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CRYPTO-ASSET MARKETS: STRUCTURE, MARKET DEVELOPMENTS IN 2022 AND POLICY CONSIDERATIONS*

ABSTRACT

This paper provides a conceptual framework to analyse risks and vulnerabilities in crypto-asset markets and describes the episodes of stress observed in these markets in 2022. The analysis is used to provide preliminary policy considerations that are relevant for financial stability. We highlight the importance of setting a clear perimeter for financial regulation and of developing global rules to address financial stability risks in the areas covered by financial regulation following the principle “same risk, same regulatory outcome”. Authorities could discourage and monitor exposures of supervised or overseen operators to areas not directly covered by financial regulation while trying to incentive the adoption of safe and sound risk management practices by entities involved or operating in these areas. Finally, we provide concrete proposals to implement these considerations.

Keywords: Cryptoassets; Financial Stability; Stablecoin; Decentralized Finance; Leverage; Investor Run

JEL Classification: G0; G1; G18

RIASSUNTO

Mercati delle criptoattività: struttura, sviluppi del mercato nel 2022 e considerazioni di policy

L'articolo fornisce un quadro concettuale per analizzare i rischi e le vulnerabilità nei mercati delle criptoattività e descrive gli episodi di stress osservati in questi mercati nel 2022. L'analisi viene utilizzata per proporre alcune considerazioni preliminari di policy rilevanti per la stabilità finanziaria. Viene evidenziata l'importanza di definire chiaramente il perimetro di applicazione

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della regolamentazione finanziaria e di sviluppare regole globali per ridurre i rischi per la stabilità finanziaria seguendo il principio “stesso rischio, stesso risultato normativo” nelle aree soggette alla regolamentazione finanziaria. Le autorità potrebbero scoraggiare e monitorare le esposizioni degli operatori vigilati o sorvegliati verso le aree non direttamente comprese nel perimetro della regolamentazione finanziaria, incentivando al contempo l’adozione di pratiche di gestione del rischio prudenti da parte dei soggetti coinvolti o operanti in queste aree. Infine vengono fornite proposte concrete per attuare queste considerazioni.

1. INTRODUCTION

Technological progress is continuously transforming financial intermediation. Some of the latest and potentially transformative innovations involve the use of distributed ledger technologies (DLTs) for the provision of financial services. These technologies create multiple copies of a database that can store, process and disseminate information on digital assets across multiple locations and entities within a short period of time, sometime just a few seconds.

The use of DLTs in combination with cryptography allows the creation of new types of private digital assets, so-called crypto-assets, that have been developed to perform several economic functions, including payments, investment and insurance. In practice, however, the thousands of crypto-assets that exist today are mainly used for speculative activities. Over the last fifteen years, these instruments have become the centre of a complex ecosystem made of investors, service and technology providers that reached almost \$3 trillion on total market capitalization at the global level at its peak in November 2021.

In this paper, we propose a conceptual framework for crypto-asset ecosystems building on recent work by academics and international organizations and use it to describe the turmoil observed in these markets in 2022. The proposed framework has two main building blocks. The first is a mapping of crypto-assets, i.e. a set of broad categories of these instruments based on their characteristics that are relevant for financial stability. We highlight three main categories of crypto-assets: traditional assets such as stocks and bonds issued on DLTs; stablecoins, i.e. crypto-assets that aim to maintain a stable value relative to other asset(s); unpegged crypto-assets, which have no clear parallel in the traditional financial system. The second building block is a stylized mapping of crypto-assets markets. We argue that this ecosystem has a multi-layered

structure and we describe the main vulnerabilities associated to each layer. These vulnerabilities are related, in particular, to operational risks, leverage, liquidity/maturity transformation, collateral risk, concentration risk.

We argue that these vulnerabilities played a key role during the strains in 2022. The episodes of stress initiated from two main events. The first is the collapse of the algorithmic stablecoin UST in May¹, which determined a series of defaults related, in particular, to the insolvency of the hedge fund Three Arrows Capital (3AC) and its lenders. The second event is the bankruptcy of FTX, one of the largest centralised exchange platform, in November. This event raised uncertainty on the governance and on the transparency of several exchanges and lending platforms operating in crypto-asset markets.

These events followed similar patterns. The market lost confidence in the stability of a building block of the market, either a stablecoin or a large trading platform. The loss of trust was followed by investors' runs and by the inability of the stressed intermediaries to maintain obligations with their clients due to poor risk management practices and inadequate regulation. Direct exposures of crypto-asset service providers to these entities and leverage transmitted and amplified the stress to the broader crypto-asset ecosystem.

We use the conceptual framework and the events described to provide some policy considerations related to the development of a regulatory framework to address financial stability risks from crypto-asset ecosystems. In particular, we highlight that there are inherent challenges in regulating some parts of the crypto-asset ecosystems, such as algorithmic stablecoins, permissionless DLTs and decentralized governance structures. In light of these challenges, authorities should set a clear perimeter defining entities, tokens and activities that can be effectively regulated and develop common rules to address financial stability risks in these areas. Rules for crypto-asset issuers and service providers that can be effectively regulated should achieve the same regulatory outcomes as those set for financial intermediaries performing similar activities in the traditional financial system. Furthermore, authorities should limit interconnections between these parts and the financial system, such as those stemming from direct and indirect exposures of regulated entities and support the identification

¹ An algorithmic stablecoin is a token whose value is stabilized through the use of algorithms. See Box 1 for more details.

of good practices for the management of risks by entities involved or operating in areas not directly covered by financial regulation. The regulatory perimeter for crypto-asset ecosystems should be regularly reviewed and could be modified if there are material changes in the functioning of these markets. Finally, we provide concrete proposals to implement these ideas, including the development of regulation for crypto-asset exchanges similar to the one applicable to traditional trading platforms, forbidding exchanges to list algorithmic stablecoins and limiting the amount of leverage that retail investors can obtain on exchange platforms.

The rest of the paper is structured as follows. Section 2 describes the conceptual framework used for the analysis and discusses the main risks in this sector; this section contains two boxes that focus on the main distinctions among different types of stablecoins and on the differences across different types of trading platforms. Section 3 provides a critical analysis of the turmoil in crypto-asset markets observed in 2022. Two boxes in this section provide insights on the investments of 3AC and on the crypto platforms mainly affected by the market stress. Section 4 provides the policy considerations. Section 5 concludes.

2. A CONCEPTUAL FRAMEWORK FOR CRYPTO-ASSET ECOSYSTEMS

In this section, we propose a conceptual framework for crypto-asset ecosystems based on recent work by academics and international organizations (CPMI, 2022; FSB, 2022a; G7 Working Group on Stablecoins, 2019; IOSCO, 2022; Schär, 2021). This framework has two building blocks. The first building block is a mapping of crypto-assets, i.e. a classification of these instruments based on their characteristics that are relevant for financial stability. The second building block is a stylized mapping of crypto-assets markets (i.e. the set of technologies, entities, services and the interlinkages among them) and of the related main risks.

2.1 Mapping of Crypto-Assets

There is no agreed taxonomy of crypto-assets at the international level. Although these instruments exist since 2009, authorities are struggling with their classification because many of these assets do not have the characteristics of traditional financial assets². The criteria proposed

² For example, crypto-assets like Ether and Bitcoin do not have an issuer and therefore may be considered more similar to (digital) commodities than to financial assets; governance tokens, which provide voting rights in the

in this paper aim at the application of the principle of “same activity, same risk, same regulation” to crypto-asset service providers.

In particular, we use a mapping of crypto-assets based on the risks that they create for consumers and the financial system. Several criteria are potentially relevant for the classification and regulatory treatment of crypto-assets³. Figure 1 suggests a high-level mapping with three main categories, which are based on the degree of similarity between crypto-assets and existing financial assets or instruments, and provides additional criteria that can be relevant to define risk-based sub-categories. This high-level mapping is consistent with recent work at the European and international level⁴.

Tokenized traditional assets, the category to the left of Figure 1, are the most similar to existing assets. Real world examples of tokenized traditional assets are bonds recently issued by the European Investment Bank and the World Bank among others and structured financial products (i.e. medium term notes) issued by Société Générale. This category can also include tokenized instruments similar to bank deposits (e.g. JPMorgan Coin) and digital representations of real assets on DLTs, such the property rights of a real estate that are stored and exchanged on DLTs (Eder, 2019; EIB, 2021; Liao and Caramichael, 2022; WB, 2019).

A classification of tokenized traditional assets can broadly follow standard approaches, with additional criteria based on the characteristics of the DLT on which tokenized traditional assets are traded. The development of the market of tokenized traditional assets would bring the benefits of DLTs (mainly related to transparency and efficiency gains) without significant disruptions to the structure of the financial system (OECD, 2020). Tokenized traditional assets have a well-identified issuer whose ability to keep its financial obligations (e.g. pay interests on a

governance of DLT-related applications, may be similar to stocks, except that they do not provide a stream of dividends.

³ For an extensive list of criteria to classify crypto-assets see, for example, Bullmann *et al.* (2019). Two possible classification criteria that have caused confusion among authorities around the world relate to the intended and the actual economic function of crypto-assets. The former relates to crypto-asset economic function foreseen by its issuer/distributor, such as whether the crypto-asset should be used as a means of payment, an investment asset, or to grant holders access to a service or product or other. The latter relates to the most common use of the crypto-asset by its holders. A well-known example of crypto-asset for which the intended and actual economic function differ is Bitcoin, which has been created to provide a means of payment but it is mainly used as a speculative asset. Tax authorities have often treated Bitcoin as a currency, thus following the intended economic function, while financial authorities have often considered it broadly similar to an investment asset, thus following the actual economic function.

⁴ See for example the Markets in crypto-assets regulation in Europe and the public consultations of the Basel Committee (BCBS, 2022).

bond or dividends on a stock) can be assessed using standard methods based, for example, on credit ratings and earnings report. Market and liquidity risks of tokenized traditional assets can also be assessed using common approaches, provided that there are enough certified data on trading activities on the DLT (on-chain data) and on exchange platforms (off-chain data)⁵. While on a conceptual level these tokens would not create particular issues, new risks could still be connected with the use of DLTs in financial markets, related for example to the permissioned vs. permissionless nature of these technologies and their consensus mechanisms (e.g. proof-of-work, proof-of-stake)⁶.

FIGURE 1 – *High-Level Classification of Crypto-Assets*

Tokenized traditional assets	Stablecoins (or «referenced crypto-assets»)	Unreferenced crypto-assets
Like: stocks, bonds, real estate	Like: investment funds	Like: lack of similarity with traditional financial assets/instruments depends on rights and obligations of token holders (case-by-case analysis)
Sub-categories based on: • DLT characteristics • Type of tokenized asset	Sub-categories based on: • DLT characteristics • Type of referenced asset (i.e. fiat money, commodity, financial asset) • Identifiable issuer • Stabilization mechanism	Sub-categories based on: • DLT characteristics; • rights and obligations associated to the crypto-asset; • presence of an identifiable issuer.
Examples Bonds issued by: • World Bank • European Investment Bank • SocGen	Examples • \$-based: Tether, USDCircle • €-based: EurTether, EURCircle, EurSys (mkt cap around €500M)	Examples • Bitcoin; • Ether; • Utility tokens (access to goods and services) • Governance tokens (voting rights) • NFTs (digital “art”)
Estimated mkt cap: <\$1B	Estimated mkt cap: \$130B	Estimated mkt cap: \$700B

Source: authors' elaboration.

⁵ There are two broad types of transactions of crypto-assets. On-chain transactions are those recorded on the DLT; off-chain ones are registered on ledgers held by crypto-asset service providers (mainly exchanges).

⁶ In permissionless DLTs, anyone can be a validator, i.e. own a node in the network that can verify and authorize transactions on the ledgers that all the participants within the network can access. In permissioned DLTs, validators are selected by the entity that govern the DLTs and are generally members of a consortium. In a DLT based on proof-of-work, validators verify and authorize transactions by spending computational effort. Proof-of-stake (PoS) protocols select validators in proportion to their quantity of crypto-asset holdings. This avoids the computational cost of proof-of-work schemes.

The second category is represented by stablecoins (or referenced crypto-assets), which are crypto-assets that aim to maintain a stable value relative to another asset or basket of assets. There are several examples of crypto-assets referenced to the US dollar (e.g. Tether, USDC, DAI, and Binance USD), lesser-known crypto-assets referenced to other fiat currencies (e.g. EUROOC referenced to the Euro) or commodities (in particular gold, e.g. PAX Gold).

Referenced crypto-assets are conceptually similar to investment funds (e.g. money market funds or ETFs), as their value tracks the one of the underlying referenced asset(s). The key difference between referenced crypto-assets and investment funds is that tokens, which are broadly comparable to fund shares, can be issued and traded on permissionless DLTs. Using these technologies to issue tokens has three main implications related to the following technological innovations:

- a) *Accessibility*. These technologies are publicly accessible at the global level, widening tokens' potential use in space and scope, i.e. tokens can be exchanged peer-to-peer everywhere in the world and be used as investments even if they are issued as means of payments;
- b) *Governance*. These technologies allow decentralized governance structures: unlike investment funds that are always associated to an asset manager, referenced crypto-assets may not have an identifiable issuer;
- c) *Stabilization*. The use of DLTs introduces innovative mechanisms to track the value of the underlying assets (see Box 1).

Finally, the crypto-assets least similar to existing assets are unreferenced crypto-assets. This category, whose market capitalization was around \$700 billion at the end of 2022, includes all crypto-assets that fail the criteria identified for the other two categories and have no clear parallel in the traditional financial system. There is a wide range of unreferenced crypto-assets, including native tokens, governance tokens and non-fungible tokens. Native tokens are minted through the consensus mechanism of a specific blockchain and serve primarily as its incentive mechanism for transactions validators. Other unreferenced crypto-assets entitle a holder to specific rights (e.g. ownership of assets, right to cash flows, claims in insolvency, or voting rights on future changes to the blockchain's governance). For this category, the application of the

principle of “same activity, same risk, same regulation” is problematic, as tokens in this category may not perform the same function as existing asset in the traditional financial system. Furthermore, like referenced crypto-assets, unreferenced ones may not have an identifiable issuer.

Box 1 – *Asset-Backed and Algorithmic Stablecoins*

Stablecoins play a key role in crypto-asset markets. Given the inherent volatility of unreferenced crypto-assets, stablecoins pegged to fiat currencies serve as a means of payments and store of value. In particular, they are borrowed against other crypto-assets in lending platforms or used as collateral for trading crypto-assets in traditional exchanges.

There are two main categories of stablecoins, distinguished according to the type of stabilization mechanism: i) asset-backed stablecoins and ii) algorithmic stablecoins.

Asset-backed stablecoins seek stability by providing users a claim on a portfolio of assets. There are two main design models in this category. In the first model, which includes most existing stablecoins, users have a claim based on a portfolio of assets, called reserve, which are segregated from the issuer’s balance sheet (reserve-backed stablecoins)⁷. In the second model users have a claim on the issuer. The assets that guarantee the value of tokens are not segregated from the issuer’s balance sheet and the value of tokens is rooted in the public’s trust in the issuing institution⁸.

The most traded asset-backed stablecoins are Tether (USDT), USD Coin (USDC), and Binance USD (BUSD). Their assets are all pegged to the US dollar. In particular, USDT was launched by Tether Limited, owned by the Hong Kong-based company iFinex Inc., which also owns Bitfinex, a cryptocurrency exchange. The reserves are invested in bonds, loans, and commercial paper⁹. USDC is managed by Centre, which is a consortium founded by Circle, a payment technology

⁷ Given the absence of a regulatory framework for stablecoins in many countries, the claim on reserve may be restricted to certain conditions. For example, Tether provides a redemption claim only to selected counterparts (typically exchanges or large investors), which act as market makers in Tether’s secondary market. Users’ ability to liquidate Tether tokens depends on the willingness of these selected counterparts to trade at par in the secondary market. Furthermore, Tether issuer (Tether Limited Inc.) retains the right to suspend redemptions even from selected counterparts.

⁸ Phillips (2022) presents a discussion on the legality and applicability of deposit insurance on tokenized deposits in the US. Moreover, as argued above, stablecoins in this category can be classified as tokenized traditional assets, providing that the regulatory framework for deposits can also be applied to this type of stablecoins (BCBS, 2022).

⁹ Following a \$18.5 million settlement paid in 2021, Tether agreed to provide quarterly disclosures of its reserve assets. Investors criticized Tether after they found that only one quarter of reserves are invested in cash (Delivorias, 2021).

company. The composition of their reserves are quite opaque, as Circle only reports that they are invested in cash and cash equivalents. Finally, BUSD has been issued by Binance, which is one of the largest cryptocurrency exchange, and Paxos Trust, a blockchain company. According to their attestation report, the reserves are generically invested in US government debt and bank accounts.

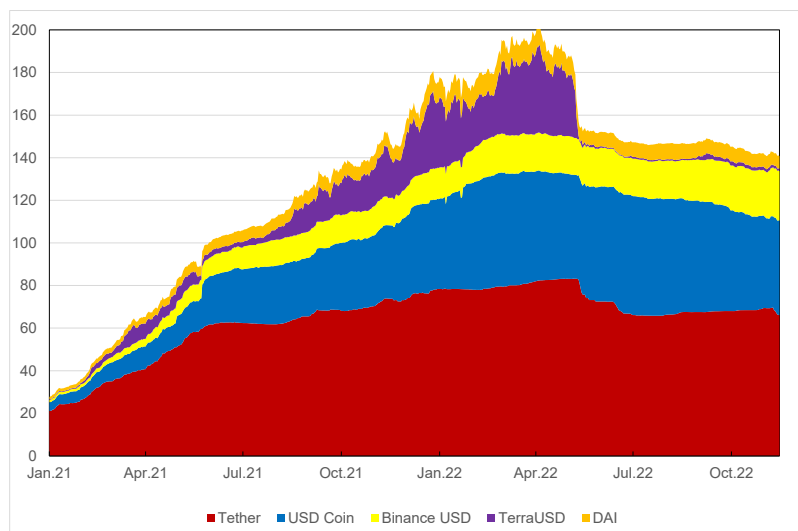
The second category is represented by algorithmic stablecoins, which stabilize their value through the use of algorithms. While in principle there could be several design models in this category, in practice there have been two main algorithmic stablecoins. The first model is DAI, a stablecoin whose value is backed by on-chain assets, like Ethereum or other asset-backed stablecoins. Its design model relies on a system of smart contracts¹⁰. Indeed, an algorithm calculates the supply of coins to keep the DAI value close to 1 US dollar. In addition, DAI's design model uses algorithms to compute the amount of collateral needed to reduce the volatility of DAI by managing margin calls when the value of the underlying collateral falls below a pre-specified value¹¹.

The second model is the one of Terra/LUNA. From its inception in November 2020 to the collapse in May 2022 described below, Terra USD (UST) maintained its peg to US dollar by relying on an arbitrage mechanism between two tokens, UST itself and its sister coin LUNA. An investor could always convert 1 token of UST with \$1 worth of LUNA and vice versa, regardless of the market price of either token. When the value of 1 UST token was below \$1, traders could make profits buying 1 UST and selling it for \$1 of LUNA. The increase in demand for UST would raise its price back to \$1. Conversely, when the value of 1 UST token was above \$1, traders could swap \$1 of LUNA with 1 UST, thereby making a profit. The increase in supply of UST would reduce its price to \$1. LUNA tokens derived value from their use in the Anchor protocol, a decentralized platform where these tokens earned interests (see Section 3).

As of mid-November 2022, the overall market capitalisation of stablecoins was around \$140 bn (Figure A.1). Tether, USD Coin and Binance USD had a market capitalization of \$66 bn, \$44 bn and \$23 bn, respectively; while DAI had a market capitalization of \$6 bn. For comparison, the overall market capitalization of stablecoins pegged to euro is lower than \$500 million.

¹⁰ A smart contract is a software based on the distributed ledger technology (DLT) that allows the automated execution of an instruction without human intervention (FSB, 2023).

¹¹ DAI tokens are over-collateralized through a deposit of other crypto-assets in a smart contract, called "vault". If the collateral value falls below a pre-specified ratio (which can vary depending on the type of crypto assets and it is generally around 150 per cent), the vault owner must return borrowed DAI or increase collateral. A failure to return or increase collateral triggers a liquidation of the collateral with a penalty.

FIGURE A.1 – *Market Capitalization of Stablecoins (\$bn)*

Source: Coinmarketcap.com.

2.2 Structure of Crypto-Asset Ecosystems

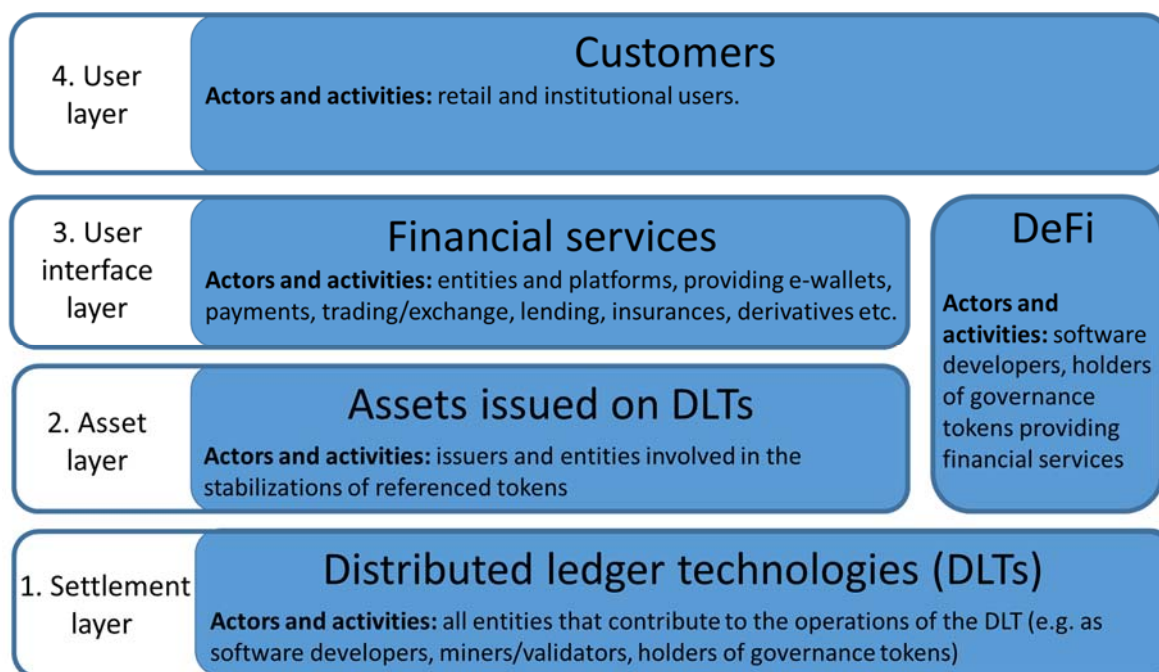
Crypto-assets are digital assets that are mainly used as investment instruments and, in the case of stablecoins pegged to fiat currencies, as means of payment supporting activities performed on DLTs. Therefore, from a conceptual perspective, the structure of crypto-asset ecosystems resembles the structure of traditional financial markets. Crypto-asset ecosystems have a multi-layered structure (Figure 2; G7 Working Group on Stablecoins, 2019; Schär, 2021). Starting from the bottom of Figure 2, the first layer (settlement layer) is composed of the DLTs where crypto-assets are issued and on-chain transactions are executed. It comprises all entities that contribute to the operations of the DLT, such as software developers, validators and holders of governance tokens¹². The second layer (asset layer) consists of all assets created on DLTs and also includes issuers and entities involved in the stabilizations of reference tokens (i.e. stablecoins). The settlement and the asset layers constitute the back-end of crypto-asset ecosystems, i.e. all functions that do not involve a direct interaction with users. The third layer (user interface layer) is instead the front-end, comprising all activities and entities that provide access to DLTs and related services to users (e.g. custody, trading, lending, insurance). Finally,

¹² The governance of DLTs generally relies on governance tokens, which give holders the right to vote on issues that govern the development and operations of a DLT.

the top layer (user layer) includes users and investors in crypto-assets, which are generally classified as retail and institutional, with the latter being subject to financial regulation.

Some activities in the asset layer (e.g. issuance) and interface layers (e.g. trading or lending services) can be performed by smart contracts executed directly on DLTs (decentralized finance, DeFi). In this case, the entities involved in these activities are those involved in the functioning of the DLT itself, such as software developers and holders of governance tokens. We can distinguish between centralised finance (CeFi) and decentralised one according to the different degree of centralization of entities operating in these layers (Box 2). CeFi refers to financial services provided by an entity, a crypto-asset service provider (e.g. exchanges, wallet providers), which processes and records all activities by its costumers (e.g. transactions between trading parties). By contrast, in DeFi systems, services are provided by decentralized applications through the automatic execution of smart contracts directly on the blockchain, with little or no involvement of well identifiable entities (Aramonte *et al.*, 2021).

FIGURE 2 – *The Structure of Crypto-Asset Ecosystems*



Source: authors' elaborations.

Each layer inherits the properties and risks of the layers below it¹³. Similarly, changes or malfunctioning of a DLT will affect all assets issued and traded on such DLT and the services related to such assets. In addition, the interconnection between layers could be high as some entities may perform multiple activities in different layers (vertical integration). For example, some exchanges are also issuers of stablecoins.

Different layers present different types of challenges for regulators. Entities participating to the settlement layer mainly include software companies, non-financial corporations and communities of developers that may not fall within the scope of financial regulation. In this case, key issues for authorities include the fact that these entities do not perform regulated activities and therefore the legal framework provides limited power to design rules applicable to these entities¹⁴. Another key challenge for authorities is to regulate decentralized governance structures, which pose several hurdles for the enforcement of financial regulation. These governance structures can be used in both the asset layer, for example for issuing crypto-assets, and the user interface layer.

Box 2 – *CEX and DEX Trading Platforms*

Crypto exchanges provide their customers several services, including the ability to buy and sell crypto-assets, generally by holding highly leveraged positions. Trading of crypto-assets can take place on a centralised exchange (CEX) or on a decentralised exchange (DEX). In the former case, transactions are executed by an intermediary, which performs activities similar to those of a traditional exchange or an over-the-counter broker. In the latter case, transactions are executed by smart contracts directly on the DLT.

CEX is currently the most adopted method as it is cheaper than DEX, especially for smaller transactions. Indeed, trading on DEX is associated with an execution cost (so-called gas fees) that is needed to incentivize other users to validate the transaction on the blockchain. On the other hand, DEXs are still used for their greater anonymity and interoperability with other DeFi applications.

¹³ For example, a programmable settlement layer, i.e. DLTs with smart contract functionality like Ethereum and Cardano, allows a richer set of activities in the asset and the user interface layers than a settlement layer without such built-in functionality (e.g. Bitcoin).

¹⁴ One potential solution is to include these entities in the perimeter of financial regulation as service providers.

There are two main types of DEXs distinguished by the activities performed on-chain: i) “order book” exchanges, characterized by a centralized entity that maintains an order book; ii) “automated market makers” (“AMMs”), which is a model entirely on-chain where the exchange of assets is automatically managed by an algorithm.

“Order book” exchanges are similar to CEXs (or traditional exchanges). Two different types of traders operate in both systems: traders who want to buy or sell a particular crypto-asset at a certain price (“makers”) submit their order to the keeper of the order book, who publishes it for other traders who may want to match the order (“takers”). However, in a CEX the order of a taker is submitted to the intermediary that execute the order. In contrast, in a DEX, a taker submits the order to the protocol (i.e. a collection of smart contracts), which executes a peer-to-peer exchange of the crypto-assets between the maker and the taker. As a result, an operator does not have the control of the users’ crypto-assets.

In contrast, in AMMs the price of an asset is automatically calculated by an algorithm, which estimates an exchange ratio between two crypto-assets A and B, deposited in a smart contract (or “liquidity pool”). The exchange rate is automatically determined, relying on a function of the ratio of assets held in the pool. The price is therefore automatically set by the AMM algorithm by calculating the ratio of the two crypto-assets. If the ratio of A to B increases, the price of A relative to B will decrease. The change in the exchange ratio generally depends on the size of the trade and the pool liquidity¹⁵; therefore, AMMs are substantially dependent on arbitrage opportunities.

2.3 Risks of Crypto-Asset Ecosystems

Entities in each layer face different types and degree of risks when they provide financial services by allowing users to access the desired service (e.g., custody, exchange, and lending). The risks to which each entity is exposed mainly depend on their degree of centralization.

CeFi entities are generally exposed to the same types of vulnerabilities as traditional finance. These vulnerabilities include credit, liquidity and market risks, which are amplified by the volatility of certain crypto-assets or the opaque structure and activities of entities operating in these markets. In particular, lending platforms are highly exposed to a liquidity mismatch, also

¹⁵ If the liquidity in the pool is thin and the order is sizable, the ratio of A to B (hence the price) could change significantly.

because they generally do not have strong liquidity management practices. For example, many platforms hold large exposures to a limited number of counterparties (see Section 3). As a result, the collapse of a significant borrower may lead to a rise in outflows due to customer withdrawals. The value of their assets and collateral is highly volatile as their loans are typically backed by crypto-assets that may become potential illiquid during market stress episodes. These events may threaten the platforms' ability to serve their customers, pushing managers to freeze deposit withdrawal. This mechanism raises the so-called "first mover advantage" of depositors, increasing in turn the risk of runs.

As regards DeFi platforms, the liquidity provision in decentralised protocols appears to be very highly concentrated as on average half of the deposits are provided by fewer than 10 accounts. This structure may raise liquidity risk as a large withdrawal of one or few users may lead to bank run-like behaviours¹⁶. In addition to traditional risks, these platforms are characterized by the so called "decentralization illusion" of governance (Aramonte *et al.*, 2021). Despite the claim of decentralised governance, also DeFi need a certain degree of centralization as all DeFi platforms have central governance frameworks to set strategic and operational priorities (e.g. "governance tokens" that allows platform developers to change the protocol underlying the applications). This structure may not be known by all users, creating diverging incentives across developers and other investors. Moreover, the reliance on a group of users that validates the transactions raises the risk that a small number of large "validators" can gain enough power to alter the blockchain for financial gain. A high concentration is also observable among DeFi projects as more than two thirds of total value locked (TVL) of DeFi projects is locked in the Ethereum blockchain (as of November 2022). This implies that issues in this blockchain may affect almost all the DeFi market, with significant risks for the stability of the crypto-ecosystem. More generally, both in DeFi and CeFi, highly concentrated markets are associated with several well-known issues in terms of higher risks of collusion and misconducts, such as insider trading¹⁷.

¹⁶ The regulatory framework applicable to these service providers generally relies on the classification of the crypto-assets listed on the platforms in the national legal framework (FSB, 2022b). Platforms that provide services related to crypto-assets classified as regulated instruments are generally subject to financial regulation. In jurisdictions where crypto-assets are not regulated instruments or for platforms that provide only services related to crypto-assets that do not qualify as regulated securities, these entities may be subject only to general-purpose regulation, such as AML/CFT or tax evasion.

¹⁷ Recent studies find evidence of systematic insider trading when a platform announces the listing of a new cryptocurrency. Recently, supervisory authorities started to prosecute platforms' employees for the use of private information to obtain illicit financial gains.

Finally, a vulnerability of all entities in this sector is the extensive use of leverage. A key factor that drove the crypto-market development was the lending of crypto-assets in exchange of collateral. This service was initially offered by crypto exchanges but, afterwards, new specialized players (i.e. crypto lenders) entered the market trying to gain market shares by offering more aggressive yields. Offering a high yield to attract more deposit in order to obtain larger resources for the lending activity created a spiral of leverage¹⁸. As a result, this business model was highly vulnerable to an abrupt decrease in the market value of crypto-assets, which may lead to a depreciation in the collateral and, in turn, may trigger a spiral of margin calls.

Crypto exchanges generally offer, especially before the 2022 crisis, high levels of leverage to their investors (up to 125 times the initial investment), significantly greater than regulated exchanges. Borrowed funds are often re-used to serve as collateral in other transactions. Therefore, an investor may pledge a crypto-asset (i.e. a stablecoin) to get a loan, use these additional resources to obtain a second loan (e.g. on a different platforms) and so on. This mechanism allows investors to obtain large exposures starting from a small amount of initial resources. The re-usability of collateral also raises the interconnectedness across markets as crypto-assets are used as collateral to borrow other types of crypto-assets. As a result, a rise in the volatility of one crypto-asset is quickly transmitted to the entire crypto-market through the depreciation of collateral and the high interconnections among platforms. However, given the opacity of the market and significant data gaps, the actual level of leverage in the crypto-market is difficult to assess.

Moreover, the risks deriving from interconnections are rising due to the growing involvement of highly-leveraged institutional investors in the crypto-market. Recent analyses show that institutional investors, such as hedge funds and other asset managers, became the most prominent operators both in terms of trading volume and assets under management (Auer *et al.*, 2022)¹⁹.

¹⁸ For example, the lending platform Celsius operated with an assets-to-equity ratio of 19-to-1 as of October 2021, close to double that of a typical US bank (Wall Street Journal, 2022a). Similarly, FTX lent significant amount of crypto-assets to its affiliated hedge fund Alameda.

¹⁹ According to survey data (Fidelity, 2021), hedge funds and other alternative investment funds expanded their participation in the crypto-market in the last couple of years. The main motivations are search-for-yields strategies and hedge against inflation. Surveyed European investors showed a greater propensity for crypto-assets than US ones, likely as the number of regulated investment products that offer digital asset access is greater in European markets. Currently, institutional investors mostly hold the two leading cryptocurrencies, Bitcoin and Ether.

3. THE TURMOIL IN CRYPTO-ASSET MARKETS IN 2022

The turmoil in crypto-asset markets in 2022 is related to two main events. The first is the collapse of the algorithmic stablecoin UST in May, which initiated a series of defaults related, in particular, to the insolvency of the hedge fund Three Arrows Capital (3AC) and its lenders. The second event is the bankruptcy of FTX, one of the largest centralised exchange platform, in November. This event raised uncertainty on the governance and on the transparency of several crypto-platforms.

In both cases the market lost confidence in the stability of a building block of the market, either the stablecoin UST or the large trading platform FTX. The loss of trust was followed by investor runs and by the inability of the stressed intermediaries to maintain their obligations with their clients due to poor risk management practices. Direct exposures of crypto-asset service providers to these entities and the high level of leverage of the involved operators transmitted and amplified the stress in the broader crypto-asset ecosystem (Figure 3).

FIGURE 3 - *The Market Turmoil in Crypto-Markets in 2022 (\$tn)*



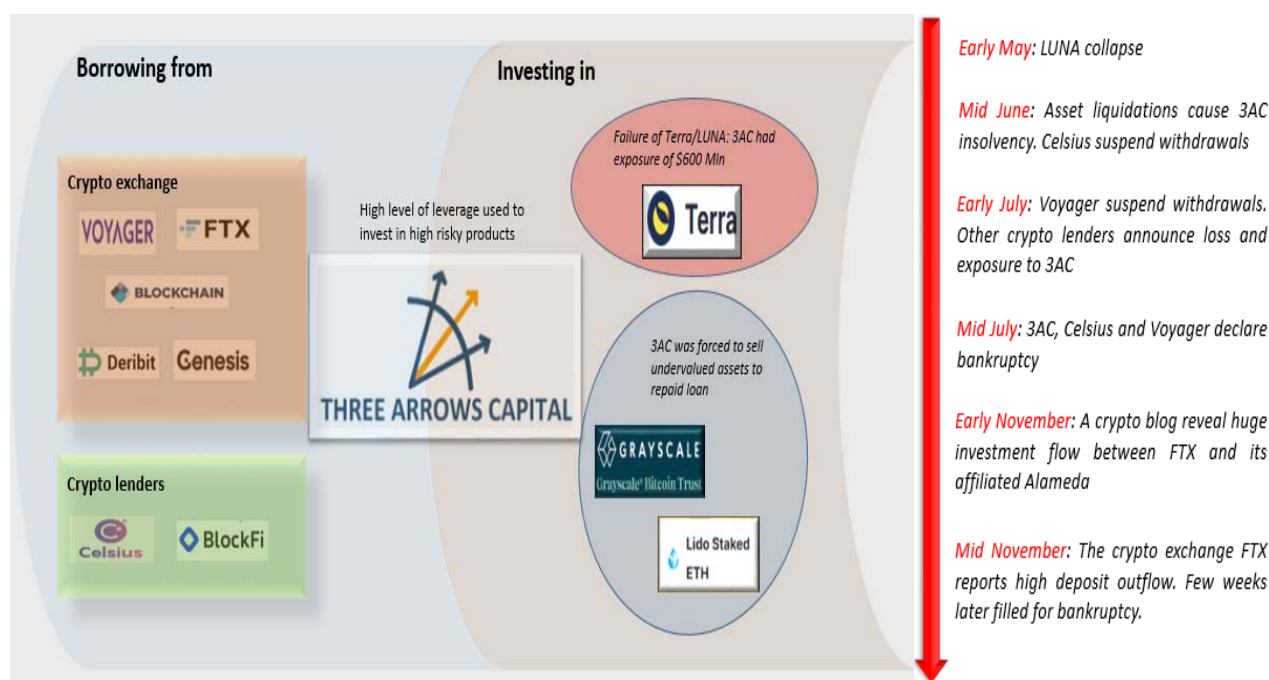
Source: Coinmetrics.

Notes: the chart considers the market capitalization of all instruments traded in the crypto-markets. Vertical lines identifies the collapse of UST, the crisis of 3AC and the one of FTX, respectively.

3.1 The Collapse of UST

In May, three main events significantly affected crypto-asset markets: i) the collapse of UST; ii) the insolvency of the hedge fund Three Arrows Capital (3AC); iii) the failure of several lending platforms with exposures to 3AC (Figure 4). Despite prices of all major crypto-assets fell by around 50 per cent between November 2021 and April 2022, no major issues emerged in the crypto-asset ecosystem during this period²⁰. The market capitalization of stablecoins grew steadily from \$160 billion in December 2021 to a peak of \$200 billion in April 2022 (Figure 4) and there were no significant cases of insolvency among service providers. This suggests that the market turmoil that begun in May 2022 was mainly related to vulnerabilities in crypto-asset markets rather than to the broader correction of asset markets observed at the global level since November 2021.

FIGURE 4 – *Main Events and Interconnections of the Turmoil in Crypto-Asset Markets*



Source: authors' elaboration.

²⁰ This reduction was generally determined by investors' decreasing risk appetite due deteriorating expectations about global economic growth and fear of inflation and monetary policy tightening.

The crash of UST in May was the first trigger event of the turmoil in crypto-asset markets. Since the beginning of May, investors started to withdraw large amounts of UST from Anchor, the decentralized lending platform where the stablecoin was used as a means of payment and store of value²¹. The trigger of this sell-off is unclear, however several commentators suggested that investors started to doubt the sustainability of Anchor's business model, which relied on continuous inflows of investors' funds to remain profitable (Bloomberg, 2022). Despite the promised return of 20 per cent on deposits, Anchor struggled to attract new capital in the broad bear market that started in November 2021.

Anchor's flawed design and governance amplified outflows from the lending platform. During the period of stress, Anchor's governing entities imposed limits to the daily amount of UST that could be converted into LUNA; this decision, coupled with the lack of intrinsic value of UST, generated a first mover advantage among UST holders. These events contributed to the collapse of both Terra and Luna tokens, which lost a combined market capitalization of \$50 billion between May 4 and 13.

The collapse of Terra/Luna determined significant downward pressures on the price of Bitcoin. The impact on the crypto market of UST/LUNA collapse was amplified by the selling of a large amount of Bitcoin by Luna Foundation Guard (LFG)²², in an attempt to stabilize the price of UST. The attempt to stabilize the price of UST failed and the sale of Bitcoins furtherly lowered the prices of crypto-assets.

These events led to a temporary de-peg of Tether, the largest stablecoin. On May 12, the price of Tether bottomed at \$0.95. Strains in the market of stablecoins determined significant outflows from the tokens that investors considered more vulnerable and partly led to an increase in the market capitalization of stablecoins considered more resilient²³.

²¹ Anchor is inherently connected with UST. One of the main factors that contributed to the increasing demand of UST was the opportunity for owners of the stablecoin to create deposits at anchorprotocol.com, which operated on the Terra blockchain. In particular, the protocol promised an annual yield of almost 20 per cent by lending deposited UST to borrowers. As a result, many investors bought and deposited UST attracted by high yields. Before the crash, more than 75 per cent of UST supply was deposited at Anchor.

²² LFG was created as part of the Terra ecosystem to deploy funds and maintain the value of UST in case of stress. In April 2022, it owned \$3 billion in Bitcoin, which were sold to keep the UST peg.

²³ In May, Tether and DAI, the second largest algorithmic stablecoin after UST, lost \$10 billion and \$2 billion in market capitalization, respectively. In the same period, the market capitalization of USDC, which invested reserves mainly in highly liquid assets, increased from \$49 to \$54 billion.

3.2 The Insolvency of Three Arrows Capital and its Implications

The Terra/Luna collapse and the broad crypto market downturn led Three Arrows Capital, a large hedge fund specialized in crypto-asset markets, to insolvency. The fund held highly leveraged positions by borrowing crypto-assets from lending platforms and investing them in illiquid instruments, such as LUNA and Staked Ether (Box 4). Following the market turmoil, 3AC failed to meet margin calls on its borrowed crypto-assets and had to liquidate its positions, incurring in significant losses and causing a further decrease in the value of crypto-assets. The fund was ordered to liquidate on 27 June 2022.

The default of 3AC directly affected several lending platforms and exchanges that held significant exposures to this fund, having extended in some cases unsecured credit (Box 5). Indeed, 3AC borrowed from more than 30 different lenders and, as of July, it owed to its creditor around \$3.5 billion. Many of the fund's counterparties were, in turn, unable to meet demands from their investors, including retail holders. Several crypto lenders that had direct or indirect exposures in 3AC faced severe financial issues prompted by asset-liability mismatch, high level of unsecured debt concentrated to few counterparties and the use of low quality (i.e. highly volatile) collateral to secure loans. These issues forced some large 3AC crypto-lenders to first pause withdrawals (Box 5), in an attempt to stop investors from claiming back their deposits, and eventually to declare bankrupt. Other lenders suffered heavy loss and critical operational dysfunctions that led to huge lay off. The panic widespread with massive liquidation of crypto-asset exacerbating prices downfall.

These events had limited spillovers onto the traditional financial system or the real economy, though some financial and non-financial corporations were affected²⁴.

²⁴ For example, Canada's second-biggest pension and insurance fund, Caisse de Dépôt et Placement du Québec, invested a small share of its assets in Celsius before it went into bankrupt. Nuri GmbH, a German company with business ties with Celsius and Solarisbank AG (a fintech company that offers a banking-as-a-service platform with its German banking license), filed for bankruptcy in August.

Box 4 – The Investments of 3AC

3AC was a Singapore-based hedge fund specialized in high risk/high return investments in crypto-asset markets. 3AC managed an estimated \$10 billion of assets in March 2022, which were mainly invested in LUNA, Bitcoins, Greyscale Bitcoin Trust (GBTC) and Staked Ether (stETH). In May the fund held an investment of \$600 million in LUNA.

3AC was one of the largest holders of GBTC. Greyscale Bitcoin Trust is a trust that invests only in Bitcoin, thus allowing investors to gain exposure to the crypto-asset without buying and storing it directly. As a regulated product, the trust allows accredited investors to purchase shares of the fund in exchange of Bitcoins, which can be sold on the secondary market to retail investor after a lock-up period of six months. Since its inception in 2017, the trust experienced significant demand from traditional investors, thus making the fund trade at high premium over the price of Bitcoin (as high as 105 per cent in September 2017). This premium was a source of profit for institutional investors, who purchased shares directly from the trust and sold them to the market after the six months lock-up period. As of November 2022, the trust managed \$13 billion of assets.

The 3AC strategy consisted in borrowing Bitcoins from the market and exchange them for GBTC shares, which 3AC held for the lock-up period and then sold at premium price. Even when the premium on GBTC shares turned into a discount in the first quarter of 2021, 3AC continued to borrow from lenders expecting a market rebound. When margin calls on the borrowed Bitcoin were sent, 3AC was forced to liquidate its trust shares at high discount.

3AC also earned a liquidity premium by trading stEther. StETH are crypto-assets that are redeemable for Ether tokens staked on the Ethereum blockchain plus the staking yield. These tokens were particularly popular during the transition of main Ethereum blockchain from the proof-of-work consensus mechanism to the proof-of-stake consensus mechanism, called ‘The Merge’, which happened on 15 September 2022. While Ether tokens staked on the Ethereum blockchain cannot be traded, stETH can always be traded, generally at parity with the Ether price or at small discount.

The 3AC strategy was similar to the one used for GBTC. 3AC borrowed Ethers and swap them for stETH earning a return. For most of the time, stETH has traded at par with ETH, but after Luna crashed, the price slid to as low as a 7 percent discount on the price of Ether. At the time of the turmoil, 3AC held around \$100 million in stETH, which the fund was forced to convert back to Ether to meet margin call at a lower price, incurring in heavy losses.

Box 5 – *The Platforms Affected by the Collapses of LUNA and 3AC*

Several platforms suffered heavy losses related to their direct or indirect exposures to 3AC. In particular, (a) Celsius and Voyager Digital went bankrupt; (b) Blockchain.com and BlockFi suffered heavy losses and severe operational dysfunctions; finally, (c) also several other platforms were affected but with marginal consequences.

(a) Celsius was a lending platform with significant asset-liability mismatch. It was a lending platform with \$25 billion in deposits of crypto-assets. The platform had 1.7 million users at the end of 2021 and offered investors yields on deposits of crypto assets up to 19 per cent. In June 2022, Celsius paused withdrawals on its platform, citing “extreme market conditions” after the sharp reduction in the price of Ether and other cryptocurrencies; it filed for bankruptcy in July (Celsius, 2022). Voyager Digital was an exchange platform that also provided loans in crypto-assets to 3.5 million clients. The loan book grew from \$380 mn in March 2021 to around \$2 bn in March 2022, with only 11 per cent collateralized loans. This platform has extended a \$650 mn unsecured loan to 3AC. The collapse of their biggest counterpart led to an influx of customer withdrawals, pushing managers to freeze deposit withdrawal and, afterwards, declare bankruptcy (CoinDesk, 2022a).

(b) BlockFi is a lending platform that faced significant liquidity issues in June 2022 when it had to liquidate the position of 3AC. The crypto lender provided a significant amount of unsecured credit, reporting \$1.8 billion loans with a collateral value of \$1.2 billion, mainly constituted of Bitcoin and shares of GBTC. During the turmoil, BlockFi raised interest rate on its deposit to attract new customers and paused withdrawals. When loans were liquidated, the collateral was sold at a discounted value. After the crypto-market collapse, the assets of the platforms decreased from \$5 bn to less than \$1 bn. The platform was bailout by FTX with the issuance of a \$250 million revolving credit facility (TheBlock, 2022). Similarly, Blockchain.com is a crypto exchange that had an exposure to 3AC of \$270 million. The unfeasible recover on this exposure led managers to lay off 25 per cent of their staff.

(c) Given the large base of 3AC’s lenders, other platforms were affected by the fund liquidation. For example, Deribit, a crypto exchange, allowed 3AC and other investors to get an exposure to several crypto-asset derivatives by placing limited collateral. When 3AC failed to meet margin calls on Bitcoin and Ether derivatives, Deribit began to liquidate its positions. On 15 June 2022 it terminated the lending agreement and demanded payments of the outstanding loans, interest and negative asset value of the account that amounted to \$80 million. Other trading platforms including BitMex, FTX and Genesis, liquidated their exposures to 3AC, with no major consequences on their business.

3.3 The Bankruptcy of FTX

A second significant market turmoil was triggered by the crisis first, and the bankruptcy later, of the crypto exchange FTX in November. FTX is a CEX platform with more than one million registered users at the end-2021, an estimated year-to-date trading volumes of around \$630 billion and with more than \$16 billion of client funds before its crisis. FTX is also the issuer of FTT, a utility token that grant holders a discount on trading fees and other benefits from the FTX trading platform. Finally, FTX is affiliated to Alameda Research, a Hong Kong-based crypto hedge fund, as both are owned by Sam Bankman-Fried, the CEO of FTX.

On November 2, a leaked report revealed that Alameda invested about 40 per cent of its \$15 billion assets in FTT and it held a high debt towards FTX, for roughly \$10 billion. The report suggested that FTX was lending out the funds of their clients, without their permission and violating the Terms of Agreements of FTX, to Alameda Research, which in turn used FTT as collateral.

The disclosure of these insights contributed to a loss of trust in FTX, which in turn pushed customers to get their funds back and finally led to its bankruptcy over about 9 days. On November 5, the CEO of Binance (the largest CEX) announced on Twitter the intention to liquidate the entire position held in FTT. The next day, FTX clients rushed to get their funds back, withdrawing roughly \$5 billion from the platform. On November 7, Binance refused to accept an offer from Alameda to buy the whole Binance position in FTT, confirming that it would have sold his FTT position in the market, and FTX clients claimed that the withdrawal process became slower and difficult. Both events furtherly fuelled a massive liquidation of FTT, leading to a reduction of about 30 per cent in its price over few hours. On November 8, the FTT price dropped by 70 per cent after FTX disclosed that around \$8 billion of withdrawals could not be fulfilled. The same day, Binance announced that it would have bailed out FTX, pending due diligence. However, on November 9, Binance withdrew from the agreement citing alleged mishandled customer funds and potential US investigations.

On November 11, FTX filed for bankruptcy in the US; the Chapter 11 filing includes FTX's US entity, Alameda Research and about 130 affiliated companies. The filing reported that the difference between the consolidated assets and liabilities of all companies affiliated with FTX was about \$30 billion; the group had more than 1 million creditors (CoinDesk, 2022b; Il Sole 24

ore, 2022). The filing also stated that on November 11 FTX suffered a cyber-attack that resulted in an outflow of more than \$600 million from FTX's crypto wallets to an unknown account.

As of mid-November, the FTX bankruptcy led to an additional reduction in the market capitalization of the crypto-market (Figure 5), although this was more limited than that caused by the Terra/Luna collapse. Among other crypto market players, BlockFi, which in late June was saved with a credit revolving facility provided by FTX (see Box 5), suspended client withdrawals and it considered to file for Chapter 11 too. Interestingly, DeFi lending proved to be resilient both during the turmoil in May/June and after the FTX crisis as it is over-collateralised, while CeFi crypto lending is generally not. The spillover to the traditional financial system was limited to the investors of the platform, which were mainly venture capital funds (e.g. Sequoia Fund) and, to a lesser extent, other institutional investors (e.g. Ontario Teachers' Pension Plan; CNBC, 2022; Morgan Stanley, 2022; Reuters, 2022).

These events highlighted the unclear regulation of cross-border exchanges. FTX has a complex corporate structure: it is an offshore company as is based in the Bahamas and, therefore, was regulated by the Securities Commission of the Bahamas (FTX, 2022)²⁵. In Europe, FTX operated through a Cyprus-based subsidiary, which was regulated by the Cyprus Securities and Exchange Commission and passported to the European Economic Area. Finally, the platform does not directly operate in the USA but it has an American entity, FTX US. FTX and FTX US are therefore separate entities with different management and licensing, but have similar owners and investors²⁶.

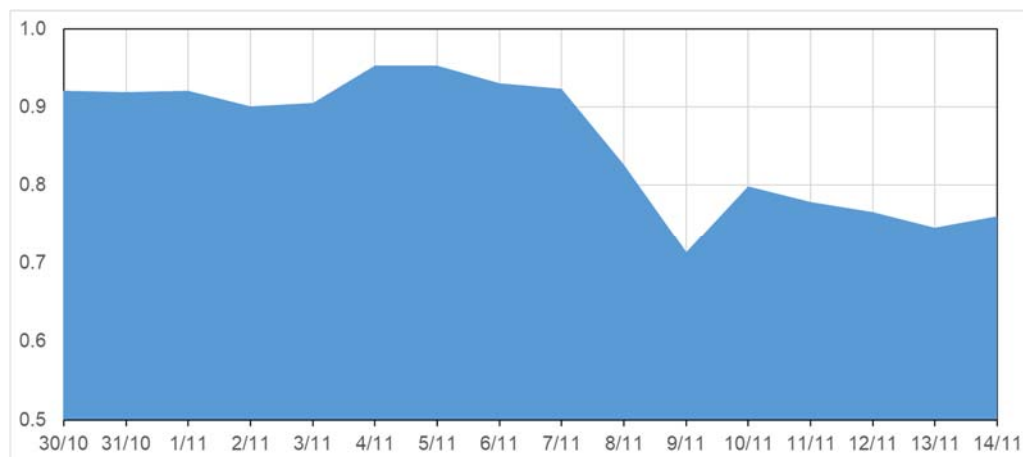
Moreover, the bankruptcy of FTX exposed fundamental vulnerabilities of exchanges. First, the trust in these markets was severely affected by the lack of transparency, the organizational complexity, the weak corporate governance and risk management, as well as the inappropriate use of client funds. Indeed, funds deposited in an exchange should be available on demand; in contrast, FTX lend out client funds to an affiliated company, which invested them in risky activities. Moreover, accepting its own liability as collateral for margin loans made to clients and

²⁵ On November 10, the Securities Commission of the Bahamas froze the assets of FTX.

²⁶ In particular, the derivatives exchange of FTX US, FTX US Derivative, is a US federally regulated commodity derivatives exchange and clearinghouse, licensed by the Commodity Futures Trading Commission (CFTC). However, after the collapse of FTX, also the US Department of Justice and the Securities and Exchange Commission investigated FTX US to assess whether some of its crypto lending products qualify as securities and to examine its ties with the parent company headquartered in the Bahamas (Wall Street Journal, 2022b).

outside of its platform (including Alameda) exposed FTX to an extreme “wrong-way risk”²⁷. Indeed, a loss of confidence in the solvability of FTX is positively correlated with a reduction in the value of the collateral, which in turn further undermines FTX’s financial stability.

FIGURE 5 - *The Crypto-Market Capitalization between October 30 and November 14, 2022 (\$tn)*



Source: Coinmetrics.

Notes: the chart considers the market capitalization of all instruments traded in the crypto-markets.

4. POLICY CONSIDERATIONS

The 2022 turmoil in crypto-asset market highlighted the need to develop an effective regulatory framework for issuers and service providers in these markets. The episodes of stress did not generate material spillovers to the traditional financial system nor to the real economy, thanks to the low interconnectedness with financial intermediaries and the limited use of these assets for payments or investments by households and non-financial corporations. However, it will take time to unveil all the ramifications of the FTX bankruptcy, which was at the centre of a complex network of relationships with venture capital funds and other institutional investors. Furthermore, the interest of regulated financial institutions for these markets have not abated²⁸.

²⁷ Wrong-way risk is a form of credit risk that arises when the exposure to a counterparty increases together with the risk of the counterparty’s default.

²⁸ For example, during the summer of 2022, asset managers like Abrdn, BlackRock and Charles Schwab have signed partnerships or launched products tied to crypto-assets (Financial Times, 2022a). Nasdaq announced that it was launching a digital assets services business that would begin with custody of crypto tokens for institutional investors (Financial Times, 2022b).

If the involvement of the traditional financial system continued to grow or crypto-assets became more popular among users, vulnerabilities in this sector might gain material importance.

The conceptual framework and the analysis of the episodes of stress provided in this paper suggest the following policy considerations.

- *Setting a clear perimeter for financial regulation applicable to crypto-asset ecosystems.* Given the inherent challenges in regulating some parts of the crypto-asset ecosystems, such as algorithmic stablecoins, permissionless DLTs and decentralized governance structures²⁹, authorities should set a clear perimeter for financial regulation defining entities, tokens and activities that can be effectively regulated and develop common rules to address financial stability risks, including licensing/authorization regimes for entities operating in these areas. To avoid cross-border regulatory arbitrage, international standard setting bodies should promote the definition of an internationally-agreed regulatory perimeter and common rules. Authorities should clearly communicate to the public which areas are covered by financial regulation and which ones are not covered;
- *“Same risk, same regulatory outcome” principle for entities, tokens and activities that can be effectively regulated.* Rules for crypto-asset issuers and service providers that can be effectively regulated should achieve the same regulatory outcomes as those set for financial intermediaries providing similar services in the traditional financial system (FSB, 2022b). In particular, activities performed by issuers and service providers are generally characterized by consumer protection issues, leverage, liquidity and maturity transformation, collateral and concentration risks that should be addressed³⁰;
- *Discourage and monitor interconnections between parts of the crypto-asset ecosystem that cannot be effectively regulated and the traditional financial and non-financial systems.* While complete bans for entities, tokens and activities that cannot effectively be regulated may not be desirable nor feasible, authorities could focus on limiting and monitoring their interconnections with the financial system, such as those stemming from

²⁹ As pointed out by many commentators, the DeFi sector has come relatively unscathed by the recent turmoil in crypto-asset markets, although some DeFi platforms have gone through periods of severe outflows. For example, the lending platform AAVE has gone through significant outflows of depositors and some loans have failed to meet margin calls and have been liquidated automatically. However, such episodes of stress have not created malfunctions within the protocol.

³⁰ These vulnerabilities were amplified by several factors, including volatility of crypto-assets, flawed and opaque governance structures and the lack of adequate risk management practices by service providers and entities operating in these markets.

direct and indirect exposures of regulated entities. For example, authorities could set significant regulatory costs (e.g. capital and liquidity requirements) for direct exposures of regulated financial institutions to crypto-assets, such as those recently introduced by the BCBS for banks (BCBS, 2022);

- *Improving risk management practices in the parts of the ecosystem that cannot be effectively regulated.* Authorities could reflect on how to incentivise the adoption of safe and sound risk management practices by entities involved or operating in areas not directly covered by financial regulation. Initiatives in this area would rely on moral suasion and could include high-level principles for the safe implementation of smart contracts which may be used to deliver financial services³¹;
- *Periodic reviews.* The regulatory perimeter for financial regulation applicable to crypto-asset ecosystems should be regularly reviewed. If there are material changes in the functioning of these markets, including the underlying technologies, the perimeter could be extended to include entities and activities that were deemed unfit for regulation.

In the reminder of this section, we provide some concrete proposals to implement these principles and discuss their relationship with ongoing work by SSBs and the European Markets in Crypto-Assets Regulation (MiCAR).

4.1 Policy Considerations Related to the Asset Layer

The collapse of Terra/Luna, the outflow of investors from certain stablecoins (e.g., Tether) and their temporary de-pegging observed during days of extreme market stress suggest two main policy considerations related to the stabilization mechanism of this category of crypto-assets.³²

1. The stabilization mechanism of stablecoins pegged to fiat currencies should always rely on a reserve of assets with low credit, market and liquidity risks. Stablecoins used as means of

³¹ One example in this area is the memorandum of understanding signed by the Bank of Italy, Cattolica University and Roma Tre University to carry out research on the characteristics and good practices related to the use of smart contracts for the provision of banking, financial and insurance services (Banca d'Italia, 2022).

³² Kwon *et al.* (2021) show that it is impossible for stablecoins to achieve perfect stability. Stablecoins are exposed to three main sources of price instability (the “trilemma of stablecoins”) : i) downward price instability due to moral hazards of the issuer or entity managing the reserve; ii) downward price instability when the issuer is exposed to external market risk and has a poor financial performance (e.g. Terra); and iii) upward price instability caused by limited coin supply (DAI). Using a theoretical model for stablecoins, the paper finds that any stablecoin design can avoid at most two of these risks. As a result, the presence of risks that cannot be resolved supports the necessity of regulatory interventions for this type of tokens.

payments in crypto-asset markets must have reliable stabilization mechanisms. Given the key role of the stabilization mechanism for the value of stablecoins, there should always be a reserve of assets that can effectively guarantee the value of tokens even in periods of market stress. The market value of the assets in the reserve should exceed the value of tokens in circulation to reassure holders about their ability to redeem their tokens.

2. Issuers of stablecoins pegged to fiat currencies should provide reliable and up-to-date information on the composition of reserve assets. Opaqueness about the composition of assets backing the value of tokens can undermine the trust of stablecoins holders. Information about the assets that back the value of tokens cannot be provided solely by issuers, given the potential risks of misreporting, but should be provided by an independent entity (e.g., audit firm) with official reports (i.e., not with simple attestations). Finally, the frequency of the report should be commensurated to the cash-like nature of stablecoin pegged to fiat currencies (e.g., monthly or at higher frequency).

The first consideration is broadly consistent with recent policy work by SSBs and with MiCAR. However, the work by SSBs applies to large stablecoins, called “global stablecoins” (GSC) by the FSB (FSB, 2022c) and “stablecoin arrangements that are considered systemically important financial market infrastructures” by the CPMI-IOSCO, although SSBs clarify that their work could also apply to all stablecoins. The spillover of the collapse of Terra/Luna to the broader crypto-asset ecosystem highlights the importance to apply this consideration to all stablecoins pegged to fiat currencies.

The second consideration is consistent and expands the FSB recommendations on global stablecoins. In particular, the implementation guidance of Recommendation 8 highlights GSC arrangements should provide to all users and relevant stakeholders information on, among other things, the composition of and the investment mandate for the reserve assets. The FSB also provides a common disclosure template for reserve assets, which may be used by any stablecoin arrangement if there are no specific supervisory disclosure requirements applicable to the GSC. The above consideration highlights the importance of requiring issuers to provide such information with sufficient frequency.

MiCAR does not contain transparency requirements related to reserve assets of reserve-backed stablecoins with a single reference value (so-called “e-money token”, EMT). Although MiCAR requires issuers of stablecoins referencing a basket of assets or fiat currencies (so-called “asset-

referenced tokens”, ART) to provide clear, accurate and transparent information on the value and the composition of the reserve assets and update such information at least once a month on a publicly and easily accessible place on their website, similar requirements are not envisaged for EMT issuers. However, it is important to recall that EMTs can be issued only by banks and e-money issuers, which are subject to reporting and transparency requirements about their investments.

4.2 Policy Considerations Related to the User Interface Layer

Exchanges and lending platforms were key amplifiers of market stress. Their weaknesses were related to both poor risk management practices and the lack of regulatory requirements that could maintain their ability to meet investors’ outflows, particularly during periods of market stress. This suggests the following considerations related to lending/borrowing activities and exchange services:

3. Crypto-asset service providers engaging in lending activities and/or borrowing crypto-assets from clients should be subject to adequate regulation addressing credit, market and liquidity risks. In particular, a regulatory framework for these entities should introduce prudential requirements (capital and liquidity requirements) that are proportional to the risks taken by these intermediaries. Lending platforms performing maturity transformation (e.g., offering deposit services denominated in crypto-assets redeemable on demand and providing loans in crypto-assets) should comply with liquidity requirements. Furthermore, lending activities should be subject to a framework for measuring and controlling risks associated to large exposures.
4. Crypto-asset exchanges should be subject to the same regulatory treatment as that applied to trading platforms in traditional financial systems. In particular, the regulation of crypto-asset exchange platforms should include operational and legal segregation of client funds, as well as other rules for consumer protection and the management of conflicts of interest.

The first consideration is broadly consistent with the FSB recommendations on crypto-asset activities and markets (FSBb). In particular, according to the implementation guidance of Recommendation 5, authorities should require crypto-asset service providers to identify and

manage risks arising from leverage and credit, liquidity, and maturity transformation. Authorities should also have in place rules, policies and enforcement tools that comprehensively address these risks both in normal times and in times of stress.

MiCAR does not contain specific regulation nor prudential requirements for lending and borrowing activities in crypto-assets³³. Indeed, within 18 months after the date of entry into force of the regulation, the Commission will present a report to the European Parliament and the Council providing, in particular, an assessment of the necessity and feasibility of regulating, lending and borrowing of crypto-assets.

The second consideration is broadly consistent with both FSB recommendations on crypto-asset activities and with MiCAR, which introduces several rules to address consumer protection risks³⁴.

As highlighted in the previous sections, significant level of leverage by certain institutional investors (e.g., hedge funds) and by retail investors on exchange platforms amplified the stress. This evidence supports the following consideration:

5. Authorities should limit the amount of leverage that retail investors can obtain on exchange platforms and collect information on the use of leverage by funds investing in crypto-assets, particularly by those that are not subject to leverage limits.

The FSB recommendations contain general requirements to address leverage risk³⁵. MiCAR does not generally addresses risks related to the build-up of leverage by investors in crypto-asset markets.

Finally, a key factor in the events leading to the FTX bankruptcy was the use of the utility token FTT issued by FTX as an instrument for speculative activities performed by FTX itself, the affiliated hedge funds Alameda and other investors. FTT was also accepted as collateral by FTX as well as potentially by other entities in the market. This suggests two main considerations

³³ For example, MiCAR contains minimum capital requirements for services related to trading and investment activities. These requirements are generally defined by the largest between the (one quarter of) fixed overhead costs and absolute thresholds that vary with the specific activities performed by the service provider.

³⁴ For a detailed illustration of MiCAR see Ardizzi *et al.* (2023) in this issue.

³⁵ See previous considerations related to crypto-asset service providers engaging in lending activities and/or borrowing crypto-assets from clients.

related to the provision of multiple services by a single entity (so-called crypto-conglomerates) and the treatment of crypto-assets that do not qualify as regulated securities (e.g. utility tokens):

6. Crypto-asset service providers performing multiple services (e.g., custody of client funds, brokerage, providing credit for margin trading, exchange, clearing and settlement) should have an effective independent risk management function for each activity or bundles of similar activities, particularly when these activities can create conflict of interests within the service provider. For example, conflicts of interest may arise when a service provider issues, manages, invests or provides loans in the same crypto-assets held by its clients.
7. Authorities should consider the introduction of restrictions or specific requirements related to the use of utility tokens as investments. Such limitations could involve, for example, the inability of the issuers to buy back such tokens or the prohibition for exchanges to list such tokens. Authorities could also discuss similar limitations for governance tokens and for any other token that is created to perform a different function than those performed by existing financial assets.

The FSB recommendation 9 on crypto-asset activities and markets specifically addresses risks associated to crypto-asset service providers performing multiple activities. In particular, the implementation guidance highlights the importance of addressing risks and conflicts of interests arising from the combination of multiple activities, including disaggregation and separation of certain functions that create those risks, such as custody, trading, settlement, lending, borrowing or proprietary trading performed by the same entity. MiCAR does not generally addresses risks arising from vertically-integrated services provided by the same entity, although it contains several requirements whose strict interpretation may help address such risks³⁶.

5. CONCLUSIONS

This paper documents the complex structure of crypto-asset ecosystems and their significant vulnerabilities. These issues amplified the turmoil observed in 2022, highlighting the need to develop an effective regulatory framework for issuers and service providers operating in these markets.

³⁶ For example, MiCAR addresses potential conflict of interests between crypto-asset service providers and: (a) their shareholders or any person directly or indirectly linked to them by control; (b) their managers and employees; (c) their clients, or between clients.

SSBs and international authorities are working to mitigate a wide range of risks associated with crypto-assets and related activities – often outside the regulated area or non-compliant with existing regulation – while preserving the potential benefits associated with the use of DLTs in the provision of payment and financial services. Given the global nature of these markets, the definition of internationally consistent policy principles for an effective regulation of crypto-assets is essential to avoid the risk of harmful fragmentation arising from different approaches³⁷.

To this end, it is important to come to a global shared analysis of the risks associated to different types of crypto-assets and their underlying technologies and identify which types of crypto-assets can support public policy objectives. In this respect, treating all crypto-assets in an undifferentiated way may hinder a clear debate about standards for robust regulation and supervision of these instruments. The main benefits associated to a globally shared conceptual analysis of crypto-assets and their underlying technologies include the development of a comprehensive data collection framework for these instruments, such as the one currently being developed under the new Data Gaps Initiative, and promoting cross-border and cross-sector cooperation, helping authorities coordinate their initiatives, identify potential regulatory arbitrages and gaps and improve their communications to market stakeholders.

³⁷ This is desired by many scholars and practitioners. See Savona (2023) in this issue.

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