TVL of more than USD 6.6 billion, makes up more than half of the asset-related services in the DeFi ecosystem. Similarly, the application Lido represents 82% of TVL in all staking protocols.³⁵ Note that this concentration seems prima facie at odds with DeFi's claims of decentralisation.

Some DeFi protocols appear to be connected to the traditional financial system through their use of reserve-backed stablecoins.³⁶ To the extent that other DeFi protocols follow suit, this could become a channel for transmission of shocks between the crypto-asset world and the traditional financial system and warrants further monitoring.

2.1.4 Conclusions from market developments

To summarise, the following conclusions emerge from the information available:

- Crypto-asset market capitalisation still appears to be very small. Including reserve-backed stablecoins and bitcoins thought to be lost, the amount of global crypto-assets is still only 0.8% of the size of the EU financial sector.
- EUR-referenced reserve-backed stablecoins remain an extremely small market – accounting for less than €1 billion. By comparison, the two largest USD-referenced stablecoins have a market capitalisation of nearly USD 116 billion.
- Price volatility for native tokens can be quite high, especially compared with traditional indexes and commodities.
- The price volatility of reserve-backed stablecoins, which promise redemption at par, is far higher than it should be, namely zero.
- Daily crypto-asset trading turnover is 4-5% of crypto-asset market capitalisation, four times that of the equivalent figure for the US equity market. This high figure may be influenced by wash trades.
- DeFi is currently small and serves the crypto-asset world with no discernible connection to traditional finance.

³⁵ Holders of a crypto-asset can lock up – stake – their holdings in order to participate in the validation mechanism on proof-of-stake validated blockchains. In exchange, users earn a reward from the transaction fees generated by activity on the blockchain. Staking is defined for the purposes of this analysis as the posting of crypto-assets for the purpose of being allowed to participate in the validation of a blockchain and to receive the related validation fees in return.

³⁶ See Financial Stability Board (2023).



While the information above gives a reasonable picture of the current state of crypto-asset markets, again it is important to recall the limitations of the data shown. These include price manipulation schemes, the intentional overstating of trading volumes by crypto-asset trading platforms and the difference between quoted market capitalisation and what is commonly known as free float or fully diluted market capitalisation.

2.2 Identifying the investors in crypto-asset markets

While obtaining reliable price and quantity information may be difficult, getting a sense of the investors in the crypto-asset world is even more challenging. The nature of the distributed ledger means that the owners of tokens may only be identified by a cryptographic signature. Any individual can easily generate more than one identity (address) to split their holdings of any token across multiple addresses. Beyond that, it is simple enough for anyone to mask their location when accessing any website providing services related to crypto-assets. Taken together, this makes the crypto-asset world pseudonymous, albeit law enforcement and anti-money laundering authorities have made significant progress in deploying technology solutions to help trace crypto-assets and make it more difficult to use anonymously “on-ramps” and “off-ramps”, such as crypto-asset trading platforms, wallets and transfers of funds to bank accounts.

Furthermore, many individuals access the crypto world through intermediaries that both run internal markets and act as aggregators and custodians.³⁷ The biggest of these is Binance, which has roughly a 60% market share among crypto-asset exchanges.³⁸ While Binance provides virtually no public information on its operations, reports suggest it may account for as much as three-quarters of crypto-asset trading activity and have as many as 30 million customers.³⁹

So, again, interpreting any available information requires caution.

One information source relates to “on-chain” activity. That is, since blockchain transactions are visible, it is possible to see how many individual addresses there are and how much is being moved from one address to another. These could be individuals, who may have more than one account, or they could be institutions with many customers that are engaged in netting operations.

To start, information gleaned from the public blockchain indicates how many entities have a bitcoin balance. To overcome the fact that some participants may have multiple addresses, the commercial data provider **Glassnode** utilises various heuristic methods to identify unique entities. Current Glassnode on-chain metrics for the bitcoin network suggest that there are over 33 million entities with a non-zero bitcoin balance, with around 250,000 entities active on a daily basis as senders or receivers (Chart 8). The data show that the number of entities has grown consistently since bitcoin’s inception in 2009. By contrast, activity grew through 2017 and then fell, before

³⁷ “Custodian” is used loosely here. These intermediaries do not provide the service that a traditional financial sector custodian provides. Press reports suggest that many crypto-asset-specific institutions do not segregate accounts, and their terms of service do not preclude them from using the assets for lending or otherwise using the assets for their own purposes.

³⁸ See CryptoRank, “**Crypto Exchanges Ranked by Adjusted Volume (Spot)**”.

³⁹ It is interesting to note the March civil enforcement action of the Commodity Futures Trading Commission against Binance, where the people at Binance are alleged not only to be evading US law themselves, but also to be facilitating criminal activity by others (see Commodity Futures Trading Commission, 2023).



starting to grow again in 2020. This pattern is consistent with the increasing centralisation of the system in entities like exchanges.

Chart 8
Entities on the bitcoin blockchain

(all entities in millions, active entities in thousands, 31 Jan. 2009-31 Mar. 2023)



Sources: Glassnode and ESRB calculations.

Notes: Monthly averages. An entity is a cluster of addresses that are controlled by the same network entity. They are estimated through advanced heuristics and Glassnode's proprietary clustering algorithms. Note that entity-based metrics are based on data science techniques and statistical information that changes over time and are therefore mutable – the data are stable, but recent data points are subject to slight fluctuations over time.

There could be as many as 2,000 blockchains in existence. Most of these are likely to be inactive. Some, like Terra, were once large and now barely exist. The bitcoin blockchain is the oldest, biggest (by market capitalisation) and most active (by trading volume). That said, the Ethereum blockchain both allows for far more flexible structures, such as the inclusion of smart contracts, and has shifted to the far less energy-intensive proof-of-stake validation mechanism, so it may be more important for the foundations of the crypto-asset system.

While identifying important participants remains a challenge, there are indicators that enable some of the major players on the bitcoin and Ethereum blockchains to be determined. Focusing on bitcoin, participants can be divided into four categories: crypto-asset exchanges, miners (or validators), lost bitcoin holders and investors (both retail and institutional). The information suggests that crypto-asset exchanges play a dominant role. They hold 12% of the bitcoins in existence and are responsible for the bulk of trading volumes. Miners who provide transaction verification services hold a roughly constant 10% share of circulating bitcoin supply. Furthermore, bitcoins that have not moved in seven or more years and may be lost now amount to around 20% of supply.

The market structure for ether appears to be shifting gradually. The share of ether held by retail investors with small balances has doubled since January 2021. Meanwhile, the share of ether held by exchanges has been decreasing since September 2020.



Finally, Chainalysis (among other providers) produces estimates of crypto-asset value and volume by geographic region.^{40,41} Data are for on-chain transactions and are reported by country and region, albeit not for the EU as a whole. Chainalysis reports information graphically, so it is difficult to be precise. Nevertheless, its primary measure of volume – a concept it labels “cryptocurrency value received” – suggests that EU activity is roughly the same size as that of the United States, receiving in the range of USD 1 trillion over the 12-month period ending June 2022.⁴²

Box 2 European crypto-asset trading platforms

The European market may represent a non-negligible part of the global crypto-asset market. Between July 2021 and June 2022, investors located in Western Europe may have been accountable for around 15% of total trading volumes in crypto-assets at the global level.⁴³

The structure of the European market of crypto-asset trading platforms is generally opaque, as in many other jurisdictions. There is no official information on the number of these trading platforms operating in Europe nor on the scale of their EU operations, although many European countries that have registration requirements provide public lists of registered entities.

According to private data providers, there are 48 trading platforms supposedly incorporated in Europe, almost half of which are in Estonia or Malta (Chart A).⁴⁴ But while these trading platforms appear to be located and operate in Europe, the opacity of their governance structures makes it often difficult to determine with certainty whether they are truly European companies.

⁴⁰ See Chainalysis (2022).

⁴¹ Its note on methodology (page 4): “[W]e estimate countries’ cryptocurrency transaction volumes for different services and protocols based on the web traffic patterns of those services and protocols websites, with web traffic data provided by **Similarweb**. Relying on web traffic data means that usage of VPNs and other products that mask online activity could throw off our rankings, but given that the index takes into account hundreds of millions of transactions, VPN usage would need to be extremely widespread to meaningfully skew the data. Experts we interviewed for the report generally agreed that our index matches their perceptions of the markets they operate in, giving us more confidence in the methodology.”

⁴² Interpolating the information in the figures on pages 29 and 37 of the **Chainalysis report** yields an estimate of almost exactly USD 1 trillion for the EU. It should be noted that, since Chainalysis uses on-chain information, these data are less likely to be subject to the inflation arising from wash trading that plagues the reported volume of transactions on exchanges.

⁴³ See Chainalysis (2022).

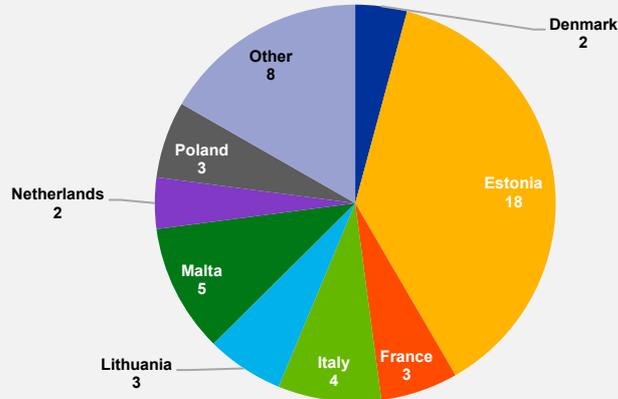
⁴⁴ Binance is often mistakenly reported as incorporated in Europe, even though it is registered for crypto-asset services in Cyprus, France, Italy, Lithuania, Poland, Spain and Sweden. On 21 February 2020 the Malta Financial Services Authority (MFSA) issued a **statement** that Binance is not authorised by the MFSA to operation in the crypto-asset sphere and is therefore not subject to regulatory oversight by the MFSA.



Chart A

Number of crypto-asset trading platforms reported as incorporated in Europe

(March 2022)



Source: CryptoCompare.

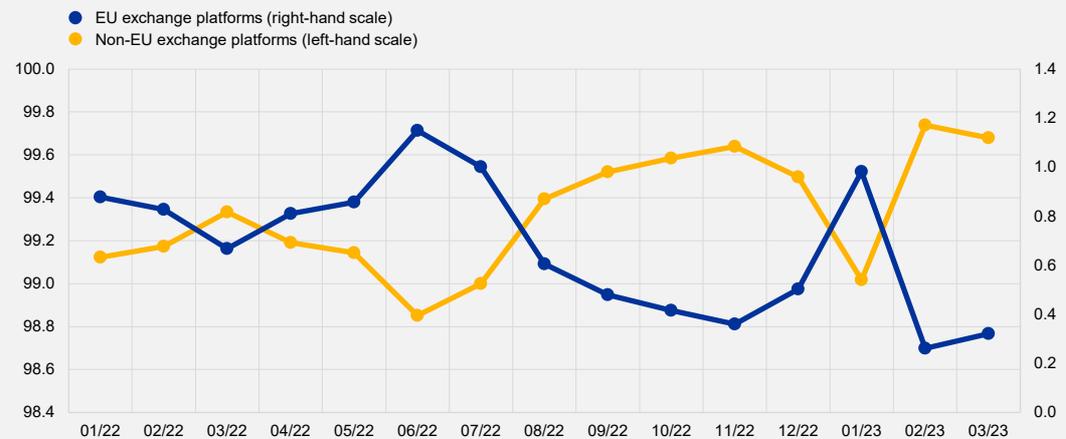
Notes: The category "Other" covers Austria, Cyprus, Germany, Ireland, Luxembourg, Slovenia and Sweden, with one exchange each. There is also an "EU exchange", which covers decentralised exchange 1inch Network. This is broadly tied to the EU according to CryptoCompare.

Market data suggest that the European market may be dominated by trading platforms that are not located in the EU. To get some sense of the footprint of these trading platforms in Europe, one possible indicator is the volume of euro trading on various trading platforms, assuming that all EUR-referenced transactions are attributable to EU residents. The available evidence suggests that in 2022 more than 99% of the value of transactions between crypto-assets and the euro were done on non-European exchanges (Chart B).

Chart B

Share of EUR-referenced transactions reported by trading platforms located in the EU

(1 Jan. 2022-1 Mar. 2023)



Source: CryptoCompare.



Volume data suggest that market trading may be highly concentrated. The top three EU-incorporated trading platforms account for over 85% of daily reported volumes. Other crypto-asset trading platforms supposedly incorporated in Europe show significantly lower average trading volumes, and several of these trading platforms record no trading volumes at all, even if they seem to be in operation. This may be because they are subsidiaries of larger entities that are recording the transactions elsewhere. Many platforms, including larger ones (based on available data), were inactive in certain months of 2022 (reporting no trading data) or reported likely inflated volumes.

European crypto-asset trading platforms engage in numerous activities beyond simply matching buyers and sellers. These include custody, deposit-taking (including staking), margin lending and derivatives contracts. Possibly more troubling is that most issue tradable utility tokens that provide discounts on fees. As with FTT issued by FTX, this provides the opportunity for misbehaviour. Not only could the issuer be tempted to manipulate the price, it could also try to use the tokens as collateral for loans.

2.3 Linkages between crypto-assets and traditional finance

There is limited information available to assess the exposures of the traditional financial sector to crypto-assets. Besides notable exceptions such as the ad hoc analysis carried out by the Basel Committee on Banking Supervision (BCBS), including via the quantitative impact study to which the European Banking Authority (EBA) contributed,⁴⁵ and the survey of European banks as part of European banking supervision, very little information is available.

That said, there currently appears to be little or no risk to the traditional financial system for at least four reasons.

First, as noted in the prior sections, the quantities remain quite small. Even the most generous estimate of value places the entire crypto-asset world at roughly 0.8% the size of the EU financial sector.

Second, the booms and busts in the crypto-asset market have had virtually no impact on traditional finance.⁴⁶ Over the two years beginning January 2021, crypto-asset market capitalisation rose from USD 775 billion to USD 2.8 trillion, then returned again nearly to its January 2021 level. Meanwhile, the global equity market index rose from 2,690 to 3,248 and is currently at 2,785.⁴⁷ While the general pattern is the same, the fluctuation is roughly one-tenth the size. More importantly, as shown in panel a) of Chart 9, while price volatility in the crypto-asset market appears common across instruments (bitcoin and ether show similar patterns), it tends to be substantially higher than that of real assets (oil and gold) or European equities.

⁴⁵ For results, see the [Basel III Monitoring report](#) and the [crypto dashboard](#).

⁴⁶ Conversely, Federal Reserve Bank of New York research finds that [US macroeconomic news and monetary policy surprises appear to have little effect on bitcoin prices](#).

⁴⁷ Source used for MSCI data: "[MSCI World Historical Data](#)".

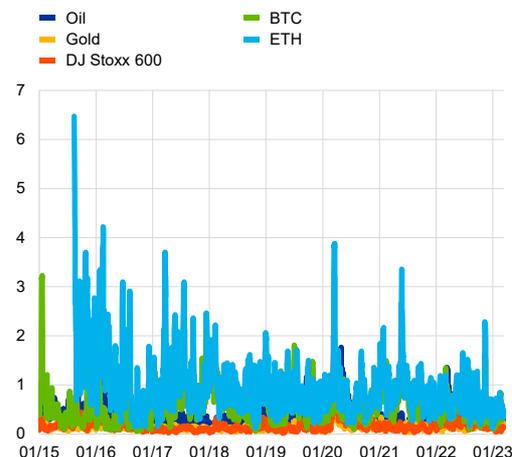


Chart 9

Bitcoin and ether volatilities compared with traditional financial sector volatilities

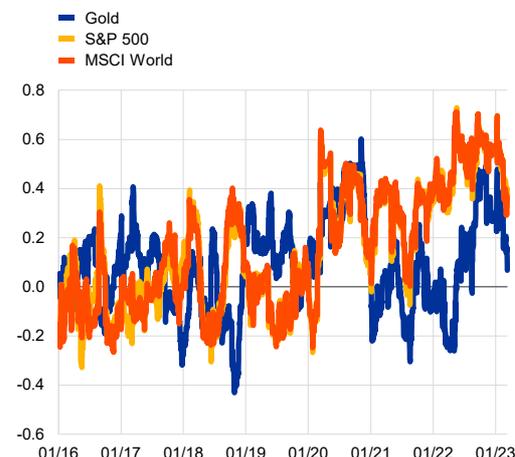
a) Volatility of daily prices of selected crypto-assets and other financial assets

(volatility measure)



b) Correlations of changes in the prices of bitcoin and other assets

(volatility measure)



Sources: CryptoCompare. Bloomberg Finance L.P. Refinitiv and ESRB calculations.

Notes: Bitcoin price as in the CCAGG. 60-day rolling return correlations. Volatility as the annualised seven-day rolling standard deviation of daily percentage changes of prices. Crypto-asset prices as of 26 January 2023.

Third, crypto-assets do not appear to be a useful hedge in a portfolio of equities, bonds and gold. Looking at panel b) of Chart 9, the 60-day rolling correlation between returns on holding bitcoin and equities (either S&P 500 or MSCI World) and gold fluctuates from around -0.2 to +0.6. In other words, this is not much like gold and only on occasion a hedge against equity market movements. This suggests that adding bitcoin to a portfolio of global equities, global bonds and gold is unlikely to improve mean-variance efficiency.

Finally, insofar as the limited data available permit an assessment, traditional financial intermediaries have de minimis exposures, if any, to crypto-assets. For example, a recent survey by the European Central Bank (ECB) revealed that banks currently have very limited activities related to crypto-assets, and while there is some exploratory work taking place, future adoption rates over the next three years are likely to be low compared with other technologies.⁴⁸ This finding is also backed up by EBA data gathered via the results of the Risk Assessment Questionnaire submitted to a large number of EU banks twice a year.⁴⁹

More specifically, the reported direct exposure of EU banks to crypto-assets is miniscule. Only two of 105 banks reported banking book exposure, and only one reported trading book

⁴⁸ The information was collected in the context of an ECB survey on digital transformation and fintech covering in principle all significant institutions directly supervised by the ECB in summer 2022. The aggregated results are expected to be published during the course of 2023.

⁴⁹ See European Banking Authority (2022a).



exposure towards crypto-assets. In all three cases, the quantities were extremely small – the total for all three being less than €100,000.

Regarding further direct or indirect exposure to crypto-assets, the picture is similar.⁵⁰ One bank reported exposure to crypto-asset-linked derivatives, with a notional value of €100 million. Two banks reported holding crypto-assets totalling €5 million in assets under management, and three banks reported holding a total of €212 million under custody.⁵¹

The story is not so different for investment funds in the EU. Based on information⁵² collected by the European Securities and Markets Authority (ESMA) from national competent authorities (NCAs), the exposure of EU investment funds to crypto-assets is limited. NCAs reported a total of 111 funds with crypto-asset exposure, all being AIFs (April 2022 survey). There are no comprehensive data on these funds (e.g. NCAs were not always in a position to report the net asset value (NAV) for these funds, partly because some had been launched only recently; the exposure of these funds to crypto-assets was not necessarily known and would vary over time). The majority of these funds were small in size (NAV below €100 million); there was one notable exception, but the fund in question had an exposure to crypto-assets below 10%. By way of comparison, there are a total of around 60,000 EU-domiciled investment funds (UCITS and AIFs) representing an aggregate NAV of around €18 trillion.

In the same way that intermediaries rarely know the counterparties of their counterparties, it is impossible to know whether borrowers are using the proceeds of loans for the purchase of crypto-asset instruments. A leveraged investor could have crypto-assets as part of their investment portfolio. This could create a transmission channel for shocks between the two spheres. For example, as crypto-assets fall in value relative to equity and bonds, standard portfolio rebalancing would dictate selling traditional assets and purchasing crypto-assets to keep the portfolio share allocated to crypto-assets constant. While this would dampen the decline in crypto-assets, it would create downward pressure on equity and bond prices. Given the apparent lack of integration of crypto-assets into the portfolios of individual and institutional investors in the traditional system, this mechanism seems to be extremely muted (at least so far).

Nevertheless, there are two clear connections between crypto-assets and traditional finance: (i) reserve-backed stablecoins themselves, and (ii) the use of traditional intermediaries by crypto-asset players.

2.3.1 Connections via reserve-backed stablecoins

Issuers purchase traditional sector debt and have accounts at conventional banks. A run on a reserve-backed stablecoin would generate forced selling of marketable debt and withdrawals from

⁵⁰ The situation in the United States also appears similar, with the Federal Reserve denying Custodia Bank's application to become a part of the Federal Reserve System. The order denying the application provides a lengthy discussion of the difficulties associated with any crypto-asset-related activities, which may serve as a warning to US financial institutions that want to get involved in this type of business (see Federal Reserve System, 2023).

⁵¹ The ECB survey also notes that a number of banks are using distributed ledger technology. While it is not fully certain, it may be the case that these are proprietary, permissioned systems, not open, permissionless ones. As such, they bear little resemblance to the blockchains that form the foundations of the crypto-asset world.

⁵² See Guagliano and Kern (2022).



banks. There is always the possibility that this could turn into a broader panic. At this stage, however, the value of all stablecoins remains under USD 140 billion.⁵³ To put this in perspective, 35 banks supervised by the ECB have larger consolidated assets, around 70 global corporations have a larger market capitalisation, and this is roughly equal to the global annual revenue of Mercedes Benz and General Motors.

2.3.2 Connections via traditional intermediaries

Crypto-asset players, whether issuers or service providers, typically require traditional intermediaries to provide accounts that facilitate the transfer of resources between conventional fiat currencies and crypto-asset tokens. While these institutions can be chartered banks, they do not need to be.⁵⁴ Such intermediaries could face runs, regardless of their legal form. Without access to central bank lending facilities, they might fail.⁵⁵

Overall, at this stage, this report concludes that the connections between the crypto-asset and traditional financial worlds remain extremely modest. The crypto-asset sector is not yet systemic for the financial system.

2.4 How might crypto-assets become systemic?

Regarding the systemic importance of crypto-asset markets, the report identifies a clear need to monitor and evaluate market developments further (see the policy options set out in Section 3). Could market disruptions— sudden declines in valuation, further bankruptcies of intermediaries or the like – spill over and impede the ability of the traditional financial system to provide fundamental services such as payments, credit intermediation and capital market access? The answer is almost certainly not for the immediate future. In that sense, crypto-assets do not currently pose a systemic risk. How might that change? Here are three possibilities:

1. the interconnectedness with the traditional financial system may increase over time;
2. some of the connections to the traditional financial system may not be easily identified before they cause problems;
3. similar technologies may be adopted in traditional finance⁵⁶.

Annex A.1 lays out three highly speculative scenarios under which stress could begin in the crypto-asset world and then be transmitted to the traditional financial system. These are:

⁵³ See CoinGecko, "**Stablecoins by Market Capitalisation**".

⁵⁴ A list of institutions that provide such services includes Revolut, Monzo and Coinbase, some of which are banks.

⁵⁵ Silvergate Bank is a chartered bank in California with access to the Federal Reserve, so it does not meet this criterion. It failed, nevertheless.

⁵⁶ The by now widely known risks notwithstanding, distributed ledger technology and crypto-assets can also be seen as innovations that might shape the future of financial markets. Numerous governments have decided to support DLT-related industries and compete for their business. Working towards shared minimum standards in regulating and supervising crypto-asset markets seems even more relevant against that background, so as to avoid regulatory arbitrage at the global level.



- (a) a run on a large reserve-backed stablecoin;
- (b) the collapse of large crypto-asset segments after being integrated into the traditional financial system;
- (c) the rise in prominence of crypto-assets in the payment system.

For any of these scenarios to become systemic, there would have to be sufficient size, ample interconnection with the traditional system and the supply of a service for which there are no ready substitutes.

As always, leverage is important. There are three types of leverage related to crypto-assets. First, there is leverage inside the crypto-asset system, where investors borrow using crypto-assets to gain additional exposure to crypto-assets. It is difficult to see how this self-referential leverage could pose risks to the traditional system. Second, there is leverage gained through exposure to crypto-asset-referenced futures, such as those traded on the Chicago Mercantile Exchange (CME).⁵⁷ While it is true that these offer potentially significant leverage, margin requirements are far larger than what is required for S&P 500 futures.⁵⁸ In other words, leverage in conventional futures markets is far higher. Finally, there is the possibility that crypto-asset investors are obtaining leverage by borrowing fiat currency from traditional intermediaries. Such borrowing would normally be collateralised by conventional financial assets. If that is so, the lender would be protected in the event of borrower default. So, in the end, leverage in the crypto-asset world is only a problem if there are connections with the traditional financial system – something that needs to be monitored.

2.4.1 Conclusions on the potential for systemic relevance

Crypto-assets could become systemically relevant in several ways. First, if a stablecoin were to grow significantly, say by a factor of 10 or 20 so that it is the size of one of the largest MMF providers – BlackRock’s MMFs total USD 450 billion – then, in the absence of central bank backing, a run on such a stablecoin could result in asset fire sales that damage the entire system.⁵⁹ Second, should crypto-assets become integrated into the traditional financial system, with traditional intermediaries having direct or indirect exposure, booms and busts would lead to systemic disruptions. Importantly, this would happen only in the absence of the sorts of regulatory safeguards that are currently in place for exposure to more conventional risks. Third, the emergence of a token with stable value could result in a medium of exchange that is commonly used in the payment system. While it may not improve on current government-backed money, if it were to gain widespread use, such a token would share the well-known fragilities of the current system. Over the centuries, lessons have been learned about how to make systemically important payment systems safe⁶⁰. More specifically, in the EU, regulatory requirements under MiCA and

⁵⁷ See CME Group, “[Bitcoin, Futures and Options](#)”.

⁵⁸ The CME bitcoin futures contract requires a maintenance margin of USD 30,500 for a contract of five bitcoins, which is currently around USD 100,000. By contrast, the S&P 500 futures contract has a maintenance margin requirement of USD 10,600 for a contract that is 50 times the S&P 500 index, at a value of USD 200,000. In other words, the bitcoin contract requires nearly three times the margin for half the notional value.

⁵⁹ The fact that central banks have now on several occasions stepped in to provide backstops to MMFs makes it unlikely that they would allow this to happen. See the discussion in Buiters, Cecchetti, Dominguez and Sánchez Serrano (2023).

⁶⁰ See Committee on Payment and Settlement Systems (2001).



oversight arrangements under the Eurosystem oversight framework for electronic payment instruments, schemes and arrangements should extend to this “new” world.



3 Policy options

This section of the report sets out considerations to mitigate potential financial stability and macroprudential risks from crypto-assets and DeFi. It takes account of developments in the context of the negotiation of MiCA, which is widely regarded to be a decisive step toward the regulation of crypto-asset issuance and service provision in the EU.⁶¹ MiCA focuses primarily on consumer and investor protection in crypto-asset service provision and crypto-asset issuances. It also includes prudential safeguards, in particular for issuers of ARTs and EMTs, with a view to mitigating financial stability and monetary policy issues.

This report identifies three policy priorities (each with several sub-parts). The first of these, the need to enhance monitoring capabilities, including by additional reporting, is the most urgent, in particular to improve capacities to monitor potential interconnectedness between the traditional finance and crypto-asset sectors, and within the crypto-asset sector. The priorities take account of crypto-asset market developments, conclusions as to the current systemic (non-) relevance of the sector and emerging regulatory initiatives globally, from a financial stability and macroprudential policy perspective. They should help further strengthen and “future-proof” capabilities to assess potential risks to financial stability and ensure authorities have the capacity to act in a timely manner to address them. They should also inform any additional regulatory initiatives in the future.

Priorities, ranked by urgency and importance:

1. Improve the EU’s capacity to monitor potential contagion channels between the crypto-asset sector and the traditional financial sector, and within the crypto-asset sector.
2. Carry out assessments of risks posed by (a) crypto-conglomerates, taking account of market developments following the application of MiCA; and (b) leverage using crypto-assets, and identify potential additional actions to mitigate observed risks.
3. Promote EU-level knowledge exchange and monitoring of market developments, focusing on the following areas where risks may emerge, notably relating to (a) operational resilience, (b) DeFi, and (c) crypto-asset staking and lending.

Important in themselves, such assessments would also contribute to the European Commission’s future review of the application of MiCA. Furthermore, the ESRB will encourage and monitor the implementation of the policy options with a view to considering whether possible action is required in the future.

⁶¹ The application dates for different titles of MiCA vary, with the asset-referenced and e-money token provisions applying from 12 months from entry into force and the crypto-asset service provider provisions from 18 months from entry into force.



3.1 Methodological approach

Underlying the findings and proposals set out in this section, in addition to the observations made in Section 2, is a comprehensive review of:

- recent crypto-asset market developments, including the collapse of Terra, Luna and FTX, and the impact of the collapse of Silicon Valley Bank, Silvergate and Signature;
- the revised text of the proposal for MiCA, on which a provisional agreement of the European Parliament and Council was reached in June 2022,⁶² and as endorsed by the Council and the European Parliament's Economic and Monetary Affairs Committee (ECON) in October 2022⁶³ (Annex A.2 summarises the main provisions);
- regulatory initiatives in key third countries (Canada, China, Hong Kong, India, Liechtenstein, Japan, Singapore, South Korea, Switzerland, UAE [Dubai], the United Kingdom and the United States);
- regulatory initiatives at the international level, including the BCBS standard on the prudential treatment of banks' exposures to crypto-assets (December 2022)⁶⁴; the FSB's consultative documents on proposed revised recommendations for the regulation, supervision and oversight of global stablecoin arrangements (October 2022)⁶⁵, and the proposals for the international regulation of crypto-asset activities (October 2022)⁶⁶; and analytical activities planned in 2023 and the CPMI-IOSCO report on the application of the Principles for Financial Market Infrastructures to stablecoin arrangements (CPMI-IOSCO 2022).⁶⁷

There are no particular features in the main third-country jurisdictions from which the EU could take inspiration from a financial stability or macroprudential policy perspective. The EU's framework under MiCA fully reflects the FSB's (October 2020) initial **recommendations** for the regulation, supervision and oversight of global stablecoin arrangements, and also the proposed **revised recommendations** and other proposals as published by the FSB in October 2022 (for global stablecoin arrangements and crypto-asset activities and markets). MiCA also encompasses a wide range of crypto-asset services, mandating authorisation, governance, conduct of business and prudential requirements for service providers.

3.2 Priority 1: Strengthen monitoring capacity

Reporting and monitoring capacity must be strengthened. As noted previously by the ESRB and the FSB,⁶⁸ the identification and quantification of risks to financial stability from the crypto-asset

⁶² See Council of the European Union (2022a).

⁶³ See Council of the European Union (2022b).

⁶⁴ See Basel Committee on Banking Supervision (2022).

⁶⁵ See Financial Stability Board (2022d).

⁶⁶ See Financial Stability Board (2022c).

⁶⁷ See Committee on Payment and Market Infrastructures and Board of the International Organization of Securities Commissions (2022).

⁶⁸ See Financial Stability Board (2022a) and Financial Stability Board (2022d).



sector is possible only with transparent, consistent, timely and trusted data on crypto-asset markets and their linkages with the financial sector (and, increasingly, within the crypto-asset sector). As set out in the previous section of this report, data are currently sparse, partly because financial institution reporting does not require the specific reporting of crypto-asset exposures and, pending the application of MiCA, crypto-asset markets and entities largely fall outside of regulatory and supervisory perimeters and associated reporting requirements.

Standardised reporting is needed. Monitoring crypto-asset developments, interconnectedness and risks to financial stability requires standardised reporting and disclosure requirements for (i) traditional financial sector institutions (e.g. credit institutions) with exposures to crypto-assets; (ii) fund exposures, and (iii) entities within the crypto-asset sector. Immediate actions should address key current deficiencies in EU monitoring capabilities that MiCA will not address in full. Increased transparency would also facilitate better risk pricing by market participants, a key driver of financial stability.

1.1: Introduce reporting requirements for financial institutions with exposures to crypto-assets

No regular reporting is currently available.⁶⁹ MiCA will not establish requirements for financial institutions to report exposures to crypto-assets (whether covered by MiCA or not), and sectoral measures do not impose specific reporting obligations for such exposures. That leaves only ad hoc data collections (e.g. the previously mentioned data collection carried out during the development of the BCBS standards, and EBA data collections in the context of regular Risk Assessment Questionnaires). For non-bank financial institutions, data are extremely scarce, besides the recent ESMA survey (Section 2.3) and some indirect sources of information, which suggest small exposures so far. For example, data from SHSS or Lipper give an indication of funds' holdings of crypto-asset-related securities (exchange-traded funds, exchange-traded products, crypto-funds, etc.) but not of direct crypto-asset holdings.

Monitoring is necessary across financial sectors. Implementation in the EU of the BCBS standard on banks' exposures to crypto-assets would establish reporting requirements.⁷⁰ Nevertheless, this report emphasises the need to ensure consistent and regular reporting not only by credit institutions but also, importantly, other parts of the traditional financial sector (see further reflections on funds' crypto-asset exposures in 1.2 below).

The EBA, ESMA and NCAs should work together to develop reporting templates and, where appropriate, identify areas in which EU financial services may require amendment.

⁶⁹ See Annex A.3 for an assessment by the ESRB's Exploratory Group on Accounting Developments and Financial Stability of the accounting valuation of crypto-assets.

⁷⁰ See Basel Committee on Banking Supervision (2022).



1.2: Monitor interconnectedness between the fund sector and the crypto-asset sector

EU investment funds are investing in crypto-assets, albeit currently at a slow pace.

Institutional investors including hedge funds, venture capital funds and asset managers have recently increased investments in crypto-assets, raising the risk of spillovers to the traditional financial sector. This has been further aided by the increasing availability of crypto-asset-based derivatives and securities next to direct exposures.⁷¹ As noted above, however, a recent ESMA survey found that only around 111 Europe-based investment funds have direct exposure to crypto-assets, showing that the exposure of EU investment funds to crypto-assets is currently limited.

Funds are vulnerable to shocks along several dimensions (see, for example, FSB, 2017),⁷² such as liquidity mismatch between fund investments and redemption terms and conditions for open-ended funds, and leverage. Funds' asset sales can also negatively affect market prices of these assets, notably during a fire sale.

Funds tend to be highly interconnected – with each other (through cross-holdings), but also with other financial intermediaries and non-financial entities (in particular households). From a financial stability perspective, funds' intra-sectoral connectedness is important since it enhances the propagation of shocks through the fund sector. Funds' inter-sectoral connectedness then has additional effects on fund investors, most importantly the wider financial system.⁷³

Current EU regulation does not stipulate explicit rules regarding funds' investment in crypto-assets. European legislation does not impose any restrictions on AIFs wishing to invest directly or indirectly in crypto-assets. For undertakings for collective investments in transferable securities (UCITS), however, crypto-assets are in principle not directly investable (they are not eligible investments according to Article 50 of the Eligible Investments Directive). By contrast, building exposure to crypto-assets through indirect investments such as exchange-traded notes is not explicitly prohibited. At Member State level, divergent regulatory regimes exist. For example, unlike in Germany and Spain, UCITS in Luxembourg are explicitly not permitted to invest indirectly in crypto-assets.

A consolidated picture of the EU fund sector's exposure to crypto-assets would be beneficial for financial stability purposes. Building on information about funds' exposures to crypto-assets, a stock-take should be carried out of Member States' approaches to the regulation of funds' direct and indirect holdings of crypto-assets based on existing and any additional data, acquired from supplemental reporting (Sections 1.1 and 1.3). An analysis based on that stock-take could then assess potential vulnerabilities from crypto-asset exposures for different types of funds (for open-ended funds, for instance, liquidity mismatch and run risk would be more important than for closed-ended funds). The analysis could inform an assessment of whether a (partial) harmonisation of rules could serve to limit potential vulnerabilities and regulatory arbitrage and what

⁷¹ See Auer et al. (2022).

⁷² See Financial Stability Board (2017).

⁷³ Fricke and Wilke (2020) show that German investment funds are predominantly held by financial intermediaries outside the fund sectors and that these actors would bear the vast majority of fund sector losses.



rules in particular should be harmonised. There may be a need to introduce (direct and indirect) exposure limits (for certain types of funds, e.g. open-ended funds).

1.3: Enhance reporting requirements within the crypto-asset sector

MiCA will impose reporting requirements on certain entities carrying out crypto-asset activities within the scope of this regulation. For example, issuers of ARTs (with a higher value issued than €100 million) must report to the competent authority information on their customer base, the value of the ART issued and the size of their reserve assets, the average number and value of transactions per day, and an estimate of the average number and value of transactions per day associated with uses as means of exchange within a single currency area. Issuers of ARTs must also disclose information to the public on their website (the amount of ARTs in circulation, the value and composition of their reserve assets and an audit report). The reporting provisions also apply to EMTs denominated in a currency which is not an official currency of an EU Member State. Reporting requirements for both ARTs and EMTs, especially in terms of size and composition of reserve assets, are essential to understand interconnectedness with the traditional financial system, based on custody arrangements and common asset holdings.

There will also be requirements for crypto-asset service providers (CASPs) operating a trading platform. They must provide public information on trading (any bid and ask prices, the depth of trading interests at those prices, and the price, volume and time of the transactions executed in respect of crypto-assets traded on their trading platforms) and give the competent authority access to data so they can monitor trading. Enhanced monitoring arrangements will apply to “significant CASPs” (those with at least 15 million active users). For these CASPs, NCAs will need to keep ESMA up to date about key supervisory developments (regarding ongoing or concluded authorisation processes, withdrawals of authorisation and ongoing or implemented supervisory measures).

Beyond the obligations on issuers and CASPs operating trading platforms, however, MiCA sets out no further standardised reporting requirements. For example, wallet providers, including exchanges/trading platforms that provide e-wallet services, are not required under MiCA to report any data pursuant to a standard template.

Harmonised additional reporting requirements, related to systemic risk monitoring, for crypto-asset entities covered by MiCA would be beneficial. NCAs and the EBA, in carrying out their supervisory tasks, may require entities within their sphere of supervision to report data. But limited harmonisation could result in authorities potentially requiring issuers and CASPs to report different types of data, or at different frequencies, outside a standardised EU-wide framework that could facilitate pan-European system-wide monitoring. It is therefore very important that the EBA and ESMA work together with their respective national authorities to develop, at their own initiative, standard templates that NCAs could require issuers and CASPs to use for the reporting of data. This would benefit both the industry (CASPs would not need to develop individual reporting systems calibrated to reporting obligations in individual Member States) and supervisors (by allowing the comparison of common data points).



1.4: Introduce reporting requirements to map exposures between crypto-asset trading platforms and other relevant entities

Recent market developments have illuminated the potential for contagion across trading platforms, via both direct and indirect transmission channels.

Direct channels of contagion would be those where the trading platforms have direct exposures through holding each other's tokens, through investments at an early stage or through extending loans to each other. For example, Binance had significant holdings of FTX's token FTT (equivalent to around USD 500 million at prevailing market prices in November 2022), which it had received as part of an earlier exit from equity in FTX. Crypto-asset trading platform Kraken also held FTT, albeit a rather negligible amount in USD terms. FTX also had a number of investments in other crypto-asset firms, some of them lending platforms. During the turmoil in May 2022, when some crypto-asset firms ran into difficulties, FTX and its affiliate Alameda Research extended loans to bail some of them out (although mainly to centralised lenders, not to trading platforms). If such loans are collateralised by the tokens of the trading platform getting into trouble, there could be direct contagion. If the tokens of other trading platforms are part of the liquidity holdings of trading platforms (if, indeed, possible under custody agreements), this could also lead to contagion.

Indirect transmission would occur through sentiment. If there is a loss of confidence among users, they could leave the centralised trading platforms more generally or not use them anymore. This could hit especially those platforms with similar business models. Under the best-case scenario, this would just lead to less revenue for those trading platforms. But withdrawals could become so large as to threaten the viability of the trading platform, even though not directly related to the safety of that trading platform.

MiCA will create a framework for the regulation of EU-based trading platforms, but there is scope for further measures to mitigate systemic risks. MiCA would have prevented or mitigated the impact of FTX's failure, had that trading platform been established in the EU and had MiCA been applied (e.g. to ensure effective governance, mitigate conflicts of interest, prohibit dealing on own account, require the segregation of client funds, etc.). Nevertheless, additional regulatory measures could mitigate potential risks to financial stability.

Specifically, authorities should consider the need for reporting requirements to inform any future assessment as to whether there should be concrete limits on the exposure of trading platforms to each other. Reporting requirements for exposures between CASPs and issuers (including close affiliates) would be useful to understand better the interconnectedness between entities and, as appropriate, inform assessments of any need to take measures to reduce interconnectedness. As explained above, however, comprehensive reporting on linkages between platforms are not expressly set out in MiCA. Requirements mainly cover trading, but not exposures between platforms. That impedes authorities' ability to map risks and assess the need (if any) for mitigants such as specific limits on how much direct exposure trading platforms or close affiliates



can have to other trading platforms, especially between very large trading platforms.⁷⁴ Specific reporting requirements on cross-platform exposures should be considered.

3.3 Priority 2: Identify and assess risks from crypto-asset conglomerates and leverage using crypto-assets, and suggest policy options to mitigate identified risks

Some potential risk transmission channels require further analysis. Taking into account the new regulatory requirements that will apply to issuers and CASPs under MiCA and the expected future implementation within the EU of the BCBS standard on banks' exposures to crypto-assets, a range of risks traditionally observed in the non-bank financial intermediation sector (liquidity, leverage, interconnectedness, etc) were reviewed. Two "core" potential risk transmission channels within the crypto-asset sector require closer analysis: (i) entities/groups conducting combinations of significant crypto-activities, and (ii) leverage using crypto-assets.

By construction, issuers of ARTs and EMTs typically hold reserves, creating an inherent interconnectedness with the traditional financial sector that will need to be monitored as experience is acquired from the application of MiCA. Indeed, the reserves required by MiCA for issuers of ARTs and EMTs will create interconnectedness with the traditional financial sector and among these assets, as well as the markets in which assets forming the reserves (required to be held by ART and EMT issuers) are traded ("interconnectedness by design"). The reserve requirements seek to address risks to token holders and make the ARTs and EMTs sounder.⁷⁵ But these rules may come at potential cost in terms of increasing links with the markets – and counterparties active in these markets – for the assets in the reserves. They may also strengthen links between issuers and financial institutions charged with holding reserve assets in custody (credit institutions and investment firms). These risks could be more pronounced for larger reserves. This is another illustration of the inherent trade-off between, on the one hand, addressing redemption and liquidity risks by means of reserves and, on the other hand, such reserve requirements contributing to increased interconnectedness. This is not unique to ARTs and EMTs. Similar questions arise concerning the use of financial instruments as risk-hedging collateral more broadly (cf. risk-propagating nature of margin calls). This form of interconnectedness risk should be monitored and considered in the context of any future review of the application of MiCA but is not considered further in this report.

⁷⁴ This could be modelled similar to the large exposure framework, where tighter limits also exist for exposures between global systemically important banks.

⁷⁵ Not all prospective issuers will be subject to reserve requirements. Credit institutions that wish to issue EMTs will not, as the legislators have deemed that their prudential safeguards in terms of capital and liquidity buffers offer token holders sufficient safeguards already. Hence, a potential increase in interconnectedness deriving from reserve requirements would stem from a material increase in issuance of EMTs by e-money institutions or issuance of ARTs. It is yet difficult to foresee the magnitude of future EMT and ART issuance in the EU.



2.1: Identify and assess risks arising from crypto-asset conglomerates, taking account of market developments following the application of MiCA

“Crypto-asset conglomerates” are a well-established concept at the international level. As described by the FSB in its October 2022 consultative document on the regulation, supervision and oversight of crypto-asset activities and markets:⁷⁶

[o]ne prominent feature of the crypto-asset market structure is that service providers often engage in a wide range of functions. Some trading platforms, besides their primary functions as exchanges and intermediaries, also engage in custody, brokerage, lending, deposit gathering, market-making, settlement and clearing, issuance distribution and promotion. Some trading platforms also conduct proprietary trading or allow proprietary trading on the platform by affiliated entities. By vertically integrating multiple functions, these service providers resemble a financial conglomerate. Similar to a financial conglomerate, these service providers have complex risk profiles. Risks originating from individual functions may be mutually reinforcing and transmit across functions.

As previously described, different combinations of activity may appear within the same entity or the same group, in either case described as “crypto-asset conglomerates”. For instance, some entities/groups may issue crypto-assets while being a trading platform and custodian wallet provider (e.g. Binance). Consolidation within the crypto-asset sector following the “crypto winter” and recent market turmoil may result in further combinations of crypto-asset services within the same legal entity or group.

Combining activities within the same entity or group can offer opportunities as well as the above-mentioned risks. Opportunities include efficiency gains through the merger of trade and post-trade functions. In view of the issues identified and potential market developments, the FSB will take forward analytical work in 2023 on the topic of crypto-asset conglomerates, building on draft recommendation 9 of the FSB’s October 2022 draft recommendations for the regulation, supervision and oversight of crypto-asset activities and markets. Indeed, the FSB’s Consultative Group for Europe observed in November 2022 that the issue requires “urgent regulatory attention”.⁷⁷

Against this background, it is important to understand what MiCA will address in the EU. MiCA will require effective governance of, and management of conflicts of interest between, different business lines of the same entity. It will also regulate the provision of each issuance activity and crypto-asset service business line. But MiCA does not stipulate any prohibitions for any combinations of services within the same entity/group. For issuers of significant ARTs and EMTs within the sphere of the EBA’s supervision, supervisory colleges should facilitate coordination in the supervision of crypto-asset ecosystems distributing significant ARTs and EMTs. Additionally, general requirements apply for competent authorities to coordinate closely in the performance of their supervisory tasks.

⁷⁶ See Financial Stability Board (2022f).

⁷⁷ See Financial Stability Board (2022e).



But, given the lack of systemic importance of crypto-asset markets and entities to date, MiCA does not include any provisions that are expressly designed to mitigate cumulative prudential, reputational or operational risks across an entity or group, such as those applicable to specific, more systemically important parts of the traditional financial sector.

For example, MiCA does not include:

- prudential consolidation rules, such as those applicable to banks under the Capital Requirements Directive/Regulation (Directive 2013/36/EU and Regulation (EU) 575/2013);
- supplementary supervision arrangements, such as those applicable to financial conglomerates within the scope of Directive 2002/87/EC (the Financial Conglomerates Directive);
- powers for the supervisor to require a “push out” of specific business activities to a separate legal entity within the group (e.g. as per the power available to supervisors under Article 11(5) of the second Payment Services Directive (Directive (EU) 2015/2366)).⁷⁸

Taking account of any market developments, and experience acquired with the application of MiCA, the activity of crypto-asset conglomerates in the EU should be studied.

Taking inspiration from the work of the European supervisory authorities (ESAs) in relation to big tech groups⁷⁹ and the June 2022 advice of the EBA in relation to the review of the second Payments Services Directive (PSD2)⁸⁰, this report advocates an analysis of the crypto-asset sector that focuses on the combinations of crypto-asset activities carried out by large issuers and CASPs active in the EU market. This should take into account the activities performed by the same legal entity and across the group. The analysis should where possible leverage the work underway at international level (in particular by the FSB), but focus on the EU market and, specifically, on identifying:

- sources of contagion or cumulative risk across business lines/group entities, including prudential, operational and reputational risks;
- possible mitigating measures, including the potential need for new regulatory requirements or supervisory tools such as those identified above (and taking account of the expected impact of MiCA);

⁷⁸ Article 11(5) PSD2 reads as follows: “Where a payment institution provides any of the payment services as referred to in points (1) to (7) of Annex I and, at the same time, is engaged in other business activities, the competent authorities may require the establishment of a separate entity for the payment services business, where the non-payment services activities of the payment institution impair or are likely to impair either the financial soundness of the payment institution or the ability of the competent authorities to monitor the payment institution’s compliance with all obligations laid down by this Directive.”

⁷⁹ January 2022. See in particular Recommendation 7 (European Banking Authority, 2022d).

⁸⁰ See European Banking Authority (2022c).



- issues relating to market concentration and potential risks arising.⁸¹

Such analysis could in addition feed into the European Commission’s review of the application of MiCA. This would include the specific assessment of the requirements applicable to issuers of crypto-assets and CASPs and the impact on operational resilience, market integrity, the protection of clients and holders of crypto-assets, and financial stability.

Cooperation among authorities is essential. Pending the outcome of the analysis, NCAs, the ESAs and the European Commission should cooperate closely in the monitoring of major crypto-asset entities/groups conducting combinations of significant crypto-activities active in the EU market, for instance in the context of the supervisory colleges to be established by the EBA under MiCA. There should also be pre-emptive discussions and coordination of supervisory information gatherings and, where appropriate, supervisory actions relevant to different business lines.

2.2: Identify and assess risks from leverage using crypto-assets

Leverage is defined as using borrowed funds to invest in assets. Investors can build leveraged positions by taking out loans from other parties or by investing in derivative financial instruments (e.g. futures) that are economically equivalent to a leveraged short or long position in the base asset.

Leverage in the crypto-asset space is available in several forms.

- Leverage offered by centralised exchanges (CEXs) and lending platforms. One form of this leverage is margin trading in spot markets (where the exchange lends cryptocurrencies to users, usually against collateral in the form of users’ crypto-assets or funds held at the exchange⁸²). Exchanges (and lending platforms) obtain funding for these activities by offering users “yield” or “earn” products⁸³, whereby the user in effect lends their tokens to the exchange for use in lending⁸⁴ (in other words, the user consents to the rehypothecation of their assets deposited in this product). Major CEXs offer margin trading leverage up to 5-20

⁸¹ Crypto-asset and DeFi markets tend to be characterised by strong network effects, economies of scale and scope, and low or zero marginal costs, and are often vertically or horizontally integrated or have business models spanning a number of different crypto-asset-related activities. This can foster the emergence of dominant players which are able to behave anti-competitively. Crypto-asset markets hence exhibit a strong dominance of a limited number of coins (e.g. USDT, USDC, BTC, ETH) and CASPs (e.g. Binance). Moreover, in DeFi, as for more “traditional” parts of the crypto-asset sector, there is a strong reliance on a few blockchains and, in this specific context, decentralised financial applications (dApps). Market concentration, contestability and anticompetitive behaviour are not primarily a financial stability issue. They are predominantly issues of competition policy and – to a lesser extent – of market integrity and consumer protection. Market concentration could eventually lead to a too-big-to-fail scenario, however, in which case it would be relevant from a financial stability perspective. Additionally, price manipulation or a cyber incident at a larger player, such as a large crypto-asset exchange, could impair the credibility of crypto-asset markets more broadly. This could lead to a wide-ranging loss of confidence in crypto-asset markets and – as a consequence – to contagion and a run on these markets, possibly with broader effects on confidence. Finally, entities in crypto-asset markets tend to be highly interconnected, as seen, for instance, during the collapse of Terra/Luna and FTX/Alameda. The failure of a large player can lead to the failure of several other entities in the sector.

⁸² For an example of this practice, see Binance (2020b).

⁸³ For example, Binance Earn product terms state that assets deposited in flexible products may be used for Binance’s business operations. They may also be used as part of the digital assets that are loaned to other users (e.g. they may be used in margin and crypto-loan products). See Binance (2022a).

⁸⁴ In effect, these products can be seen in some jurisdictions as a (non-compliant) offer of quasi-deposit/debt security products. See, for example, the settlement of BlockFi with the **US SEC** (2022).



times. Another form of leverage is available through the trading of derivatives in which crypto-assets are the reference asset. In derivative markets, some CEXs offer leverage up to 100 times⁸⁵.

- Leveraged tokens are issued by some trading platforms (e.g. Binance, Bybit) to facilitate leveraged trading with no margin requirements. The leveraged tokens are a synthetic product (a basket of futures contracts)⁸⁶ designed to track a particular token but with price changes that are a multiple of the price changes of the reference token. These tokens typically offer lower leverage (2-3 times) than classical margin trading.⁸⁷
- DeFi services enable users to obtain leverage through the borrowing or minting of tokens against collateral or the trading of highly leveraged derivatives on crypto-assets against the deposit of crypto-asset collateral (e.g. up to 50 times on GMX via perpetual swaps). Lending protocols allow users to supply tokens (provide liquidity) to be lent out. Other users can then borrow these tokens against collateral in the form of other crypto-assets, up to the limits which are set to ensure that the loan is over-collateralised. These services have automatic liquidation systems in place, which are the equivalent of margin calls that programmatically liquidate positions which fall under the prespecified over-collateralisation limit, usually because of changes in the price of the collateral versus the borrowed tokens.
- There are also centralised firms that offer “yield” products to clients, whereby clients deposit crypto-assets and are offered interest that the firm hopes to earn by lending out these crypto-assets. Depending on the particular features of these products, these firms engage in maturity/liquidity transformation. Some jurisdictions may view such services as the unauthorised provision of bank-like services or the unauthorised issuance of debt securities.⁸⁸
- Leverage in the crypto-asset system can also be present on the side of investors. Their positions in crypto-assets can be funded by debt taken out in the traditional financial system. This can take the form of investment funds investing in crypto-assets and using leverage to fund part of their balance sheet, or leveraged institutions, such as banks, holding crypto-assets.
- “Flash loans” are an instrument specific to crypto-asset markets. These are uncollateralised loans, repayable – by construction – within the same block of transactions as when they are taken out. They take advantage of the atomic nature of transactions⁸⁹ in crypto-assets. While they do offer high leverage – notably for cross-market arbitrage purposes (intended use case) and for exploitation of some categories of bugs in smart contracts (unintended use case) – the duration of such leverage is practically zero. Thus, they do not seem to contribute to leverage

⁸⁵ A sample overview can be found [here](#) (Agrawal, 2023).

⁸⁶ See, for example, Binance (2020a) or Bybit (2022).

⁸⁷ These tokens are economically similar to leveraged exchange-traded funds or leveraged exchange-traded notes tracking a particular asset, although the leveraged tokens are offered without the attempt to comply with relevant financial market regulations.

⁸⁸ See, for example, the settlement between [US SEC and BlockFi](#) (2022).

⁸⁹ I.e. that all transactions in the bundle of transactions submitted by the user to the verifying nodes must be possible to execute to allow any of them to be executed.



cycles in the crypto-asset market. Nevertheless, they are worth monitoring, notably with respect to the robustness of the technical solutions used to provide these services.

The importance of leverage for systemic risk is well known.⁹⁰ One can distinguish the effects of leverage obtained within the crypto-asset system from the effects of leverage obtained in the traditional financial system. In the first case, leverage amplifies price movements in crypto-asset markets as leveraged positions are expanded in upturns and closed in downturns (leverage cycle), and it increases interconnections between crypto-asset markets. In the case of leverage obtained in the traditional financial system, it creates a shock propagation channel to traditional finance.

A range of possible regulatory tools could mitigate these risks.

Given the potential for transmission to the traditional financial system, any leverage obtained by traditional financial institutions for crypto-asset exposures (or leverage extended by these institutions for crypto-asset investments) could be limited. This could be the first priority and can be achieved by the following.

- High capital requirements could be set for credit exposures that are used to fund crypto-asset investments (e.g. bank credit exposures to investment funds with crypto-assets in their portfolio). With regard to capital requirements for banks applicable to crypto-asset holdings, the final standard issued by the Basel Committee specifies that holdings of crypto-assets other than tokenised traditional financial assets and stablecoins meeting specific qualification conditions should attract a risk weight of 1,250%, effectively requiring 1:1 backing with a bank's regulatory capital.⁹¹
- Introducing leverage limits for investment funds exposed to crypto-assets could also be considered (e.g. based on leverage limits on the basis of Article 25 of the Alternative Investment Fund Managers Directive (AIFMD)).
- With regard to leverage obtainable within the crypto-asset space, a comprehensive approach requires a regulatory framework for crypto-asset lending activities, which are currently out of the scope of MiCA. Therefore, MiCA does not contain regulatory tools that limit the ability of a CASP to lend crypto-assets (owned by the CASP) to its clients⁹². Under MiCA, the safekeeping of clients' crypto-assets and funds, combined with the requirements regarding the custody of crypto-assets, will limit the possibilities for exchanges to use clients' crypto-assets for lending activities without the explicit consent of the user.
- Since margin trading is offered by exchanges themselves, there may be scope to (a) separate the lending activity from the operation of the exchange platform, so that any financial difficulties experienced by the lending entity do not affect the ability of the CASP to operate the platform (see also recommendation 2.1), and (b) consider the regulation of margins

⁹⁰ Excessive leverage is identified as a source of systemic risk both in the [ESRB Flagship Report on Macro-prudential Policy in the Banking Sector](#) (2014) as well as in the [ESRB Strategy Paper on Macroprudential policy beyond banking](#) (2016).

⁹¹ The Basel Committee standard also specifies an additional "infrastructure risk add-on".

⁹² Note that the regulatory treatment of the funding side is less clear, especially if the quasi-deposit "earn" products that CASPs offer to obtain crypto-assets – which can then be lent onwards – are deemed to be regulated financial products (as in the case of BlockFi in the United States).



inspired by the European Market Infrastructure Regulation (EMIR) (notably Article 41) and related regulation.

- The issuance of leveraged tokens is less likely to lead to large-scale issues. But their complexity, as well as the fact that they are issued by CASPs, may be a cause for product intervention; besides, as they will be issued as crypto-assets, their features can be examined by NCAs during the issuance process. This is, however, more a form of investor protection than a financial stability issue.
- Limiting the leverage obtainable in DeFi could be achieved by adjusting over-collateralisation limits in DeFi lending/stablecoin services. This can be implemented, however, only if governance/regulatory access point issues in the DeFi space are solved (see further priority 3).

3.4 Priority 3: Monitor market developments to ensure potential risks to financial stability and the effectiveness of macroprudential policy can be identified, assessed and mitigated

The crypto-asset market continues to evolve rapidly, and market developments may pose new risks relevant to financial stability and the transmission of monetary policy. In particular, there is a need to monitor potential risks in relation to operational resilience, DeFi and newer types of crypto-asset activity such as staking and lending. These aspects should be monitored, albeit with lower priority than the actions highlighted in priorities 1 and 2 above. Legal risk has also been identified as a “horizontal” topic but is not a matter of focus in this report.⁹³

3.1: Understand market developments and implications for operational resilience

Although crypto-assets often mimic the economic function of existing financial products, their ability to do so depends on a different underlying technology that entails new operational risks. Should any blockchain-based system become more widely adopted as a means of carrying out financial transactions, regulators and supervisors will need better data in order to

⁹³ Crypto-assets take many forms, and their legal characteristics and consequent regulatory classifications require a case-by-case analysis. Where crypto-assets take the form of tokenised traditional financial instruments, in the EU, the “normal” financial acquis applies – including the rules relating to legal enforceability contained in the Financial Collateral Arrangements Directive (FCAD) and the Settlement Finality Directive (SFD). Issues may still arise even when the scope of application is clear. For instance, the FCAD defines the applicable law using the location of the relevant securities account as a “hook”, but in a given case involving crypto-assets, there may not be any account, as DLT-based holdings are held in a distributed manner. For other types of crypto-assets (i.e. those that are not regarded as financial instruments), there are no specific rules at all. This does not mean that these crypto-assets transact in a “lawless space”, but it does mean that parties may have an absence of clarity as to which jurisdiction’s law governs claims relating to those assets. Consequently, parties to a transaction within a crypto-asset system may make different assertions based on legal doctrines in their own jurisdictions or may seek to choose the law that appears “nearest” to their cause or the one they regard as most favourable. At the same time, the more decentralised the crypto-asset landscape becomes, the more limited the parties’ influence over the question may become. The regulatory implications of these issues require continuous monitoring, including in the context of the implementation of the BCBS standard on the prudential treatment of banks’ exposures to crypto-assets.



assess and address the potential impact of technology shocks (either malicious or unintentional) on financial stability. Moreover, technology shocks in more niche blockchain-based systems could be transmitted or amplified through interlinkages with the traditional financial system.

It is helpful to categorise the operational risks associated with crypto-assets by layer of infrastructure. The base layer of crypto-asset infrastructure is the internet. This is outside the scope of this report, which instead focuses on the operational risks associated with the next layer of infrastructure: the blockchains themselves.

There is significant uncertainty with regard to software developers and validators.

Blockchains are software (more specifically, databases) and as such require maintenance and development. The open-source nature of this software raises the question whether the community of developers available and willing to support it is sufficient in quality and quantity and whether it faces adequate incentives to contribute to the smooth functioning of this infrastructure. Similarly, there is currently no way to compel validators to accept critical operational fixes proposed by the core software developers (particularly not in a timely manner). As a preliminary step, regulators and supervisors should start to monitor who those validators and developers are.

The widespread nature of blockchain creates difficulties in the application of safeguards. To apply Principle 17 of the Principles for Financial Market Infrastructure, which limit financial stability risks in this area in traditional finance, is not straightforward if the ability to enact changes in the functioning of the software is dispersed. For example, Principle 17 requires providers to design their systems “to ensure a high degree of security and operational reliability” and so that they have “adequate, scalable capacity”. Similarly, Principle 17 requires business continuity management planning, the meaning of which is not clear-cut in the blockchain world.

Regulators and supervisors should consider how they can incorporate robustness into Layer 2 solutions and bridges. The complex transaction verification procedures result in quantitative and price-based constraints to throughput. These constraints could lead to a rise in off-chain transactions in Layer 2 and the potentially brittle inter-operation of blockchains through bridges.

The technology underpinning crypto-assets is certainly not immune to cyberattacks; indeed, high-profile attacks have highlighted potential vulnerabilities. A particular concern is ensuring that blockchains are protected against cyberattacks, which will require the monitoring of code for potential vulnerabilities and the patching of those vulnerabilities with the adoption of new code. Blockchains benefit from their distributed nature, but their security is not absolute, particularly because of the increasing concentration of validators. One recent report found that “[t]he number of entities sufficient to disrupt a blockchain is relatively low: four for Bitcoin, two for Ethereum, and less than a dozen for most [proof-of-stake] networks”.⁹⁴ Questions also arise as to whether quantum computing could be used to compromise encryption algorithms underlying blockchains, and blockchains may also be vulnerable to coordinated attacks used to disable validators. Such attacks would be expensive, but certain nation states or terrorist groups may have sufficient incentives to carry them out. Concentration issues in the validation space may also raise issues

⁹⁴ See Sultanik et al. (2022).



that imply a need for regulation from both a competition and regulatory (operational risk) perspective.

Different operational risks arise at the next layer of tokens and smart contracts hosted on blockchains. Smart contracts should be a particular focus of attention given their high transaction speed combined with their self-executing nature, which affords fewer opportunities for intervention. Bugs in smart contracts have therefore proven to be a popular target for hacks. Again, smart contracts are typically open-source software, so it is unclear who is responsible for maintaining their code. In some circumstances, changes to the code to patch problems would need to be accepted by the participants in a distributed governance mechanism, which could prove challenging to coordinate.

Taking these risks into account, there are a variety of precautions that could be taken.

Regulators and supervisors could consider requiring disclosure of smart contract code prior to use and verification that smart contracts meet minimum reliability and cybersecurity standards on an ongoing basis. Regulators and supervisors could also consider whether they need a means of halting the execution of smart contract code in some circumstances (for example, to slow down margin calls in order to prevent liquidations with fire sale externalities). One possibility might be to have a regulator/supervisor maintain a data feed, known as an oracle, that works as a circuit breaker to prevent smart contract execution. But smart contracts execute rapidly, and this kind of circuit breaker would be effective only if regulators could trigger the oracle fast enough. Regulators/supervisors may therefore wish to consider some kind of latency requirement for smart contract execution, such as a minimum timeframe from when the request is made to when the request is executed. These issues are particularly important for the regulation of DeFi services.

All in all, regulators and supervisors may need to address specifically the new technology risks. The range of policy measures to be considered may be broad but, unlike the existing tradition, fits under the regulation of the production function headline. The meaning of this term can range from the application of exhaustive certification requirements for software developers to controls, the establishment of codes of conduct or measures to ensure that software developers invest heavily in designing and maintaining critical code components or the actual definition of standards (as the National Institute of Standards and Technology in the United States seems to be doing). The pros and cons of different alternatives necessarily require detailed assessment.

Applicable regulatory measures in the EU already intended to help mitigate operational risks include:

- the Eurosystem oversight framework for electronic payment instruments, schemes and arrangements, which has been revised to include digital payment token schemes (November 2021);⁹⁵
- MiCA, which requires effective governance and risk management (including with respect to operational risk) with regard to issuers of ARTs and EMTs and CASPs;

⁹⁵ See European Central Bank (2021).



- the Digital Operational Resilience Act (DORA), which encompasses “financial entities” (including CASPs) and will require the highest standards of digital operational resilience.

The effectiveness of these measures in mitigating the risks identified above should be monitored.

3.2: Understand DeFi developments and implications for regulation and supervision

Although DeFi remains relatively centralised at present, it should be given further

consideration. In this report, the discussion of DeFi focuses on crypto-asset services that are delivered using smart contracts and have at least some decentralisation of governance.

Decentralisation of governance can take place both “off-chain” through an informal system of rules, procedures and societal norms, and “on-chain”, whereby holders of so-called governance tokens can vote on changes to the code. As noted above, available data suggest that DeFi services currently account for a very limited volume and value of crypto-asset activities (much more activity is concentrated at centralised intermediaries). Nevertheless, the DeFi market should be monitored for several reasons.

First, there may be an indirect effect from forthcoming regulation on DeFi. The future regulation of CASP activities, combined with the challenges of regulating activities with decentralised governance, may pose arbitrage risks. Furthermore, existing DeFi services may gain market share if compliance with regulations reduces the scale of activity of a centralised CASP (or if a CASP decides not to offer its services in the EU market and its role is taken over by DeFi to some extent).

Second, DeFi services play an important role in crypto-asset lending and borrowing. This enables leveraged investment, which in turn increases certain risks such as procyclicality.

Third, DeFi services increase the complexity and interconnectedness of crypto-asset markets. This can happen notably due to composability (the ability to construct complex investment positions using multiple services) and rehypothecation of collateral.

Fourth, automated procedures within DeFi can cause volatility. Collateralised lending services within DeFi feature the automatic liquidation of collateral when the collateralisation level falls below a predefined limit. In cases where liquidations are caused by a fall in the market price of tokens locked as collateral, such automated execution amplifies market volatility. In a volatile market, such automated order flows can lead to market disruptions. In traditional financial markets, such disruptions, associated with sudden order flows generated by high-frequency trading algorithms, have been observed in the form of “flash crashes”.⁹⁶

Fifth, the automation of DeFi services gives rise to new types of operational risk related to the robustness of code used to deliver these services. This risk has multiple aspects.

- While DeFi services are advertised as decentralised – and indeed, their reliability does not depend on the functioning of an off-blockchain entity in the same way as in the case of

⁹⁶ For a description of such an episode on the US equity markets in May 2010, see Biesenbach and Cipriani (2012).



centralised finance (CeFi) – the code of smart contracts used to deliver a service becomes the central point of failure.

- The open-source nature of the code used to deliver these services opens it to scrutiny from benevolent parties, possibly leading to proposals for improvement but also enabling potential malevolent actors to find and exploit security holes.
- Furthermore, in many cases it is not clear how large – and how committed – is the community of developers that deals with the maintenance of these smart contracts, or how its incentives are structured.
- Moreover, it is technically possible to deploy smart contracts in a way that their code cannot be modified or removed⁹⁷ without a “fork” in the blockchain⁹⁸, thus making corrections in the code difficult to introduce.
- Yet another operational risk aspect is the robustness of solutions linking DeFi software to inputs from outside its blockchain (oracles).⁹⁹ Such links are often needed, for example when the valuation of collateral used in lending protocols is based on prices from CEXs.

Sixth, a key challenge for regulating and supervising DeFi services is linked to their governance. Nominally dispersed governance structures (e.g. governance executed through the voting of governance token holders), combined with the pseudonymity of permissionless blockchains, results in the dispersion of accountability. Hence it is difficult to identify accountable actors and to coordinate the actions of entities with governance powers, or to identify other regulatory access points that could facilitate changes recommended by regulators/supervisors. Moreover, if voting participation is low, it can make it easier to introduce malicious changes to code. The governance structure of DeFi services can make it unclear whether they are captured in the regulatory perimeter. Existing regulation is focused on identifying entities (legal or natural persons) that are accountable for the provision of regulated financial services.

In view of these issues, a series of potential actions, albeit of lower priority, has been identified. In terms of higher priority, a key issue is the clarification of the regulatory perimeter with respect to DeFi activities. MiCA in its recitals sets a seemingly high hurdle for DeFi activities to be included within its scope (“services provided in a fully decentralised manner without any intermediary”). This boundary (e.g. the meaning of “fully”) will be further clarified by practical application. The MiCA framework foresees an interim report on the evolution of DeFi, and legislative answers, produced by the European Commission (after consulting the EBA and ESMA) within 18 months after the entry into force of MiCA. There may be an important role for the European Commission/ESAs to promote a coordinated approach across EU NCAs. Such a coordinated interpretation of the perimeter, as well as the identification of types of entities that could be held accountable for the functioning of DeFi services (see the discussion on “regulatory access

⁹⁷ Such modification usually requires an “admin key”, a private cryptographic key that enables the modification of the smart contract’s code.

⁹⁸ This would require validators to agree on a new transaction history that starts at a point in time before the smart contract in question was deployed. A well-known case of such modification was the “**DAO**” in 2016, when a fork was executed on the Ethereum blockchain to reverse the transactions through which an attacker was able to steal funds from the DAO, a distributed autonomous organization built as a fund for Ethereum-based projects (del Castillo, 2016).

⁹⁹ For an assessment of the importance of oracles, as well as broader supervisory challenges, see Roukny. (2022).



points” below), would best be formed on the basis of joint work among the European Commission, ESAs and NCAs. Given that other international bodies also work on these issues (e.g. the FSB and the Organisation for Economic Co-operation and Development), there could be important synergies from global cooperation.

To strengthen the robustness of DeFi services, effective regulation should make use of relevant entry points as well as overall disciplining mechanisms.¹⁰⁰ DeFi developers and DeFi deployers stand out as significant entry points to regulate. Relevant vectors for regulating DeFi developers are as follows.

- DeFi developers could be required to abide by specific regulations covering the design and creation of smart contracts – e.g. a law that imposes specific audit, testing or design requirements on DeFi-related smart contracts.
- DeFi developers’ intellectual property rights relating to smart contracts could be regulated – e.g. through laws imposing limitations on how smart contract code may be licensed. This amounts to a version of the safety-based licensing regime encountered in the health industry.
- In particular, DeFi could contain an upgrade/modification (including shutdown) functionality (with governance requirements around its use) to allow for the rectification of errors in code as well as the introduction of regulatory limits (e.g. to constrain the leverage obtainable through such services).
- The regulation of DeFi deployers (i.e. licensees of DeFi smart contracts) could be based on tort liability or regulation in order to incentivise them to thoroughly audit smart contract code prior to deployment and thus reduce the likelihood that faulty code is deployed.
- Furthermore, requirements for oracles that interact with DeFi smart contracts may be necessary to ensure that they function robustly.

Risks that can build up from the longer-term use of DeFi should also be addressed.

Assuming significant growth in DeFi and any limits to the effectiveness of the measures described above, it may be appropriate to consider some requirements on centralised entities which make use of DeFi (such as CASPs offering crypto-asset portfolio management) in order to address risk build-up resulting from use of DeFi services. Such limits would probably be a part of wider risk limits. Supervisors responsible for crypto-asset market supervision should in any case enhance their information-gathering capacity related to DeFi markets in order to keep abreast of the developments and risk build-up, as well as any links to traditional finance activities.

3.3: Understand crypto-asset staking and lending and implications for regulation and supervision

The impact of crypto-asset staking and lending should be clearly understood. The May 2022 recommendation of the EBA states that the emerging activities of crypto-asset staking and lending

¹⁰⁰ Such as liability of developers for the functioning of the software used to deliver DeFi services.



should be subject to close monitoring.¹⁰¹ Although volumes and values remain extremely low at present, it is noted that these activities often pose significant risks to consumers, as highlighted by the recent bankruptcy of the crypto-asset broker Genesis on which several crypto-asset lending services were based as well as the fact that unstaking tokens is currently not technically possible on the Ethereum blockchain. Crypto-asset lending also contributes to leverage in crypto-asset markets (as highlighted in Section 3.3). The EBA should therefore continue to monitor such activities in close cooperation with the European Commission and ESMA and develop appropriate recommendations regarding the regulation of such activities.

¹⁰¹ See European Banking Authority (2022b).



4 Conclusion

While this past year has been turbulent for crypto-assets and DeFi, systemic implications have not materialised. The evidence so far shows that the crypto-asset world has few links with, and provides few services to, the traditional financial sector and the real economy. Currently, none of these realised links are considered vital.

Given the exponential growth dynamics of crypto-assets seen in the past, the future development of these markets is uncertain. There are various instances in which crypto-assets could pose a systemic risk, for example if (i) their interconnectedness with the traditional financial system increases over time, (ii) their connections to the traditional financial system are not identified before they cause problems, and (iii) similar technologies are adopted in traditional finance.

The report identifies a number of potential policy options that could enable authorities to understand better the developments and potential financial stability implications of crypto-assets. The options aim to ensure that authorities have the capacity to act in a timely manner to address potential systemic risks. They should also inform any additional future regulatory initiatives.

The report proposes three areas of focus, listed in order of urgency and importance.

- **Improve the EU's capacity to monitor potential contagion channels between the crypto-asset sector and the traditional financial sector, and within the crypto-asset sector.** The aim is to improve monitoring capacity through the introduction of regular reporting requirements for financial institutions with exposures to crypto-assets. Monitoring the interconnectedness between the fund sector and crypto-asset sector is considered valuable for financial stability. Furthermore, there may be benefits to enhanced reporting requirements, for systemic risk purposes, within the crypto-asset sector itself. Finally, given the potential for contagion across trading platforms, it is proposed to introduce reporting requirements to map exposures between crypto-asset trading platforms and other relevant entities.
- **Carry out assessments of risks posed by (a) crypto-asset conglomerates and (b) leverage using crypto-assets, and identify potential additional actions to mitigate observed risks.** Taking into account market developments following the application of MiCA, it could be useful to identify and assess any risks arising from crypto-asset conglomerates, given the potential for cumulative prudential, reputational or operational risks. Also, given the degree to which leverage can take place within the crypto-asset market, it would be prudent to identify and assess systemic risks stemming from these positions.
- **Promote EU-level knowledge exchange and monitoring of market developments, focusing on (a) operational resilience, (b) DeFi, and (c) crypto-asset staking and lending.** The purpose is to ensure that potential risks to financial stability and to the effectiveness of macroprudential policy can be identified, assessed and mitigated. The use of different underlying technology for crypto-assets may bring about varied novel operational risks that must be considered by regulators and supervisors. A greater degree of understanding of developments in DeFi and the implications for regulation and supervision



should be pursued in the future. More specifically, it would be useful to investigate governance arrangements to ensure a consistent application of regulation to these services. Finally, the impact of crypto-asset staking and lending should be clearly understood.



Annex

A.1 Speculative scenarios of potential systemic risk

This section outlines three scenarios under which stress in the crypto-asset ecosystem could affect the traditional financial system. While there may be self-reinforcing feedback that amplifies the initial shock, the scenarios are not concerned with shocks that originate in the traditional system.

A.1.1 Run on a reserve-backed stablecoin

As noted, reserve-backed stablecoins have connections to the traditional financial system. Because their assets are conventional fixed income instruments – sovereign and private bonds, commercial paper, repos and deposit accounts – a large run on their liabilities poses a clear financial stability risk.

While their balance sheets mimic those of money market funds (MMFs), reserve-backed stablecoins may have more pronounced fragilities. First and foremost, they are not subject to regulation, nor are they backed by a clear legal framework or have clear access to a lender of last resort. Moreover, the transparency of their accounting varies. As noted, Tether's (USDT) disclosures contain very little detail on the assets held. While Binance USD (BUSD) reports CUSIPs for the US Treasury securities that it holds both outright and as collateral in repos, it is not clear what this means. Finally, USD Coin (USDC) provides monthly audited financial statements (and, as noted in Box 1, holds roughly three-quarters of its assets in Circle Reserve Fund). This divergence leads to uncertainty about the quality of reserves that are supposed to back issuers' tokens. Given earlier episodes, when faced with a shock (like the collapse of TerraUSD), crypto-asset players do discriminate, favouring those they see as more secure.¹⁰²

Tether's market capitalisation has fluctuated between USD 20 billion and USD 83 billion over the past two years. If that were to grow significantly, and Tether were to suffer a run, this could have significant consequences for the financial system as a whole.

In its most recent financial disclosure (30 September 2022), Tether reported that it held USD 12 billion out of USD 68 billion in categories labelled "corporate bonds, funds and precious metals", "other investments" and "secured loans." The remaining assets were invested in US Treasury bills (USD 40 billion), MMFs and bank deposits (USD 13 billion), and reverse repos (USD 3 billion).¹⁰³ So nearly 20% of its assets may be relatively illiquid.

Imagine that Tether expands by a factor of 20 and simply scales its (still opaque) balance sheet accordingly. Now consider the consequences of a significant fall in the value of some of the assets

¹⁰² In late May 2022, as TerraUSD crashed, the value of Tether dropped to USD 0.94585. Meanwhile the price of USDC rose briefly to USD 1.0077. Conversely, when USDC broke its peg in March 2023, the value of Tether rose.

¹⁰³ Note that commercial paper and certificates of deposit currently represent less than 1% of Tether's assets – USD 50 million. This means that they seem unlikely to play much of a role in a run. Tether's financial statements are available [here](#).



held as reserves.¹⁰⁴ Knowing this, holders of Tether attempt to redeem their tokens. Importantly, since only registered users can redeem Tether directly from the issuer, others would either have to sell their tokens into the falling market or rely on an intermediary (such as an exchange) to do so on their behalf. Importantly, Tether only even claims to guarantee redemption for registered users. In addition to information, registration requires a USD 150 fee, and the minimum transaction amount is USD 100,000.¹⁰⁵

This could affect the traditional financial system in two important ways. First, if Tether is forced to fire sell its assets, this could drive down the value of corporate bonds, other assets and commercial paper. Second, to the extent that Tether holds reserves on account at traditional banks, a withdrawal of its deposits could put funding stress on the banks.

This run could turn into a broader panic in three ways. First, fire sales in fixed income markets could spread and cause broader stress. Second, withdrawals from banks could cause stress in the banking system. And third, in the same way that a run on one bank causes a run on other banks, a run on Tether could cause a run on similar structures. The closest analogue in the traditional system would be MMFs.

Proposals such as that by the US President's Working Group on Financial Markets to restrict reserve-backed stablecoin issuance to chartered banks would turn these into conventional demand deposit liabilities and significantly reduce the possibility of a run.¹⁰⁶ Not only would the issuers face banking regulation and supervision, but the tokens would also be entitled to deposit insurance. The likelihood of a run and ensuing panic would then be the same as it is for the banking system now.

Furthermore, even if a stablecoin such as Tether were to suffer a run, central banks have tools to reduce the transmission and amplification of the shock. First, recent history makes clear that policymakers are willing and able to intervene to stabilise financial markets.¹⁰⁷ Second, since traditional banks have access to central bank lending facilities, they likely will be able to meet the withdrawals.

Since the Regulation on Markets in Crypto-assets (MiCA) aims to ensure that the provision of services on crypto-assets is subject to licensing, prudential requirements and supervision, runs on stablecoins are also much less likely. More specifically, the new regulation aims to ensure stablecoin parity with one currency (referred to as an e-money token (EMT) within MiCA). To do this, MiCA requirements include reserves to be held in segregated accounts, funds to be held in low-risk, highly liquid short duration assets, and reserves to be regularly audited. For significant EMTs – a criterion for significance is reserves being above €5 billion – requirements are strengthened, and supervision is transferred from national authorities to the European Banking Authority (EBA).

There are, however, a few caveats to the view that MiCA solves this problem. First, it does not go into effect until 2024. Second, MiCA does not fully exclude exposure of EU entities or investors to

¹⁰⁴ The case where the US Treasury market becomes illiquid is ignored. If that were to happen, a run on Tether would be the least of concerns.

¹⁰⁵ See Wright (2022).

¹⁰⁶ See U.S. Department of the Treasury (2021).

¹⁰⁷ See Buitier, Cecchetti, Dominguez and Sánchez Serrano (2023).



stablecoin issuers outside the EU and thus not under EU regulation. Third, MiCA makes no provisions for regulating decentralised finance (DeFi). So, to the extent that smart contracts provide a transmission channel for runs on stablecoins to influence the traditional financial system, the problem still exists. Finally, as with the case of MMFs, the absence of a central bank backstop means that sudden changes in the liquidity of the assets backing stablecoins could still occur and spread.

A.1.2 Integration of the crypto-asset and traditional financial system

As noted previously, linkages between the crypto-asset ecosystem and the traditional financial sector are limited. Banks as well as non-bank financial institutions (NBFIs) remain hesitant to engage in crypto-asset-related activities (except for those specifically focusing on crypto-asset businesses). For banks in jurisdictions that adopt the recently promulgated Basel Committee standard, this seems unlikely to change.¹⁰⁸ Some NBFIs both invest directly in crypto-assets and engage in trading, however, be it for themselves or for their customers. In addition, there is the possibility that traditional financial and real assets will become tokenised.

Once traditional financial institutions hold and trade crypto-assets, the risks that exist with conventional instruments will be replicated. These include but are not limited to losses from trading and market-making, defaults by borrowers and forced liquidations triggered by margin calls. Since these risks appear identical to the current ones, it is expected that existing bank, insurance company, pension fund, hedge fund and asset manager risk management technologies and supervisory frameworks would be able to contain them.¹⁰⁹ Similarly, in the crypto-asset and DeFi world, cyclically invariant collateral rules generate procyclical lending. Again, this is a well-known problem in the traditional financial system that can be solved with appropriate haircut and margin rules.

The current crypto-asset world is characterised by high leverage. This should be rectified before traditional intermediaries are allowed to participate. That is, capital requirements should preclude a conventional bank obtaining the 125 times leverage that Binance currently allows its derivatives customers, or the 101 times leverage that FTX allowed prior to July 2021.

New challenges come from the DeFi system, with smart contracts leading to new risks. First, inflexible collateral requirements and the forced liquidation of leveraged positions could become more prevalent. This is the well-known problem of fire sales. During periods of high volatility, derivatives exchanges may delay or even suspend collateral calls – not indefinitely but for a few hours or even overnight. They do this to arrest what would be precipitous price declines that could arise from cascading fire sales. If liquidation is built into an automated process like a smart

¹⁰⁸ See Basel Committee on Banking Supervision (2022).

¹⁰⁹ While certain aspects of the crypto-asset world are borderless – for example, it is unknown where Binance is “located” – the transmission to the traditional financial system is within a jurisdiction. If the local authorities enforce existing regulations protecting consumers and investors, ensuring market integrity, and preventing illicit activity, they should be able to control the risks of crypto-asset incursions.



contract, the entire system would, without fire breaks, become far more fragile and crisis-prone than it already is.

Second, smart contracts require external information sources (oracles) that are susceptible to both corruption and malicious manipulation. While crypto-assets are still largely self-referential, there is the potential for large-scale tokenisation of real-world assets (both financial and real). If this were to happen, the system would become much more reliant on oracles. Ensuring that ownership of tokenised assets is recorded on a proprietary, permissioned blockchain would mitigate this problem, as it would drastically reduce the possibility of large-scale automated responses to suspect information.

Finally, there is the issue of ramps between the crypto-asset and traditional financial system. As it currently stands, the purchase of real economy goods or services requires the conversion of crypto-asset tokens into fiat money. That is, getting in and out of the crypto-asset world requires a traditional bank to act as on-ramp and off-ramp. One of the key players in the system was Silvergate, a small California-chartered bank with total assets of USD 15 billion (and equity of USD 1 billion), which went into liquidation on 8 March 2023. In 2021, Silvergate accounted for roughly one-third of the total volume of USD 2.5 trillion in transactions between crypto-assets and fiat US dollars.¹¹⁰

Crypto-asset users are often indirectly exposed to multiple sources of governance risk at the same time. For example, a decentralised exchange service could be manipulated by the service provider, price oracle provider or the blockchain transaction validator. The track record of financial crime in the crypto-asset system shows that these risks do materialise frequently in all ways that financial regulation has been developed to prevent. To name just a few examples, fraud¹¹¹, price manipulation¹¹² and insider trading¹¹³ are just what one would expect in an unregulated environment. Under a scenario where crypto-assets would grow outside the sphere of regulation, there would be many more opportunities to circumvent the safeguards protecting the integrity of markets.

But even if a traditional bank servicing the needs of crypto-asset players were to grow very large, it could create systemic risk only if it were undercapitalised or faced liquidity shortages. Accordingly, the regulation and supervision of traditional leveraged intermediaries need to be sufficiently rigorous, so authorities should redouble their efforts to ensure that bank and non-bank financial intermediaries are resilient to any shocks emanating from the crypto-asset world.

A.1.3 Crypto-assets become prominent in the payment system

The third possibility is that native tokens of some blockchains – something analogous to bitcoin – or stablecoins become prominent in the payment system. That is, instead of using bank deposits or conventional currency for the purchase of goods and services, an important volume of transactions

¹¹⁰ Clients pulled USD 8.1 billion in deposits from Silvergate during a “**crisis of confidence**” (Asgari and Franklin, 2023) in late 2022, forcing the sale of assets and underscoring the impact on the regulated financial sector of the collapse of FTX.

¹¹¹ See Palma, Chaffin, Oliver and Shubber (2022).

¹¹² See Stempel (2022).

¹¹³ See The Guardian (2022).



would take place using crypto-assets. Defining the level at which crypto-assets would be prominent in a payment system is challenging, since a direct comparison cannot be drawn with traditional payment systems. For example, in 2022, VISA reported nearly 200 billion transactions in 160 currencies with a value of over USD 14 trillion.¹¹⁴ By comparison, bitcoin facilitated 92 million¹¹⁵, Ethereum 409 million¹¹⁶ and Polygon 960 million¹¹⁷ transactions in 2022, to name a few examples.

Only a small fraction of the crypto-asset volume comes from purchasing goods and services. Moreover, there is currently no payment system in use that would rely solely on crypto-asset infrastructure. Rather, there are a few alternative crypto-asset payment methods, such as crypto-asset credit cards used for retail payments, which rely to a large extent on traditional payment systems. Typically, the use of these crypto-asset payments also requires an off-ramp for conversion of the crypto-assets to a fiat currency. Using crypto-assets as payments introduces qualitatively different risks for financial stability compared with a traditional payment provider. If VISA services were to shut down, people could still use alternatives. By contrast, if a blockchain were to shut down, consumers would no longer have access to their assets. Due to this aspect, a crypto-asset becoming prominent in payments is more akin to banking services. Drawing a comparison with banks, the crypto-asset sector as a whole would already make it onto the list of systemically important banks. But the interconnections to traditional finance are still weak. With this in mind, the scenario defines crypto-assets being prominent in payments, when their market share in payments for goods and services grows close to that of the largest traditional payment services.

This scenario might materialise through the technology being adopted by traditional service providers or crypto-asset service providers (CASPs) under MiCA. The regulation mitigates many but not all risks of the layered crypto-asset infrastructure. Most notably, the assets may still be integrated into public blockchains, like Ethereum, which raises issues beyond the single service providers.

Numeraires are convenient. Prices would likely be quoted in units of the crypto-asset used for payments if the value of the crypto-asset, measured relative to a consumption basket, were relatively constant (i.e. with a mechanism for stabilising the value). Native tokens on the largest blockchains, like bitcoin, do not have such stabilising mechanisms. In the rare cases where crypto-assets are used for payments, consumers prefer to use stablecoins. Therefore, stablecoins are the most likely candidate for wide use in payments under the given scenario. We also consider the possibility of a native crypto-asset becoming widely used for payments. The response from states and central banks may vary from a conservative approach¹¹⁸ in developed countries to embracing the technology in the developing world. There has already been some evidence of the adoption of native tokens in some emerging market countries, where a loss of confidence in traditional payment systems has increased the demand for bitcoin.¹¹⁹

The widespread use of crypto-assets as payments could lead to an increase in the occurrence of operational and cyber risks, which could rapidly become systemic. The widespread use of

¹¹⁴ See VISA (2022).

¹¹⁵ CryptoCompare.

¹¹⁶ See Etherscan (2022).

¹¹⁷ See Polygon (2022).

¹¹⁸ See Mersch (2019).

¹¹⁹ See Weathley and Klasa (2021).



blockchain-based crypto-assets would create operational resilience risks if there were flaws in the code, congestion in block production or bad governance. The assertion of decentralisation hides the fact that blockchains are changed through a governance process, where stakeholders exercise power. The controlling resources are the validators (proof of work or proof of stake) and nodes representing the users. In addition, the core developers have considerable power in the governance process. A controlling share of the resources opens up attack vectors, which might completely halt a blockchain, selectively process transactions or change the transaction history. This would have a significant impact on financial stability by denying users access to their assets or tampering with the record of asset ownership. Despite claims of decentralisation, most widely used blockchains are highly centralised. Even for bitcoin, the collusion of only four entities could disrupt the system¹²⁰. Traditional trusted institutions in charge of the payment system would be replaced by unknown entities that manage to pool a controlling share of the resources governing the blockchain.

High decentralisation and security in blockchains come at the cost of efficiency in transaction throughput¹²¹. This means that it may take a long time to process transactions, and the throughput may be intentionally slowed with spam attacks. The congestion has important implications for how the transactions are ordered. Unlike in traditional finance, they are not in chronological order. Instead, the block validators or the miners pick the order of transactions from the incoming pool of transactions. They are incentivised to pick the transactions that offer the highest fees. Alternatively, the validators can fully customise the block content to extract profits from market manipulation (miner extractable value)¹²². In traditional finance, this would be akin to investments to access the fastest data feeds for high-frequency trading purposes. The process of block production makes this investment explicit on a per-block basis.

The operational resilience of blockchains is also at risk due to unintended errors in their code. The technology is still relatively new, and the challenges to operational resilience may also depend on the scale. An example of an internal flaw in the code was a bug found by bitcoin core developers in 2018, which would have enabled denial of service and supply inflation¹²³. The flaws in the code could manifest due to external technological developments, such as quantum computing, which could threaten the cryptographic security of bitcoin¹²⁴. If such flaws in the blockchain code were to become widespread, they would pose a direct threat to financial stability through the manipulation of records of asset ownership or denial of access to assets.

The risks of bad governance, financial crime, market manipulation and scams are manifest throughout the crypto-asset infrastructure and services described above. The risks stem from unidentified or poorly regulated service providers and a false claim of decentralisation disintermediating the trust in those third parties. Most of them use decentralisation as a sales pitch, but in reality there are hardly any truly decentralised services. The spectrum of centralisation-

¹²⁰ See Sultanik et al. (2022).

¹²¹ See Buterin (2021).

¹²² See Auer, Frost and Vidal Pastor (2022).

¹²³ See BitcoinCore (2018).

¹²⁴ See Kearney and Perez-Delgado (2021).



decentralisation can be broken down into three rough categories: (i) centralised finance (CeFi), (ii) DeFi, and (iii) true DeFi.

CeFi refers to services that are run by centralised intermediaries. They are often the main access points between fiat currencies and crypto-assets. Crypto-asset exchanges, stablecoin issuers and lending services are the most notable CeFi services. Under the given scenario, CeFi would most likely remain the most important segment in crypto-asset markets and gain market share from traditional counterparties. Despite the emphasis on decentralisation in crypto-assets, the current CeFi domination in crypto-asset markets shows that people prefer convenience over complicated, self-custodial decentralised services.

DeFi covers a large variety of activities that seek to offer more decentralised versions of CeFi services. The core DeFi services are smart contracts deployed on a blockchain, which creates the illusion of decentralisation¹²⁵. These smart contracts are usually upgradable; however, some people are in direct control of this, or it is based upon the voting power of the governance tokens¹²⁶. Distribution of governance token ownership may be concentrated right from the outset or centralise over time, as empirical evidence suggests¹²⁷. In both cases, similar governance risks as in CeFi apply to the benefactors and decision-makers behind DeFi services.

True DeFi is the extreme case of non-regulation-compliant governance, where governance votes are sufficiently decentralised. Alternatively, a service can run on an immutable smart contract, where there is no governance. In such cases, the functioning of the service still relies on the security and decentralisation of the blockchain that it is built on. Currently, true DeFi services do not exist, which makes their widespread use a highly unlikely scenario. As such, true DeFi would be unregulated, permissionless, uncensored and would disintermediate middlemen in the payment system. The underlying open-source code might evolve into secure practices over time. This would lead to a need to restart the service after every error, however, because of an iterative trial-and-error deployment of immutable smart contracts.

The governance and operational resilience of blockchains differ dramatically from traditional payment systems. If crypto-asset payments were to grow in tandem with crypto-asset financial services as described in scenario 2, the rapid interlinkages of prices and services would increase the probability of single failures becoming systemic. These services contain multiple layers of operational and governance risks – from the blockchain, as described above, as well as from CASPs, smart contracts, oracles and bridges. Smart contracts in particular enable full automation, meaning materialised risks would spread in the form of crypto-assets throughout the ecosystem, potentially triggering further risks. Unlike in the traditional payment systems, which must comply with strict operational resilience guidelines and controls, there are neither specific guidelines nor entities preventing such systemic risks of crypto-assets used for payments. Under the scenario of wide crypto-asset payment instrument and service use, the failures would most likely be frequent and system-wide, as exemplified by the boom-and-bust cycles in the industry. The problems resemble the lessons already learned in crises of traditional finance over the centuries. But the

¹²⁵ See Aramonte, Huang and Schimpf (2021).

¹²⁶ The usual path to claim decentralisation is to distribute governance tokens to users, investors and developers. These tokens are then used to vote on the smart contract upgrades.

¹²⁷ See Jensen, von Wachter and Ross (2021).



speed of history repeating itself would accelerate if the developments took place in an online setting.

A.2 Overview of the key features of MiCA

In September 2020, the European Commission proposed a regulation on Markets in Crypto-Assets (MiCA). This regulation seeks to promote responsible innovation within crypto-asset markets, provide market integrity and consumer and investor protection, and preserve financial stability. On 30 June 2022 the co-legislators reached political agreement. The European Parliament adopted the final text on 20 April 2023, with the Council endorsing it on 16 May 2023. The final text, translated into the EU's 24 official languages, is expected to be published and enter into force in July 2023. The regulation's provisions on "stablecoins" will start to apply 12 months later, while the remainder (e.g. on CASPs) will start to apply after 18 months.

MiCA is the first comprehensive regulation of previously unregulated crypto-assets in the world. It will therefore be thoroughly reviewed going forward. First, the European Securities and Markets Authority (ESMA) will as of 2024 report annually on crypto-asset market developments (e.g. level of issuance, use of crypto-assets, and number of and nature of service providers). Second, the Commission will report on the application of the regulation. A first report – coinciding with the full entry into application – will review the latest market developments and their impact notably on the perimeter of MiCA, with a particular emphasis on non-fungible tokens (NFTs) and DeFi. A second broader review will be provided after two years, leading to a full review after four years. Where appropriate, these reports may be accompanied by legislative proposals.

The remainder of this annex provides an overview of the key building blocks of MiCA, focusing on how the framework has evolved during the legislative negotiations and on areas of relevance to the European Systemic Risk Board (ESRB). It therefore complements the description of the Commission's proposal contained in the 2022 (unpublished) report of the High-Level Exploratory Group on Crypto-Assets and Decentralised Finance (HLEG).

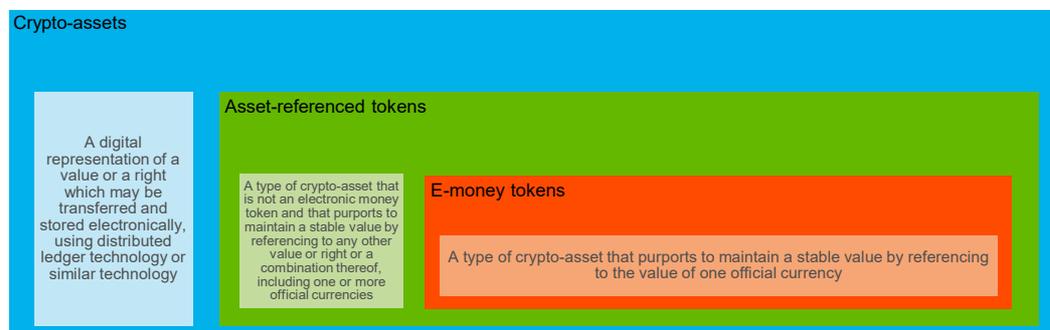
A.2.1 Scope and taxonomy

Currently, whether a crypto-asset is subject to EU regulation depends on whether it qualifies as a financial instrument. If yes, it would be subject to the same rules as ordinary securities (notably the Markets in Financial Instruments Regulation/Directive, MiFIR/D). If not, it would fall outside EU financial regulation and only be subject to regulation at Member State level, to the extent that this exists. MiCA is designed to fill this regulatory vacuum by bringing hitherto unregulated crypto-assets within the regulatory and supervisory fold of a common EU framework.

MiCA distinguishes between three types of crypto-assets: ordinary crypto-assets, asset-referenced tokens (ARTs) and e-money tokens (EMTs) (Figure 1). The latter two are commonly referred to as "stablecoins", given their stated objective to maintain a stable value vis-à-vis an underlying reference asset.



Figure 1
MiCA taxonomy



MiCA will regulate issuers of these crypto-assets as well as entities providing a number of related services to investors (CASPs), including such things as advice, trading and custody services. MiCA further defines whether ARTs and EMTs are significant or not. ARTs or EMTs that have a significant value and are widely held, used and transacted may present higher risks to financial stability, especially if the issuer is large, interconnected and internationally active. Issuers of significant ARTs and EMTs are therefore subject to more stringent requirements and supervision by European, rather than national, authorities.

A.2.2 Issuers

The requirements applying to issuers differ substantially depending on whether the issuance concerns ordinary crypto-assets or ARTs/EMTs. Whereas for the former, requirements are relatively limited (e.g. obligation to notify supervisors via white paper before issuing the asset), they are substantively more demanding when issuing ARTs or EMTs. These requirements have also been substantially strengthened during legislative negotiations.

A.2.2.1 Authorisation and supervision

Issuers of ARTs and EMTs require prior authorisation by competent authorities and need to be established in the EU¹²⁸. For ARTs, the issuer needs to be a legal person or other undertaking established in the EU, or a credit institution authorised under the Capital Requirements Regulation (CRR). For EMTs, the issuer has to be either a credit institution or an e-money institution authorised in the EU.

¹²⁸ A legal person or other undertaking that is established in the European Union and has been authorised to do so in accordance with MiCA by the competent authority of their home Member State.



Issuers of ARTs and EMTs are supervised by national competent authorities (NCAs), unless the ARTs and EMTs are significant, in which case the issuer of the former becomes supervised by the EBA and responsibility for supervising the latter becomes shared by the EBA and NCAs.

During legislative negotiations, the authorisation process was strengthened to limit further the risks of ARTs becoming widely used as a means of exchange. As a result, the European Central Bank (ECB) or a national central bank (NCB) can veto an authorisation on the grounds of concerns related to the smooth operation of payment systems, monetary policy transmission or monetary sovereignty. To enable monitoring of the extent to which ARTs become used as a means of exchange, the issuer will also have to provide quarterly reports for ARTs with an issuance value above €100 million. MiCA also requires issuers to stop further issuance if the estimated number and value of transactions per day associated with uses as means of exchange exceed 1 million transactions per day and €200 million per day within a single currency area. For EMTs, these rules apply only to e-money tokens denominated in a currency which is not an official currency of an EU Member State.

During legislative negotiations, the rules applying to credit institutions issuing ARTs and EMTs were reviewed in order to take into account their being subject to a stringent prudential framework and European banking supervision. Credit institutions accordingly do not need an additional authorisation to issue ARTs and EMTs, but have to notify their supervisor and submit a white paper for approval. This can be vetoed by the ECB/NCBs on the grounds of payment/monetary policy concerns. When issuing ARTs, credit institutions must respect MiCA requirements with the exception of own funds and the acquisition of qualifying holdings (as regulated under the Capital Requirements Regulation/Directive, CRR/CRD). For EMTs, as credit institutions are not subject to Title II of the E-Money Directive (EMD), rules on safeguarding/reserve of assets/own funds requirements do not apply, including significant EMTs. Furthermore, issuers of significant EMTs are not subject to stricter requirements or EBA supervision. But MiCA rules on redemption, prohibition of interest and white paper, including liability, marketing, recovery and orderly redemption apply.

A.2.2.2 Prudential requirements

Issuers of ARTs and EMTs will also be subject to prudential requirements. Issuers of ARTs must have own funds measured as the highest of €350,000, 2% of reserve assets or one-quarter of fixed overhead. The own funds shall consist of Common Equity Tier 1 (CET1). Competent authorities can within certain bounds require issuers to have higher own funds (20% more if believed high risk, or 20-40% more if based on stress test results). Own funds for EMTs are based on Title II EMD, i.e. 2% of average outstanding EMTs. Prudential requirements are stricter for significant ARTs and EMTs (3% of reserves).

A.2.2.3 Reserve requirements

Reserve requirements and redemption arrangements are means to address risks to token holders. These risks are likely to be more pronounced for ARTs and EMTs, as these are more likely to be widely used. MiCA accordingly grants clear redemption rights to holders of ARTs and EMTs and



complements these rights with rules to ensure that issuers of ARTs and EMTs have the reserves necessary to honour redemption requests. This includes rules on how reserves should be composed, managed, invested and safeguarded. While designed to protect token holders and strengthen the soundness of ARTs and EMTs, such rules by design increase links between issuers of ARTs and EMTs and (i) counterparts on the markets where reserve assets are traded, and (ii) institutions charged with holding the reserve assets in custody.

A.2.2.4 Recovery and orderly redemption

Given their potentially wide use, it is important that issuers of ARTs and EMTs can honour potential redemption requests even in periods of stress that risk disrupting their operations. MiCA therefore requires issuers to have recovery plans setting out how they intend to restore compliance with the requirements applicable to the reserve of assets when the issuer fails to comply with those requirements. Issuers should submit their draft plans to NCAs for review. If the issuer fails to comply with reserve requirements, or is likely to fail, NCAs have the power to activate the measures set out in the recovery plan.

An issuer should also have in place redemption plans that set out how it intends to ensure an orderly redemption of ARTs when it is unable to comply with its obligations, e.g. due to insolvency, resolution or withdrawal of authorisation. These measures will be implemented based on a decision by the NCA. The plan should ensure the continuity of critical activities performed by issuers or by any third-party entities which are necessary for the orderly redemption. The draft redemption plan should also be submitted to NCAs for review.

A.2.3 Crypto-asset service providers (CASPs)

CASPs are subject to both generally applicable requirements as well as specific requirements tailored to specific services. MiCA also contains additional provisions for significant CASPs.

A.2.3.1 General requirements

These include several requirements such as authorisation and supervision, prudential requirements and governance and conduct requirements.

Authorisation and supervision: to ensure a regulatory and supervisory grip on entities providing services, a CASP needs to be a legal person or undertaking authorised as a CASP under MiCA, with a registered office, effective management and at least one director in the EU. Some financial institutions authorised under EU financial regulation frameworks (e.g. credit institutions, central securities depositories and investment firms) can provide services without an additional authorisation provided they notify their competent authority in advance.

Prudential requirements: to make sure that a firm can either absorb losses or be wound down in an orderly manner, CASPs must respect prudential requirements that are the higher of permanent



minimum capital requirements (€50,000-150,000 depending on the service) or one-quarter of their fixed overheads.

Governance and organisation: CASPs must have a clear organisational structure, transparent and consistent lines of responsibility, a fit and proper management structure, risk assessment mechanisms and rules for the management of conflicts of interest.

Safekeeping: where the business model leads to holding client funds, MiCA introduces rules to safeguard client funds and prevent use for own account, and requires CASPs to place clients' funds with a central bank or a credit institution.

Market abuse: CASPs must also respect rules for the prevention of market manipulation and insider trading (market abuse).

Operational risk: to protect against hacks and bugs in the blockchain, MiCA also introduces rules on having inadequate IT security procedures and systems in place to guard against cyber risks and IT failures. These specific rules complement the more general rules that CASPs must respect by virtue of falling under the scope of the Digital Operational Resilience Act (DORA).

Money laundering: to ensure that risks of money laundering, terrorism financing and sanctions circumvention are mitigated, CASPs are included in the list of "obliged entities" under the anti-money laundering (AML) framework and as such need to comply with the AML/countering the financing of terrorism rules and procedures, in line with the Financial Action Task Force rules.

A.2.3.2 Service-specific detailed requirements

MiCA also contains dedicated requirements for each of the crypto-asset services it regulates. These are summarised in Table 1. For example, trading platforms are not allowed to deal on own account but can engage in matched principal trading subject to client consent and information to supervisors; supervisors will monitor for conflicts of interest (akin to the MiFID organised trading facility regime). However, they cannot dispose of client funds or assets. Furthermore, CASPs providing custody and administration services will have to separate customer assets from their own assets, be operationally and legally separated from custodian's assets and will also be liable for assets given in custody.



Table 1

MiCA requirements for specific services

Service	Requirements
Custodians	Contractual arrangements with clients, register of positions of clients, asset segregation, liability.
Trading platforms	Operating rules, prohibition of dealing on own account for the CASP, resilience of trading systems, pre- and post-trade transparency, obligation to settle transactions on DLT.
Exchange of fiat to crypto or crypto to crypto	Non-discriminatory commercial policy, obligation to publish a firm price, execution at the price displayed at the time of receipt, transparency on orders and transactions.
Execution of orders	Best execution, clear information to clients on the execution policy.
Placing of crypto-assets	Clear agreement with the issuer before the placing, specific rules on conflicts of interests.
Receipt and transmission of orders	Prompt transmission of orders, prohibition of non-monetary benefits, no misuse of information related to client's orders.
Advice on crypto-assets	Necessary skills and knowledge, assessment of crypto-assets with the needs of clients.

A.2.3.3 Significant CASPs

MiCA confers to NCAs the power to authorise and supervise CASPs. However, for significant CASPs – i.e. those with more than 15 million active users in the EU, on average, over a year – NCAs have to keep ESMA up to date about key supervisory developments. In terms of supervisory consequences, MiCA clarifies that ESMA may use its existing powers to issue opinions, conduct peer reviews and promote coordination of supervision to ensure the orderly functioning and integrity of financial markets or the stability of the financial system in the EU, in particular as regards orders, transactions and activities with significant cross-border effects.

A.2.4 Third-country firms

Issuers wishing to make offers publicly available and/or seek admission to trading in the EU, or CASPs wanting to provide services in the EU, in general must be established in the EU. For issuers of ARTs, as highlighted above, they will have to have a registered office in the EU, while EMT issuers must set up an EU credit or e-money institution. For other crypto-assets, MiCA does not require EU establishment provided the issuer is a legal entity.

For CASPs, as previously outlined, the CASP must be a legal person or undertaking with a registered office, effective management and a director in the EU. The only exemption is if the service is provided at the exclusive initiative of the client. This is subject to limits and conditions, however, to ensure that the third-country firm is not able to build a continuous or dynamic customer relation on this basis.



A.2.5 Transitional provisions

While MiCA covers crypto-assets that have so far not been regulated at EU level, there are some national frameworks regulating certain aspects of these crypto-assets, and some firms have issued assets and provide related services. MiCA therefore contains a number of provisions to ensure an orderly transition to the new rules.

- Crypto-assets other than ARTs/EMTs admitted to trading before MiCA applies need only respect marketing rules and submit white paper within three years.
- CASPs already providing services can continue to do so for another 18 months after MiCA applies unless Member States decide to disallow this provision or reduce its duration.
- Already active issuers of ARTs can continue to issue until they receive authorisation if they seek authorisation when MiCA starts to apply.
- Credit institutions that already issue ARTs can continue to issue provided they notify competent authorities when MiCA starts to apply.

A.3 Valuation of crypto-assets¹²⁹

So far, accounting standard-setters (the Financial Accounting Standards Board (FASB) in the United States and the International Accounting Standards Board (IASB) globally) have focused their attention on unbacked crypto-assets (such as bitcoin),¹³⁰ leaving ample space for the holders of other crypto-assets to account for their holdings. The following analysis considers the accounting treatment of direct holdings of crypto-assets. Holdings of crypto-assets in a custodian capacity (for example, by crypto-asset exchanges), as well as the accounting treatment of liabilities resulting from the issuance of such instruments, are not considered.¹³¹ In any case, given the broad range of products that fall under the umbrella concept of a crypto-asset, the discussion around the accounting treatment for holdings of crypto-assets in the following paragraphs is necessarily mindful of the need to take into consideration the specific terms and conditions of an individual crypto-asset.

A.3.1 Accounting for crypto-assets

From the point of view of the holder, unbacked crypto-assets should be considered intangible assets for accounting purposes (Financial Accounting Standards Board and

¹²⁹ Drafted by the ESRB's Exploratory Group on Accounting Developments and Financial Stability following a request by the HLEG for analysis of (i) the classification and valuation of crypto-assets under IFRS, and (ii) current disclosure requirements affecting regulated financial institutions, taking into account work already foreseen in the context of the implementation of the eventual BCBS framework for the prudential treatment of banks' exposures to crypto-assets.

¹³⁰ See, for example, the **IFRIC Agenda Decision of June 2019**. For further reference, see Ernst & Young (2021) and the European Financial Reporting Advisory Group (2020).

¹³¹ For the accounting of crypto-assets by custodians, the SEC has published a statement requiring their recognition in balance sheets and their valuation at fair value (**SEC.gov | Staff Accounting Bulletin No. 121**). As regards the accounting treatment from an issuer's perspective, the European Financial Reporting Advisory Group launched a dedicated discussion **paper** in July 2020 (European Financial Reporting Advisory Group, 2020).



International Accounting Standards Board, 2022). Such crypto-assets cannot be classified as cash because they are not legal tender and are not backed by sovereign governments.¹³² At the same time, they do not meet the definition of a financial asset, since they are not considered cash or an ownership interest in an entity, nor do they represent a contractual right to receive cash or another financial instrument. Finally, unless crypto-assets are sold within the ordinary course of business of the holder, they cannot be recognised as inventories.¹³³

Under International Financial Reporting Standards (IFRS), intangible assets should, in principle, be measured at cost, subject to annual impairment tests. Generally, International Accounting Standard (IAS) 38 Intangible Assets requires such assets to be measured at cost.¹³⁴ In the particular case of crypto-assets, generally no amortisation requirement would apply given their presumed indefinite life,¹³⁵ but an impairment test would need to be carried out every year, implying in practice that their carrying amount would be the lowest of the acquisition cost and the observable fair value. In terms of capital requirements for banks, the Basel Committee on Banking Supervision (2022) has stated that crypto-assets accounted for as intangible assets should not be deducted from capital as other intangible assets.¹³⁶

Holders of crypto-assets could also decide to measure them at fair value, under the revaluation model of IAS 38, subject to meeting certain criteria. In particular, according to the provisions in IAS 38, the revaluation model can only be applied if the fair value can be determined by reference to an “active market”, defined by IFRS 13 Fair Value Measurement as “a market in which transactions for the asset or liability take place with sufficient frequency and volume to provide pricing information on an ongoing basis”. If crypto-assets were valued under the revaluation model, fair value gains in excess of the acquisition cost would be recognised in other comprehensive income, as revaluation reserves, while fair value losses would go through the profit and loss account. Upon disposal of the crypto-asset, the cumulative revaluation reserve would be transferred to retained earnings. Many crypto-assets are traded in non-regulated platforms or exchanged for other crypto-assets, without any cash involved, and exhibit large volatility in prices, raising concerns about price formation in these markets. Nevertheless, several stakeholders have been pushing accounting standard-setters to allow fair value measurement of certain crypto-assets,¹³⁷ even if determining such fair value may involve a substantial degree of judgement.¹³⁸

Crypto-assets recognised as intangible assets must apply the disclosure requirements in IAS 38. These disclosures comprise a reconciliation between the carrying amount at the beginning and at the end of the reporting period, plus additional information in case they are valued according to the revaluation model. In addition, the framework approved by the Basel Committee on Banking

¹³² E-money tokens, defined as crypto-assets that aim to stabilise their value by referencing only one official currency, could be seen as surrogates for coins and banknotes, likely to be used for making payments, similarly to electronic money.

¹³³ If crypto-assets were sold within the ordinary course of business of the holder and accounted for as inventories, according to IAS 2, Inventories, they would be valued at the lower of cost and either net realisable value or fair value less costs to sell, with changes recognised in profit or loss.

¹³⁴ For a summary of IAS 38, see [IAS 38 - IAS Plus](#).

¹³⁵ Should the crypto-asset be deemed to have a definite life, it would need to be amortised according to IAS 38.

¹³⁶ The rationale is twofold: first, the accounting treatment does not recognise the different types of crypto-assets; additionally, regarding the unbacked crypto-assets referred to in the (IASB) accounting treatment, the BCBS opts for a more conservative approach, applying a 1,250% risk weighting instead of the deduction.

¹³⁷ See International Swaps and Derivatives Association (2022).

¹³⁸ If the crypto-asset was measured at fair value, the disclosure requirements in IFRS 13 would apply in any case.



Supervision (2022) requires banks to disclose qualitative information that sets out an overview of the bank's activities related to crypto-assets and main risks related to their crypto-asset exposures, as well as information on (i) the direct and indirect exposure amounts (including the gross long and short components of net exposures), (ii) the capital requirements, and (iii) the accounting classification.

Some crypto-assets (including some stablecoins, security tokens and other tokenised traditional assets) could meet the definition of financial assets and thus be classified according to IAS 32 Financial Instruments: Presentation and IFRS 9 Financial Instruments.

To this end, the contractual rights and the underlying assets should be assessed. IAS 32 defines a financial instrument as any contract that gives rise to a financial asset of one entity and a financial liability or equity instrument of another entity. This would apply to crypto-assets that represent cash held in custody, crypto-assets that are both contractual and embody a right to receive cash or another financial asset, or crypto-assets that embody a contractual right to a residual interest in the net assets of an entity (in which case the crypto-asset would be considered an equity instrument). In these instances, the provisions of IFRS 9 would fully apply.¹³⁹ Finally, in the case of derivative contracts on crypto-assets, the related accounting treatment would depend on different factors, including in particular (i) the contractual characteristics (i.e. whether the derivatives can be settled net in cash or another financial instrument, or by exchanging financial instruments, as if the contracts were financial instruments); and (ii) whether the contracts are entered into for the purpose of the receipt or delivery of a non-financial item in accordance with the entity's expected purchase, sale or usage requirements. If the crypto-asset is readily convertible to cash or the related contract can be settled net in cash, the latter could be treated as a derivative, even if the underlying crypto-asset were not considered a financial instrument.¹⁴⁰

A.3.2 Final considerations

In general, accounting for crypto-assets is a complex topic, still subject to substantial uncertainty and allowing substantial leeway for holders to define the applicable accounting policies. This uncertainty is not caused by accounting standards themselves but is directly related to the definition of crypto-assets, which encompasses a broad range of assets with different characteristics. In general, the holder of crypto-assets may need to analyse on a case-by-case basis the most appropriate accounting treatment. However, given the growth experienced by crypto-assets in recent years (exceeding €2.5 trillion at the peak of their valuation in 2021, according to Guagliano and Kern, 2022) and the current opacity of the related markets (which also translates into large volatility in their prices), providing additional guidance on the accounting for holdings of crypto-assets, or even deciding on the accounting treatment of crypto-assets other than unbacked, could prove beneficial for users of IFRS financial statements.¹⁴¹

¹³⁹ For a summary of IFRS 9, see [IFRS 9 - IAS Plus](#).

¹⁴⁰ See Ernst & Young (2021).

¹⁴¹ See, for example, "[Crypto contagion isn't over and the lack of transparency means the industry is an 'insider's game,' EY blockchain chief says](#)". The collapse of FTX also provides insights on the importance of accounting for crypto-assets in a consistent and transparent manner (see [The Fall of FTX and How Transparent Accounting Can Restore Crypto's Future](#) and House Financial Services Committee, 2022).



Several initiatives could be considered to address the current uncertainty. As noted by the European Financial Reporting Advisory Group (2020), these initiatives could take the form of additional accounting guidance on the classification of crypto-assets other than unbacked, targeted amendments to existing IFRS standards or the issuance of a dedicated IFRS standard on crypto-assets. Doing nothing would maintain the current level of uncertainty in the accounting of crypto-assets, with the broad category of unbacked crypto-assets requiring recognition and measurement as intangible assets, other crypto-assets meeting the definition of financial asset or inventory, and a residual category, comprising crypto-assets not meeting any of the existing definitions in IFRS standards, where holders would apply IAS 8 Accounting Policies, Changes in Accounting Estimates and Errors and develop their own accounting policy. While the current size of the crypto-asset market is currently limited, this uncertainty could lead to lower transparency and comparability of information, which could have adverse consequences for financial stability if the systemic importance of crypto-assets significantly increased over the short term. In this regard, the banking regulatory framework has already addressed the prudential treatment of crypto-assets (Basel Committee on Banking Supervision, 2022), with a comprehensive analysis of their different characteristics.

While the IASB has decided not to give priority to the accounting of crypto-assets, the FASB has announced its intention to issue an exposure draft on unbacked crypto-assets and has decided they should be measured at fair value. The FASB has argued that measuring crypto-assets at fair value would better align their measurement with that of other assets held for investment purposes such as financial instruments measured at fair value.¹⁴² According to the decision taken during the Third Agenda Consultation of the IASB in 2022, there will be no separate project on crypto-asset and related transactions, although many respondents recommended that the IASB include a project on accounting for such items in its work plan. The IASB considered that crypto-assets were not material in current balance sheets and, also considering its limited resources, decided not to treat it as a stand-alone priority. The IASB will consider crypto-assets within the new project on the review of requirements for intangible assets (IAS 38), with activities expected to start in 2024.

A.4 Glossary

Although the terminology used in the crypto-asset ecosystem often relies heavily on the terminology already well established in the traditional financial system, it is necessary to exercise caution in its interpretation. For example, the term “assets” often denotes something that is valuable, but crypto-assets cannot be defined as having a clear intrinsic value. Furthermore, while decentralised finance contains the word “decentralised”, it is not always a truly decentralised system. Relative price stability may not be the case for all stablecoins, owing to variations in the ways in which they are pegged, the nature of reserve assets (if any) and their governance structure. The use of “coins” in stablecoins can be misleading as well, since coins are associated with money, and stablecoins cannot be considered actual money. While these and similar terms are

¹⁴² See Lugo (2022).



still used within this report in order to be consistent with established international work on the topic, they should not give a false indication of legitimacy.

Table 2
Glossary

Algorithmic stablecoin	A stablecoin that aims to maintain its peg without maintaining reserve assets, instead relying on an on-chain algorithm and/or smart contract that manages the supply of tokens in circulation. A common feature is a set relationship to a second crypto-asset token, wherein trading between the stablecoin and second token is intended to offer arbitrageurs profitable opportunities to return the stablecoin to its peg. The algorithm fails, however, if both the stablecoin and the crypto-asset token simultaneously drop in price, resulting in what is colloquially called a “death spiral.”
Asset-backed token	A crypto-asset that represents an interest in a physical asset.
Blockchain	A form of distributed ledger in which details of transactions are held in the ledger in the form of blocks of information. A block of new information is attached to the chain of pre-existing blocks via a computerised process (commonly called a consensus mechanism) by which transactions are validated (by participants in the network).
Crypto-asset	A type of private sector digital asset that depends primarily on cryptography and distributed ledger or similar technology. It can be transferred and stored electronically.
Crypto-asset trading platform	Any trading platform where crypto-assets can be bought and sold, regardless of the platform’s legal status.
Cryptography	The conversion of data into private code using encryption algorithms, typically for transmission over a public network.
Decentralised autonomous organisation (DAO)	A blockchain-enforced organisational structure that emphasises community, as opposed to centralised, governance. It involves mechanisms such as decision-making based on votes by “governance token” holders rather than control by management or a board of directors.
Decentralised applications (dApps)	Software applications built from smart contracts, often integrated with user interfaces using traditional web technology. These run on peer-to-peer networks or blockchain networks instead of centralised servers.
Decentralised finance (DeFi)	A set of alternative financial markets, products and systems that operate using crypto-assets and “smart contracts” (software) built using distributed ledger or similar technology.
Decentralised exchange (DEX)	A decentralised finance protocol that creates markets for exchanging one crypto-asset for another.
Digital asset	A digital instrument that is issued or represented through the use of distributed ledger or similar technology. This does not include digital representations of fiat currencies.
Distributed ledger technology (DLT)	A means of saving information through a distributed ledger, i.e. a repeated digital copy of data available at multiple locations. It enables the operation and use of distributed ledgers.
FinTech	Technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services.
Global stablecoin	A stablecoin with a potential reach and use across multiple jurisdictions and which could become systemically important in and across one or many jurisdictions, including as a means of making payments.
Mining	A means to create new crypto-assets, often through a mathematical process by which transactions are verified and added to the distributed ledger.
Oracle	A third-party service enabling smart contracts to access external data, on-chain or off-chain, that may be an input for that smart contract’s functionality.



Proof of stake (PoS)	A decentralised consensus mechanism that requires members of a network to stake (lock up) crypto-asset units in order to obtain the right to validate transactions. Validators are rewarded by newly created crypto-asset units. The probability of a participant being chosen to validate a block of transactions is based on the amount of staked crypto-assets. PoS was created as a less energy-intensive alternative to proof of work, the original consensus mechanism used to validate transactions and add new blocks to the blockchain.
Proof of work (PoW)	A decentralised consensus mechanism that requires members of a network to expend effort solving an arbitrary mathematical puzzle in order to gain the right to append a block of validated transactions to the chain. The probability of a participant being chosen to validate a block of transactions is related to the computing power expended by the participant in solving the puzzle. The goal of PoW is to increase the cost of manipulating the ledger by introducing fraudulent transactions. PoW is used widely for validating transactions on blockchains.
Protocol	Specific combinations of crypto-assets, smart contracts and user applications that are necessary for specific decentralised finance applications, including any related functional components such as user interfaces, oracles, governance and voting mechanisms, developing grants and foundations, and financial assets such as tokens, Treasuries and funds. Some of these components may be automated, and some may be carried out by individuals and entities.
Smart contract	A collection of code and data that is deployed using cryptographically signed transactions on the blockchain network. The smart contract is executed by nodes within the blockchain network; all nodes must derive the same results for the execution, and the results of execution are recorded on the blockchain.
Stablecoin	A crypto-asset that aims to maintain a stable value relative to a specified asset or a pool or basket of assets.
Total value locked (TVL)	A common metric of the size of decentralised finance protocols. It measures the value of crypto-assets or other tokens that have been transferred to the smart contracts underlying a decentralised finance protocol. Since these protocols differ in design, TVL is not a standardised measure, and reported values for specific protocols can vary substantially.
Unbacked crypto-assets	Crypto-assets that are neither tokenised traditional assets nor stablecoins.
Wallet	An application or device for storing the private keys providing access to the crypto-asset. Hosted wallets are typically services where the keys are held by a third-party provider on behalf of the client, while un-hosted wallets typically enable the users to hold and use the keys themselves.
Wallet provider	A firm that offers wallet services to holders of crypto-assets. These may involve holding private keys so that they are accessible online to the client in order to initiate transactions ("hot" storage) or keeping the keys offline ("cold" storage).

Sources: *Financial Stability Board (2022a)*, *Azar et al. (2022)* and Regulation (EU) 2022/858 of the European Parliament and of the Council of 30 May 2022 on a pilot regime for market infrastructures based on distributed ledger technology, and amending Regulations (EU) No 600/2014 and (EU) No 909/2014 and Directive 2014/65/EU.



References

- Agrawal, H. (2023), "**8 Best Crypto Margin Trading Exchanges Compared (2023)**", *Coinsutra*, 17 February.
- Aramonte, S., Huang, W. and Schrimpf, A. (2021), "**DeFi risks and the decentralisation illusion**", *BIS Quarterly Review*, Bank for International Settlements, December.
- Asgari, N. and Franklin, J. (2023), "**Silvergate shares tumble as crypto bank reveals \$8.1bn fall in deposits**", *Financial Times*, 5 January.
- Auer, R., Farag, M., Lewrick, U., Orazem, L. and Zoss, M. (2022), "**Banking in the shadow of Bitcoin? The institutional adoption of cryptocurrencies**", *BIS Working Papers*, No 1013, Bank for International Settlements, May.
- Auer, R., Frost, J. and Vidal Pastor, J.M. (2022), "**Miners as intermediaries: extractable value and market manipulation in crypto and DeFi**", *BIS Bulletin*, No 58, Bank for International Settlements, June.
- Azar, P.D., Baughman, G., Carapella, F., Gerszten, J., Lubis, A., Perez-Sangimino, J.P., Rappoport, D.E., Scotti, C., Swem, N., Vardoulakis, A. and Werman, A. (2022), "**The Financial Stability Implications of Digital Assets**", *Finance and Economics Discussion Series*, No 2022-058, Board of Governors of the Federal Reserve System, Washington, July.
- Basel Committee on Banking Supervision (2022), "**Prudential treatment of cryptoasset exposures**", Bank for International Settlements, December.
- Basel Committee on Banking Supervision (2023), "**Basel III Monitoring Report**", Bank for International Settlements, February.
- Benigno, G. and Rosa, C. (2023), "**Is There a Bitcoin-Macro Disconnect?**", *Liberty Street Economics*, Federal Reserve Bank of New York, 8 February.
- Biesenbach, A. and Cipriani, M. (2012), "**The Flash Crash, Two Years On**", *Liberty Street Economics*, Federal Reserve Bank of New York, 7 May.
- Binance (2020a), "**What Are Binance Leveraged Tokens**", 4 June.
- Binance (2020b), "**How to Use the Isolated Margin Trading Mode on Binance**", 28 June.
- Binance (2022a), "**Introduction to Binance Simple Earn**", 22 September.
- Binance (2022b), "**Binance secures Virtual Asset Service Provider registration in Spain**", 8 July.
- BitcoinCore (2018), "**CVE-2018-17144 Full Disclosure**", September.



Buiter, W., Cecchetti, S., Dominguez, K. and Sánchez Serrano, A. (2023), "**Stabilising financial markets: lending and market making as a last resort**", *Reports of the Advisory Scientific Committee*, No 13, European Systemic Risk Board, January.

Buterin, V. (2021), "**Why sharding is great: demystifying the technical properties**", *Vitalik.ca*, 7 April.

Bybit (2022), "**Introduction to Bybit Leveraged Tokens**", 10 June.

Chainalysis (2022), "**The Chainalysis 2022 Geography of Cryptocurrency Report**", October.

Chicago Board Options Exchange, "**U.S. Equities Market Volume Summary**".

Chow, A. (2022), "**The Real Reasons Behind the Crypto Crash, and What We Can Learn from Terra's Fall**", *Time*, 17 May.

Circle (2023), "**Update on USDC operations**", 15 March.

CME Group, "**Bitcoin, Futures and Options**".

CoinGecko, "**Cryptocurrency Prices, Charts, and Crypto Market Cap**".

CoinMarketCap, "**XRP**".

Committee on Payment and Settlement Systems (2001), "**Core Principles for Systemically Important Payment Systems**", *CPMI Papers*, No 43, Bank for International Settlements, January.

Committee on Payments and Market Infrastructures and Board of the International Organization of Securities Commissions (2022), "**Application of the Principles for Financial Market Infrastructures to stablecoin arrangements**", Bank for International Settlements, July.

Commodity Futures Trading Commission (2023), "**Complaint for injunctive and other equitable relief and civil monetary penalties under the Commodity Exchange Act and Commission Regulations**", Illinois, March.

Cong, L.W., Li, X., Tang, K. and Yang, Y. (2022), "**Crypto Wash Trading**", *NBER Working Papers*, No 30783, National Bureau of Economic Research, December.

Council of the European Union (2022a), "**Digital finance: agreement reached on European crypto-assets regulation (MiCA)**", press release, 30 June.

Council of the European Union (2022b), "**Proposal for a Regulation of the European parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937 (MiCA) – 20209/0265 (COD)**", October.

CryptoCompare, "**Cryptocurrency Prices, Portfolio, Forum, Rankings**".

CryptoRank, "**Crypto Exchanges Ranked By Adjusted Volume (Spot)**".

del Castillo, M. (2016), "**Ethereum Executes Blockchain Hard Fork to Return DAO Funds**", *CoinDesk*, July.



Ernst & Young (2021), "**Applying IFRS: Accounting by holders of crypto assets**", October.

Etherscan (2022), "**Ethereum Blockchain Daily Transactions in 2022**".

European Banking Authority (2022a), "**Risk Assessment Questionnaire – Summary of Results**", autumn.

European Banking Authority (2022b), "**EBA provides its advice to the EU Commission on non-bank lending**", press release, 4 May.

European Banking Authority (2022c), "**EBA replies to European Commission's call for advice on the review of the Payment Services Directive**", press release, 23 June.

European Banking Authority (2022d), "**The ESAs recommend actions to ensure the EU's regulatory and supervisory framework remains fit-for-purpose in the digital age**", press release, 7 February.

European Central Bank (2021), "**Eurosystem oversight framework for electronic payment instruments, schemes and arrangements**", November.

European Central Bank (2023), "**Take-aways from the horizontal assessment of the survey on digital transformation and the use of fintech**", February.

European Financial Reporting Advisory Group (2020), "**Accounting for crypto-assets (liabilities): holder and issuer perspective**", July.

European Securities and Markets Authority (2022), "**EU financial regulators warn consumers on the risks of crypto-assets**", press release, 17 March.

European Systemic Risk Board (2014), "**Flagship Report on Macro-prudential Policy in the Banking Sector**", March.

European Systemic Risk Board (2016), "**Macroprudential policy beyond banking: an ESRB strategy paper**", July.

European Systemic Risk Board (2020), "**Macroprudential implications of financial instruments in Levels 2 and 3 for accounting purposes**", February.

European Systemic Risk Board (2022), "**EU Non-Bank Financial Intermediation Risk Monitor 2022**", *NBFI Monitor*, No 7, July.

Executive Office of the President of the United States (2023), "**U.S. Economic Report of the President**", Washington D.C., March.

Federal Reserve System (2023), "**Order Denying Application for Membership**", Wyoming, January.

Financial Accounting Standards Board and International Accounting Standards Board (2022), "**Staff paper**", *Joint Education Meeting*, September.



Financial Conduct Authority (2019), “**Guidance on Crypto-assets**”, *Consultation Papers*, No 3, January.

Financial Stability Board (2017), “**Policy Recommendations to Address Structural Vulnerabilities from Asset Management Activities**”, January.

Financial Stability Board (2020), “**Regulation, Supervision and Oversight of ‘Global Stablecoin’ Arrangements**”, October.

Financial Stability Board (2022a), “**Assessment of Risks to Financial Stability from Crypto-assets**”, February.

Financial Stability Board (2022b), “**FSB warns of emerging risks from crypto-assets to global financial stability**”, press release, 16 February.

Financial Stability Board (2022c), “**International Regulation of Crypto-asset Activities – Questions for consultation**”, 11 October.

Financial Stability Board (2022d), “**Review of the FSB High-level Recommendations of the Regulation, Supervision and Oversight of ‘Global Stablecoin’ Arrangements**”, October.

Financial Stability Board (2022e), “**FSB Europe Group discusses financial stability outlook and policies to address risks from crypto-asset activities**”, press release, 10 November.

Financial Stability Board (2022f), “**Regulation, Supervision and Oversight of Crypto-Asset Activities and Markets**”, October.

Financial Stability Board (2023), “**The Financial Stability Risks of Decentralised Finance**”, February.

Fricke, D. and Wilke, H. (2020), “**Connected funds**”, *Discussion Papers*, No 48, Deutsche Bundesbank, August.

FT Alphaville (2023), “**The Crypt, updated**”, *Financial Times*, 14 March.

Glassnode, “**Glassnode – On-chain market intelligence**”.

Guagliano, C. and Kern, S. (2022), “**Crypto-assets and their risks for financial stability**”, *ESMA TRV Risk Analysis*, European Securities and Markets Authority, October.

House Financial Services Committee (2022), **Testimony of Mr. John J. Ray III, CEO, FTX Debtors**, 13 December.

Howcroft, E. (2023), “**Crypto investors pull \$3 bln from stablecoin USDC in three days**”, Reuters, 16 March.

IASPlus.com, “**IAS 38 – Intangible Assets**”.

IASPlus.com, “**IFRS 9 – Financial Instruments**”.



International Financial Reporting Standards Interpretation Committee (2019), "**Holdings of Cryptocurrencies**", June.

International Swaps and Derivatives Association (2022), "**Accounting for Digital Assets: Key Considerations**", May.

Investing.com, "**MSCI World Historical Data**".

Jensen, J.R., von Wachter, V. and Ross, O. (2021), "**How Decentralized is the Governance of Blockchain-based Finance: Empirical Evidence from four Governance Token Distributions**", February.

Kaye, B. (2022), "**Australian stock exchange's blockchain failure burns market trust**", Reuters, 20 December.

Kearney, J.J. and Perez-Delgado, C.A. (2021), "**Vulnerability of blockchain technologies to quantum attacks**", *Array*, Vol. 10, July.

Lugo, D. (2022), "**U.S. Accounting Rulemakers Agree That Crypto Assets Should be Measured at Fair Value**", Thomson Reuters, 17 October.

Makarov, I. and Schoar, A. (2022), "**Cryptocurrencies and Decentralized Finance**", *BIS Working Papers*, No 1061, Bank for International Settlements, December.

Malta Financial Services Authority (2020), "**Public Statement**", 21 February.

McGuinness, M. (2021), "**The ESRB at 10 years – key achievements and future challenges**", European Commission, December.

Mersch, Y. (2019), "**Money and private currencies: reflections on Libra**", speech at the ECB Legal Conference, Frankfurt am Main, 2 September.

Moller, A.P. (2022), "**Maersk and IBM Abandon Blockchain TradeLens Platform**", *The Maritime Executive*, 30 November.

Office of Financial Research, "**U.S. Money Market Fund Monitor**".

Palma, S., Chaffin, J., Oliver, J. and Shubber, K. (2022), "**Sam Bankman-Fried charged in one of 'biggest financial frauds' in US history**", *Financial Times*, 13 December.

Polygon (2022), "**Polygon 2022 Rewind**", 20 December.

Roukny, T. (2022), "**Decentralized Finance: information frictions and public policies – Approaching the regulation and supervision of decentralized finance**", European Commission, June.

Shevchenko, A. (2020), "**For Some Reason, Wash Trading Happens on Decentralized Exchanges Too**", *Cointelegraph*, 25 July.



Sor, Jennifer. (2022), "**Crypto contagion isn't over and the lack of transparency means the industry is an 'insider's game,' EY blockchain chief says**", *Business Insider*, 20 December.

Stempel, J. (2022), "**U.S. charges fraud in Mango crypto manipulation case**", Reuters, 27 December.

Sultanik, E., Brunson, T., Myers, M., Remie, A., Moelius, S., Amir, T., Manzano, F., Klimer, E. and Schriener, S. (2022), "**Are Blockchains Decentralized? Unintended Centralities in Distributed Ledgers**", *Trail of Bits*, June.

Taxbit (2022), "**The Fall of FTX and How Transparent Accounting Can Restore Crypto's Future**", November.

Tether (2022), "**Transparency**", December.

The Guardian (2022), "**Coinbase employee mired in first insider trading case involving cryptocurrency**", 12 September.

U.S. Department of the Treasury (2021), "**President's Working Group on Financial Markets Releases Report and Recommendations on Stablecoins**", press release, 1 November.

U.S. Securities and Exchange Commission (2022), "**BlockFi Agrees to Pay \$100 Million in Penalties and Pursue Registration of its Crypto Lending Product**", press release, 14 February.

U.S. Securities and Exchange Commission (2022), "Staff Accounting Bulletin No. 121", 11 April.

Visa (2022), **Annual Report 2022**.

Weathley, J. and Klasa, A. (2021), "**Cryptocurrencies: developing countries provide fertile ground**", *Financial Times*, 4 September.

Wright, L.A. (2022), "**You can redeem Tether USDT 1:1 on tether.to but there's a catch**", *CryptoSlate*, 12 May.



Imprint and acknowledgements

This report was prepared by the ESRB Task Force on Crypto-Assets and Decentralised Finance (CATF), following on from work initiated by the ESRB High-Level Exploratory Group on Crypto-Assets and Decentralised Finance.

CATF Chairs

Steffen Kern (ESMA)	Richard Portes (London Business School)
---------------------	---

Working Group Leads

Policy options	Elisabeth Noble (EBA)
----------------	-----------------------

Systemic implications	Stephen G. Cecchetti (Brandeis University)
-----------------------	--

Secretary

Jean Quin (ESRB Secretariat)

Team members

Hilary Allen	Alexandra Born	Nicola Branzoli
Louis Brune	Vera Frijters	Adam Glogowski
Wenqian Huang	Mette Kanstrup Petry	Urszula Kochanska
Mattias Levin	José Ramón Martínez Resano	Katja Neugebauer
Georg Paula	Loriana Pelizzon	Tatu Räsänen
Édouard Vidon	Melanie Wulff	

© European Systemic Risk Board, 2023

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

All rights reserved. Reproduction for educational and non-commercial purposes is permitted provided that the source is acknowledged.

The cut-off date for the data included in this report was 10 March 2023.

For specific terminology please refer to the [ESRB glossary](#) (available in English only).

PDF	ISBN 978-92-9472-339-0, doi:10.2849/131265, DT-07-23-204-EN-N
-----	---