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Making It Through The (Crypto) Winter: Facts, Figures and Policy Issues

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"The fact that money and securities are close substitutes is absolutely fundamental to dynamic economics; we should waste our time if we did not bring ourselves to realize it as soon as possible".

SIR JOHN RICHARDS HICKS

MAKING IT THROUGH THE (CRYPTO) WINTER: FACTS, FIGURES AND POLICY ISSUES*

ABSTRACT

Crypto-assets have seen strong growth in terms of price in the last years, attracting the interest of retail and institutional investors. More recently, the market has experienced a sharp decline in prices also influenced by idiosyncratic events and tighter global financial conditions. Starting from the main events that unfolded in the crypto-assets market in 2022, this paper seeks to shed light on the challenges regulation faces, the areas it needs to cover, as well as on the drivers of the most recent regulatory developments. In order to do this, we rely on a conceptual framework that attempts to distinguish the different dimensions of the elusive concept of "decentralization".

Keywords: Crypto-Asset; Bitcoin; Blockchain; Regulation; Decentralization
JEL Classification: G23; K29; O33

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RIASSUNTO

Superare l'inverno (cripto): fatti, dati e questioni di policy

Negli ultimi anni le cripto-attività hanno mostrato una forte crescita in termini di prezzo, attraendo l'interesse di investitori retail e istituzionali. Più recentemente, il mercato ha registrato un forte calo, influenzato anche da eventi idiosincratici e da condizioni finanziarie globali più restrittive. Partendo dai principali eventi che si sono verificati nel mercato delle cripto-attività nel 2022, questo lavoro si propone di far luce sulle sfide che la regolamentazione deve affrontare, sulle questioni aperte e sui fattori che hanno determinato i più recenti sviluppi normativi. A tal fine, ci si basa su un quadro concettuale che cerca di distinguere le diverse dimensioni dell'elusivo concetto di "decentralizzazione".

1. INTRODUCTION

Since Satoshi Nakamoto laid down the theoretical foundation of Bitcoin[1], a number of projects have been triggering public interest in "alternative money" and more recently in the potential of DLTs[2] as the underlying infrastructure of a the so-called "Web3"[3].

Data providers report to date about 20000 crypto-assets serving a wide range of different purposes[4]. Although Bitcoin was created to replace traditional money in retail payments, as a result of the loss of confidence in traditional finance following the Global Financial Crisis, the use of crypto-assets as a speculative investment instrument seems nowadays more common.

Lacking a globally shared taxonomy, for the purposes of this paper we will rely when necessary on the distinction between two main groups of crypto-assets: unbacked crypto-assets and asset-backed ones. The former have no backing assets, whereas the value of the latter is collateralized

[1] http://www.bitcoin.org/bitcoin.pdf
[2] According to Krause *et al.* (2017), "*DLT refers to a novel and fast-evolving approach to recording and sharing data across multiple data stores (ledgers), which each have the exact same data records and are collectively maintained and controlled by a distributed network of computer servers, which are called nodes*".
[3] According to Marchetti (2022), "*Web 3 is the proposal for a new architecture of internet applications, based on blockchain technology*".
[4] The development of this large number of tokens (we use token, coin and crypto-asset as synonyms throughout the paper) has also been made possible by the rise of different blockchain technologies. Of these, Ethereum probably represents the most important. In particular, its programmability features are much wider than those of Bitcoin, allowing for the coding of smart contracts in a Touring complete language and their execution through the Ethereum Virtual Machine (EVM). Smart contracts are nothing more than computer programs stored on the blockchain that are executed automatically when certain conditions occur and without the intervention of any user.

by a single financial asset or a basket of assets. This is a first approximation, aiming to stress the marked difference in the intrinsic value, hence in the *price volatility,* of different classes of crypto-assets. Linking the value of a token to an underlying reserve of assets is indeed the main way so far explored to create (collateralized or asset-backed) "stablecoins", i.e. tokens purporting to maintain the peg to the value of a benchmark, usually a fiat currency. Tokens that aim to track a target price by means of automatic adjustments of their supply in response to changes in demand (*algorithmic* stablecoins) belong to the realm of unbacked assets and have so far enjoyed little fortune. Nonetheless, it must be stressed that *unbacked assets* is actually a very broad category which includes very different objects[5]. Tokenized traditional assets and securities tokens – where compliant with local legislation – represent a *tertium genus,* in that they are not collateralized by assets, but embed a financial claim on an issuer, in line with the applicable securities law.

Despite the strong growth observed in recent years, crypto-assets and the related services still remain a niche segment, but not without risks. The Financial Stability Board estimates that at its peak, crypto-assets accounted for only 1 percent of all global financial assets (FSB, 2022a) further noting that despite its small relative size, the sudden growth of this segment and its growing interconnection with the financial system could soon lead it to be relevant to financial stability. Consumer protection issues may even be more urgent to tackle, given the popularity and diffusion that crypto-assets have enjoyed among retail users[6].

The fears aroused by the "eclipse" of the Terra-Luna ecosystem, in May 2022, and by other episodes of crisis, including the recent collapse of a major crypto operator (FTX) valued at $32 billion, are an important alarm bell pointing to the need of a clear regulatory approach, that defines rules for operators and for the protection of users as well as the roles of the various

[5] Some of these may have a use value within their ecosystem and entitle the holder to different forms of rights or claims. For example, *native coins* are normally specific to a blockchain, are issued according to the latter's protocol, are indispensable to its operation and may entitle the holders to receive a share of the profits generated by the network; *utility tokens* are digital assets that allow holders to receive a service or a product offered by the issuer; *governance tokens* may give holders the right to participate to the governance of a blockchain project.

[6] Just to give an idea from an end-user point of view too, in December 2017 – date of first relevant upward price peak of the crypto market, mainly represented by the Bitcoin – estimates by Statista (2022) report over 6 million number of downloads by end users of apps that allow for cryptocurrency storage worldwide, from just 130 thousand in December 2015 (two years before only). Still in the month of November 2022, despite of the recent fall during this year in the crypto market capitalization and the absence of expectations of recovery in the short term (so-called "crypto winter"), almost 9 million app-downloads worldwide can be estimated, for a total of cumulative downloads from 2015 of over 370 million (end November 2022).

authorities involved and the relative forms of collaboration, also bearing in mind the cross-border nature of these markets.

On a more positive note, effective regulation may help achieve the benefits of a novel technology that has not yet delivered on its many promises, in terms of the efficiency, resilience and transparency of the financial system.

Building on recent events in the crypto-assets market, this paper seeks to take stock of the main challenges for policymakers and the gaps to be filled. For this purpose, we introduce a conceptual framework to better understand the elusive concept of "decentralization" and how incumbents and new entrants are trying to take advantage of it. A number of seminal works – including by the IMF, the FSB and the BIS – have greatly contributed to understanding the risks entailed by crypto-assets so far, and we will extensively refer to this ever-growing body of work when helpful.

The paper is organized as follows: Section 2 describes some market trends with a focus on the developments observed in the context of significant systemic or idiosyncratic events; Section 3 provides a framework to discuss the most important regulatory challenges with respect to "intermediaries" and financial market infrastructures; Section 4 briefly summarizes the initiatives undertaken so far by global standard setters and legislators in different jurisdictions. Finally, Section 5 concludes.

2. THE MARKETS FOR CRYPTO-ASSETS: RECENT TRENDS

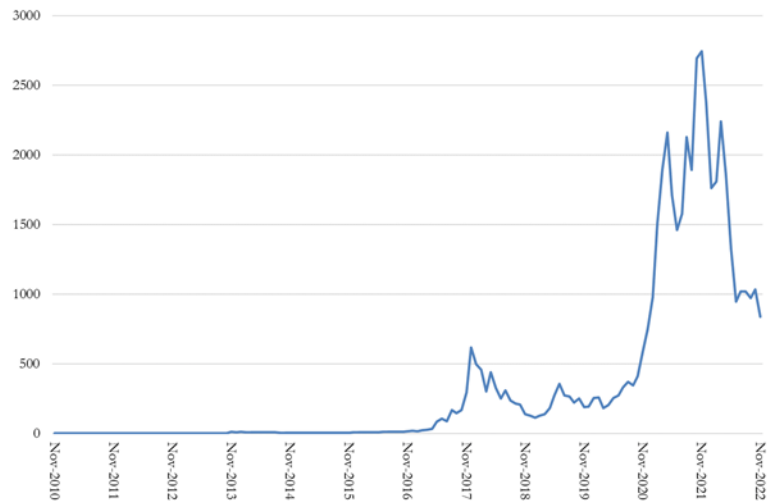
In the fourteen years of crypto-assets' existence, the market has grown steadily, and more recently, since the outbreak of the Covid-19 pandemic, we have witnessed a further expansion of this segment. In January 2020, the total capitalization of crypto-assets totaled about $200 billion (see Figure 1); by November 2021, at its peak, it had reached about 3 trillion dollars, with a growth of 1400 percent in less than two years. At the time of this paper this market has significantly shrunk: it remains well above January 2020, but about 60 percent down from its record-high.

Looking back, the first big growth moment for the crypto-asset segment was in 2017, when Bitcoin rose from $1000 (January) to about $20000 (December). This bull run was relatively

short, and the first crypto winter followed, to end in 2020 after the outbreak of the COVID-19 pandemic.

In 2022, another crypto winter began, and a number of events, of both systemic and idiosyncratic nature, occurred. These happenings make it possible to analyze the behavior of crypto-assets under less favorable or stressful financial conditions. Although crypto-asset transactions conducted on major blockchains are public, they are generally anonymous, and to date few data sources exist on the ownership and use of these assets. Therefore, our analyses will rely primarily on market data (prices, capitalization, volumes) that are publicly accessible. In addition, price trends are crucial in trying to understand whether these assets can perform the functions generally attributed to them, such as that of a means of payment or store of value. In the following paragraphs, we will examine what we consider the most significant events[7].

FIGURE 1 - *Crypto-Assets Market Capitalization*



Note: Values in billions of U.S. dollars. Market capitalization is obtained as the product of prices times the number of outstanding assets so its evolution over time is affected by both of these factors.
Source: Statista (2022).

[7] This is not meant to be an exhaustive list of what happened during 2022 regarding crypto-assets.

Monetary policy normalization – In response to the adverse events that have affected the world economy over the past two decades (global financial crisis, sovereign debt crisis, COVID-19 pandemic), central banks have supported the economy through the implementation of a series of expansionary monetary policy measures, both conventional and unconventional. In this context of high liquidity and low interest rates, investors directed their funds toward asset classes characterized by higher returns and potentially higher risk profiles.

This shift has also been reflected in the crypto segment, which has gradually undergone a process of "financialization" in the sense that crypto-assets behavior has been increasingly similar to that of traditional risky securities. In fact, the correlation between major, unbacked tokens (Bitcoin, BTC and Ether, ETH[8]) and stock indices has risen steadily, albeit with some variability, to fairly high values (see Figure 2a). However, this process of "financialization" of major unbacked crypto-assets does not appear to be limited to the extraordinary period of the pandemic. In fact, the co-movement with risky assets continued into the 2022, a time when the world's major central banks embarked on a path of monetary policy normalization with official rate hikes as well as, in some cases, shrinking their balance sheets.

However, despite the existence of this comovement with more traditional risky asset classes, unbacked crypto-assets are exposed to significantly greater price fluctuations than traditional assets, with annual volatility of Bitcoin today being more than three times that of equities; it was even higher in the past (Figure 2b).

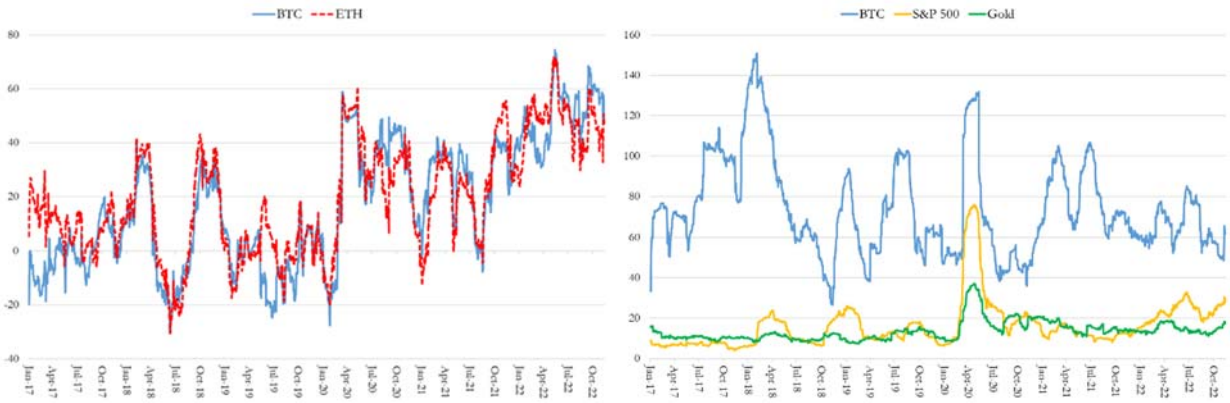
Russia-Ukraine conflict – On February 24, 2022, Russia invaded Ukraine leading to the outbreak of a conflict that lasts at the time of writing. The war, in addition to its far-reaching and dramatic consequences, brought much attention to the use of crypto-assets, even seeing the emergence of new use cases since, as noted in Jovanović (2022):

"Necessity is the mother of inventions. New materials, new sources of energy, new ways of payment and store of value may emerge from the crisis".

[8] Major tokens by market capitalization. Bitcoin and Ether alone account for about the 60 percent of the entire market in terms of market capitalization.

FIGURE 2 - *Market Indicators of Major Crypto-Assets*

(a) – Correlation with S&P 500 *(b) – Volatility*



Note: daily values in percentage. Correlation and volatility are computed on a rolling window of 60 days on a sample going from January 1, 2017 to November 15, 2022.
Source: S&P 500 and gold data are retrieved from Yahoofinance, while BTC and ETH from Coinmarketcap.

In the days immediately following the start of the conflict, European institutions and the general public were wondering whether Russia was circumventing the imposed sanctions, such as exclusion from the SWIFT international payment system, through crypto-assets (see Fleming *et al.*, 2022). Indeed, as the war began, for about two weeks, an increase in trading volumes between rubles and crypto-assets was noted; particularly toward Bitcoin and TetherUSD (USDT; see Figure 3).

To our knowledge, there is no evidence to date of actual mass-scale sanctions violations by Russia through crypto-activities. In this regard, consider that the Bitcoin blockchain can process at most 7 transactions per second[9] and Ethereum 15, rather low numbers to supplant a traditional payment system; for comparison, consider that Visa claims to be able to process about 1700 transactions per second on average (see Hafid *et al.*, 2020).

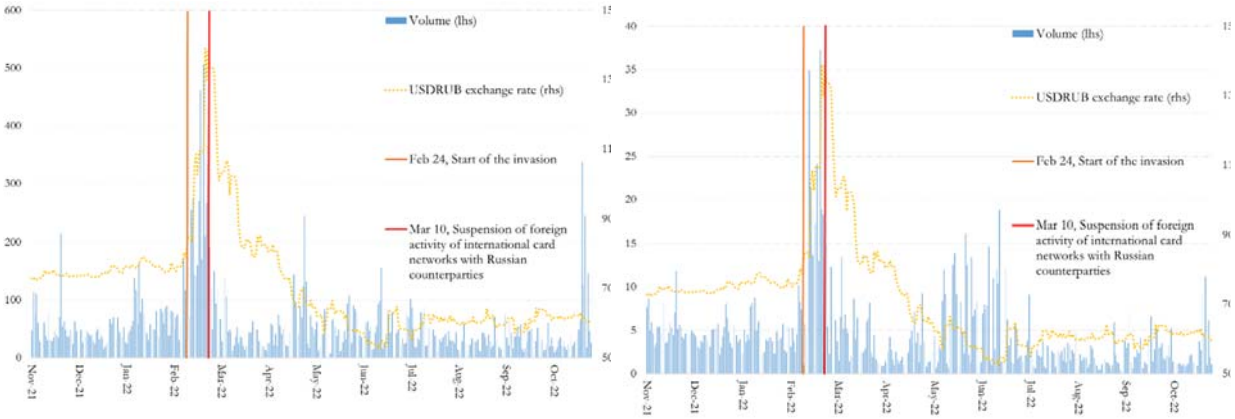
One of the possible plausible interpretations is that Russians (savers, businesses, and investors) looked for reserves of value. Indeed, as the ruble was losing value against major currencies, a search for safe-haven assets may have been triggered to preserve purchase power. In this context, both Bitcoin and (asset-backed) stablecoins may have been considered as such, the first

[9] These features refer to the original network of Bitcoin (also called layer 1 or "mainnet"). Over time, solutions, called layer 2, have been introduced to try to overcome the scalability problem of the Bitcoin blockchain. Among the most famous of these is Lightning Network proposed by Poon and Dryja (2016).

being often mistakenly seen as a store of value due to its capped supply, the second being seen as a substitute for hard currency. In addition, of course, there may have been concurrent episodes of cross-border activity by some companies or investors/oligarchs in search for diversification or concealment of capital.

FIGURE 3 - *Trade Volumes of Russian Ruble (RUB) against Major Crypto-Assets*

(a) - BTCRUB *(b) - USDTRUB*



Note: figures are expressed in base asset of the pair. In the right chart, the unit of measure is millions. Daily volumes from November 15, 2021 to November 15, 2022. BTCRUB is the trading pair Bitcoin-Russian ruble; USDTRUB is the trading pair TetherUSD-Russian ruble. USDRUB is the U.S. dollar–ruble exchange rate and expresses the equivalent of 1 U.S. dollar in Russian rubles.
Source: volume data are retrieved from Binance. Exchange rate data are retrieved from Yahoofinance.

The increased trading activity lasted approximately until March 10, 2022, the date when the freeze on foreign activity, vis-à-vis Russian counterparties, of major international payment card schemes became effective (Bloomberg News, 2022) and the (approximate) start of the ruble's recovery against the U.S. dollar. While the freeze on the operation of card schemes represents an objective constraint on the purchase of crypto-assets on centralized exchanges[10], the reduction in volume at the time of the ruble's recovery reinforces our interpretation that crypto-assets were seen as a store of value.

[10] Centralized Exchanges (CEXs) allows the buying and selling of crypto-assets replicating the operation of traditional markets where a central entity pairs the buy and sell instances recorded on the order book and based on these communicates the price of an asset. On the other hand, blockchain technology and the development of smart contracts has enabled the emergence of so-called Decentralized Exchanges (DEXs). In this type of platforms, there is generally no order book or even a central entity, and the price of assets is determined algorithmically with more or less complex formulas (AMM, Automated Market Makers).

The evidence for Ukraine is much the same as that observed for Russia, although in this case the increased activity in the crypto markets was longer-lasting, roughly until the end of July 2022.

In Ukraine, with the outbreak of war, the sale of foreign currency to retail customers was immediately banned. This may have spurred the adoption of dollar-linked stablecoins as a digital surrogate for the latter, as well as the pursuit of other assets considered as possible safe-havens such as Bitcoin.

In support of this argument, Chainalysis (2022) reported the view of an adviser to the Ukrainian Ministry of Finance who pointed out that when the Ukrainian Central Bank (NBU) eased restrictions on foreign currency holdings in July 2022, activity began to normalize (volumes between crypto-assets and hryvnia then stabilized at levels even lower[11] than those prevailing at the beginning of the war; Figure 4).

The Ukrainian case is also significant because the government has resorted to crypto-assets as a source of funding for war expenditures alongside more traditional ones. In particular, the Ministry of Digital Transformation of Ukraine has set up wallets to receive donations with various tokens (Bitcoin, Ether, and others) and has supported the creation of a collection of non-fungible tokens (NFTs), known as the Metahistory Museum of War, from the sale of which to raise additional funds.

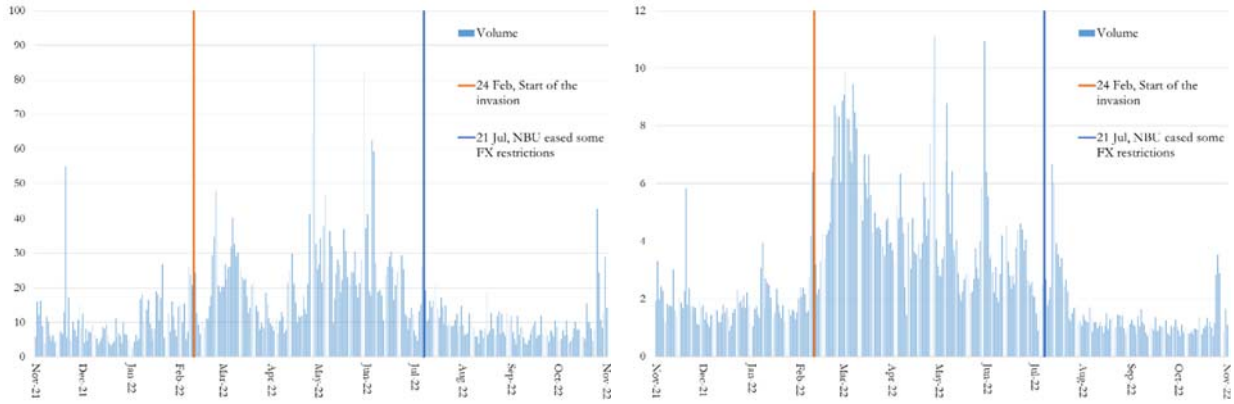
Terra-Luna collapse – Terra is a blockchain introduced in 2018 by the South Korean company Terraform Labs, on whose infrastructure several algorithmic stablecoins rest. The most popular were those pegged to the U.S. dollar (TerraUSD – UST) and the Korean won (TerraKWR – KRT). In early May 2022 UST represented the third stablecoin by market capitalization (nearly $19 billion) after TetherUSD (USDT) and USD Coin (USDC).

To understand how Terra's pegging to the reference fiat currency worked, it is also necessary to introduce Luna (LUNA), the native token of the Terra blockchain, which was also traded on exchanges and with a value not pegged to any other asset. LUNA and the activity of arbitrageurs were at the heart of Terra's price stabilization mechanism with the dollar[12].

[11] It should be noted, however, that compared to the pre-war period, general market conditions had changed greatly with generally reduced operations due to the crypto winter.
[12] The model underlying Terra/Luna stablecoin is illustrated among others by Abate *et al.* (2023) in this issue.

FIGURE 4 - *Trade Volumes of Ukranian Hryvnia (UAH) against Major Crypto-Assets*

(a) - BTCUAH *(b) - USDTUAH*



Note: figures are expressed in base asset of the pair. In the right chart, the unit of measure is millions. Daily volumes from November 15, 2021 to November 15, 2022. BTCUAH is the trading pair Bitcoin-Ukranian hryvnia; USDTUAH is the trading pair TetherUSD-Ukranian hryvnia.
Source: volume data are retrieved from Binance.

The Terra infrastructure allowed LUNA tokens to be exchanged for UST and vice versa at any time, at a guaranteed price of $1, regardless of the market price of the two tokens at the time of conversion. Should the price of UST fall below 1 U.S. dollar ($), say $0.98, users would be enticed to engage in an arbitrage transaction by buying UST in the market and then converting them to LUNA in order to realize a profit from the price difference ($1-$0.98). Converting UST to LUNA involved destroying the former (*burn*) and minting the latter (*mint*). As a result, the supply of UST in circulation is reduced by exerting upward pressure on prices and bringing UST back toward the $1 value. Conversely, in the case of UST value above $1, users would be inclined to buy LUNAs to be converted into USTs, leading to an expansion of the supply of USTs and therefore a downward pressure on their price.

An entire ecosystem was built around the Terra and LUNA tokens, among whose key players were the borrowing/lending protocol Anchor[13] and the Luna Foundation Guard (LFG). The former, which offered lenders returns in excess of 20 percent, appeared to be the main UST use case. In fact, as of April 2022 about 75 percent of all circulating USTs were staked in Anchor. The latter was founded in early 2022 with the aim of defending the UST peg. The LFG had built up

[13] The Anchor Protocol defines a money market between a lender of funds, which seeks a passive return on its stablecoins, and a borrower of funds, which seeks to borrow stablecoins by paying interest. The latter must provide crypto-assets as collateral, generally in an amount that over-collateralizes the loan (loan-to-value up to 80 percent).

reserves in crypto-assets (in addition to Bitcoin, Avalanche – AVAX, Binance Coin – BNB, and others) to about $4 billion in equivalent value representing about 20 percent of circulating USTs (Figure 5a)[14].

On May 7, 2022 on the decentralized exchange Curve[15] UST depegged (slightly below $0.99) as a consequence of its large sales to buy other stablecoins. From this point, a sell-off began, with investors making massive withdrawals from the Anchor protocol as well, in order to close their exposures to TerraUSD. In an attempt to sustain the peg, the Luna Foundation Guard began selling its reserves, but by May 10 these had run out and the depeg became more pronounced ($0.80). At this point, investors, in an attempt to limit losses, rather than sell TerraUSD on the open market and achieve a capital loss, began to convert them into LUNA since the stabilization mechanism provided that 1 UST, regardless of its value, was convertible to the equivalent of $1 of LUNA. These pressures led to a hyperinflation of LUNA and a consequent dilution of its value even bringing the capitalization below that of TerraUSD thus effectively making a 1:1 conversion impossible. By May 13, in less than a week after events began, the Terra-Luna project essentially collapsed and 1 UST was worth less than 20 cents on the dollar [16] (Figure 5b).

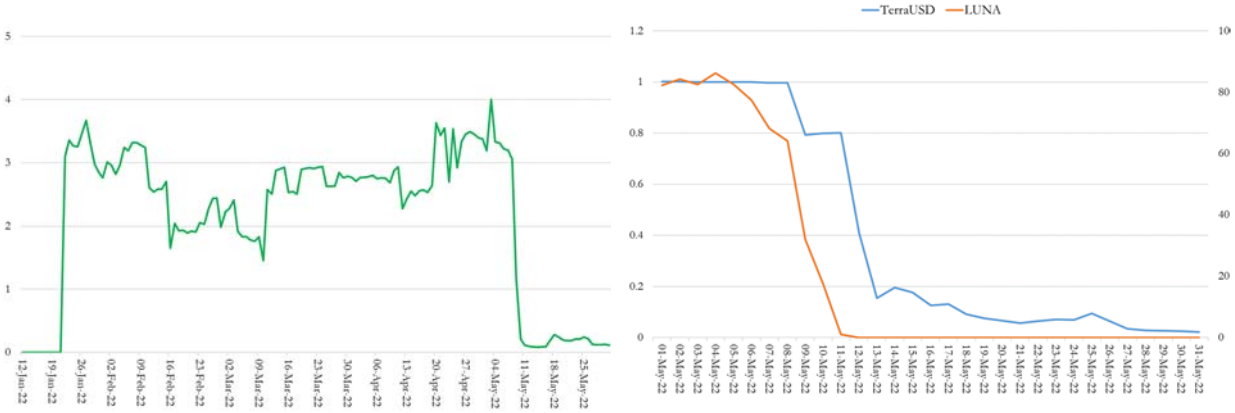
Whether the Terra-Luna collapse was the result of the manoeuvrings of malicious actors remains unclear. However, the less favorable remuneration policy applied by the Anchor savings protocol[17] may also have played a role in accelerating a downward spiral.

Among the various repercussions[18] of the Terra-Luna collapse, for the purposes of this paper, it is worth highlighting the impact on the backed stablecoin segment, in particular on the main token TetherUSD. Indeed, the latter suffered a slight depeg that lasted quite a while until the end of July 2022. At the same time, a marked reduction in its market capitalization was also observed, a symptom not only of sales of the token, but of its redemption into fiat currency (see Figure 6a).

[14] On this event see also Abate *et al.* (2023) in this issue.
[15] Curve is one of the leading AMM-based DEXs specialized in stablecoin trading.
[16] On this event see also Abate *et al.* (2023) in this issue.
[17] In March, an amendment to the deposit remuneration policy of Anchor was approved making it less profitable with a view to greater sustainability over the long term (https://forum.anchorprotocol.com/t/dynamic-anchor-earn-rate/3042).
[18] Notable consequences include the bankruptcy of the crypto bank Celsius and that of the hedge fund Three Arrow Capital.

FIGURE 5 - *Selected Terra-Luna Indicators*

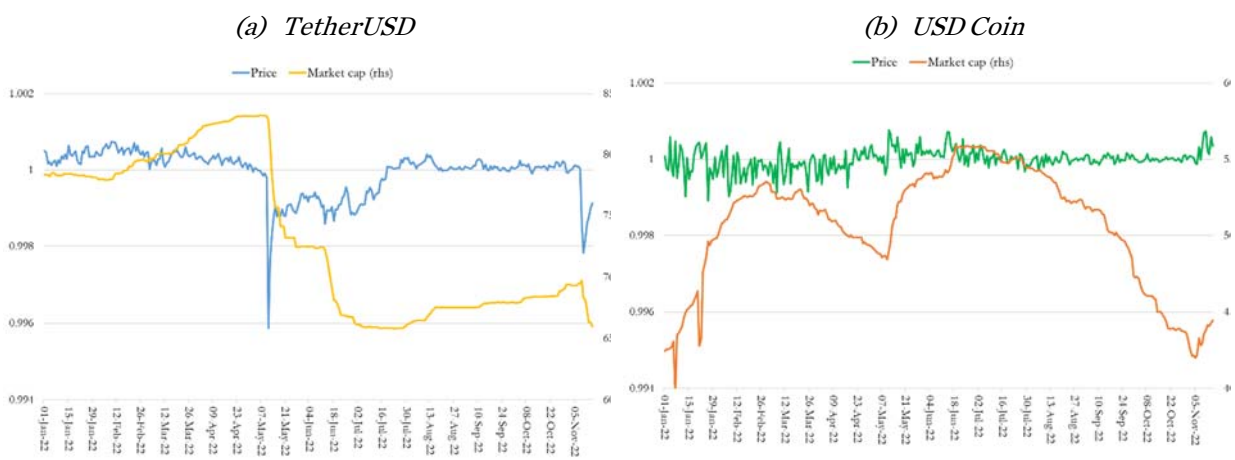
(a) LFG Reserves Value *(b) UST and LUNA Prices*



Note: left chart, daily values in U.S. dollars from May 1 to May 31, 2022; source: Coinmarketcap. Right chart, daily values in billions of U.S. dollars since the founding of the LFG (Jan 12, 2022) to May 31, 2022; source: https://dashboard.lfg.org/.

FIGURE 6 - *Major Asset-Linked Stablecoins Indicators*

(a) TetherUSD *(b) USD Coin*

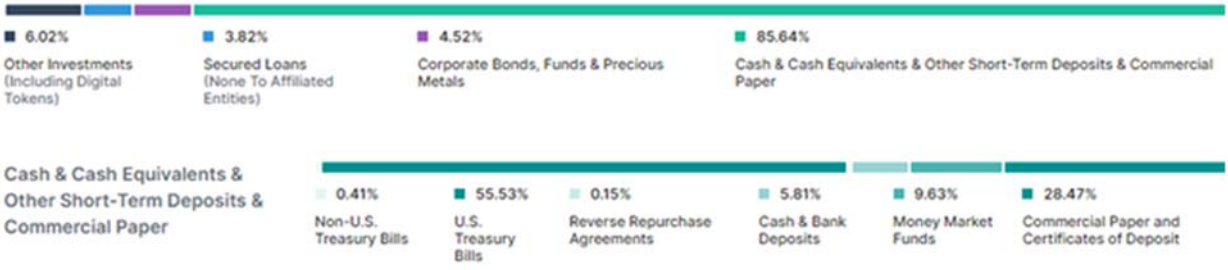


Note: prices are in U.S. dollars; market capitalizations are in billions of U.S. dollars. Daily volumes from January 1, to November 15, 2022.
Source: coinmarketcap.com.

The cause would lie in lower market confidence in the Tether's ability to redeem, mainly due to the opacity of communication about the reserves as well as their composition, which at the time of the events still included a non-negligible share of commercial paper and other illiquid assets (other crypto-assets and precious metals; Figure 7). Benefiting from this "flight" from Tether was mainly USD Coin (USDC; Figure 6b), the second-largest asset-backed stablecoin by market

capitalization, probably judged to be more transparent and with a sounder composition of reserves[19].

FIGURE 7 - *Tether Reserves Breakdown as of 31 March 2022*



Note: the total amount of the reserves was about 82 billion of U.S. dollars.
Source: https://Tether.to/en/transparency/#reports.

Despite Tether's depeg, which is no small event even if it has scaled back since, overall the asset-backed stablecoin segment seems to have withstood the shocks that hit this segment and the entire crypto-asset market in general. In fact, the entire stablecoin segment, which is made up of at least 85 percent backed tokens[20], during the turbulence phase triggered by Terra-Luna lost about 15 percent, while the entire crypto market saw a reduction in its value of about 30 percent. Overall, looking at the period from early 2022 to mid-November 2022, which includes also the FTX bankruptcy (see below), stablecoins lost around 15 percent versus more than 60 percent for the overall market. Even if we took the peak of the expansion of stablecoins in April 2022 compared to the mid-November 2022 low (Figure 8), the decline would still be much smaller than that experienced by other crypto-assets.

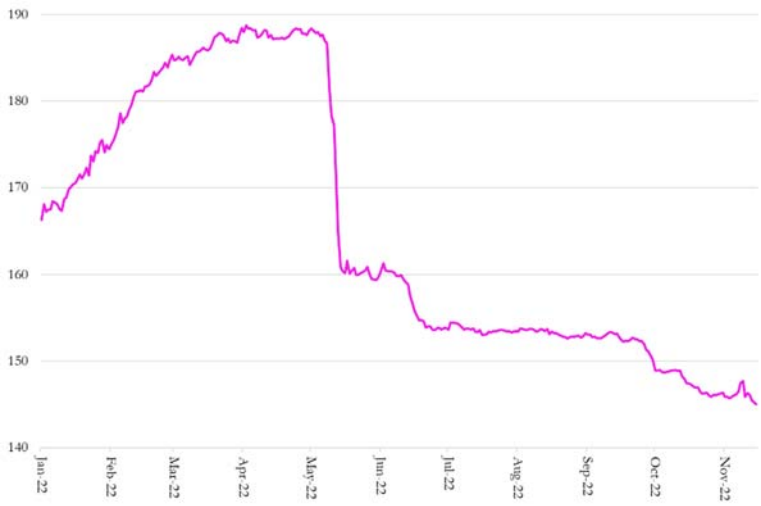
FTX bankruptcy – On November 11, 2022, FTX, one of the world's leading centralized crypto-exchanges, filed for bankruptcy. FTX is an operator offering several services including trading of crypto-assets, especially derivative contracts, and (seemingly) custody services. Like other exchanges, FTX issued its own token called FTT, a utility token providing its holders with some

[19] In those days, the CFO of Circle, one of USDC's founding companies, published a post on the company blog reporting that Circle had reserves invested only in cash (11.6 percent) and U.S. Treasury Bills (77.1 percent) https://www.circle.com/blog/how-to-be-stable-usdc-transparency-and-trust
[20] The first three tokens by market capitalization, TetherUSD, USD Coin and BinanceUSD collectively are worth about 85 percent of the segment of stablecoins.

discounts on the trading fees charged by the exchange. Importantly, FTX used a portion of its profits to buy back FTT. As well noted by Levine (2022)

"This makes FTT kind of like stock in FTX: The higher FTX's profits are, the higher the price of FTT will be. It is not actually stock in FTX — in fact FTX is a company and has stock and venture capitalists bought it, etc. — but it is a lot like stock in FTX. FTT is a bet on FTX's future profits".

FIGURE 8 - *Stablecoins Market Capitalization*



Note: daily volumes in billions of U.S. dollars from January 1, to November 15, 2022.
Source: DefiLlama.

The downfall of this operator took place in a matter of days. It all started on November 2, 2022, when CoinDesk, an online publication specialized in the cryptocurrency market, released a report in which it disclosed that the largest item of assets on the balance sheet of Alameda Research, a hedge fund founded by Sam Bankman-Fried, himself the founder of FTX, was FTT tokens. Immediately after this indiscretion the market did not seem to react, the price of FTT holding steady. The collapse of the FTT token and the crisis of confidence in FTX was triggered by the following announcement by Changpeng Zhao, the founder of Binance, the world's largest crypto-exchange by trading volume, that he would divest all FTT tokens held. On November 8 FTX (the FTT token had lost three-quarters of its value at this point) was forced to stop user withdrawals, given the high number of requests that came in. In the following days, Binance had

said it was open to a possible bailout, but backed out after analyzing FTX's accounts in more detail. FTX was forced to file for bankruptcy on November 11.

The collapse of the aforementioned platform has had significant impact on the crypto-asset market. In fact, at the beginning of November 2022 the total capitalization of these assets exceeded $1 trillion, while on the day of FTX's collapse the capitalization had fallen below $850 billion. This reduction can be attributed to the spillover effect of the event on the prices of other cryptographic assets rather than to the depreciation of FTT, which, prior to the bankruptcy, was worth a total of about $3 billion.

At the time of writing, it seems that the contagion effect mainly affected operators in the crypto industry, with marginal spillovers to traditional financial intermediaries. With regard to the former, for example, the platform BlockFi – which had significant exposure to FTX and its associated companies – was first forced to stop user withdrawals and then to declare bankruptcy as well; the broker Genesis Trading, one of the largest providers of financial services in the crypto-asset market, was forced to suspend customer withdrawals and informed the market that it was working to try to avoid bankruptcy. As far as more traditional players are concerned, the platform's collapse resulted in, among other things, the Japanese financial holding SoftBank and the American venture firm Sequoia wiping out their positions in FTX's capital.

In the days following the bankruptcy, the press published information that shed further light on the whole story. Gara *et al.* (2022) published a draft of the exchange's financial statements showing raw information, an unintelligible entry[21] and that the exchange held less than $1 billion in liquid assets against liabilities of about $9 billion. This accounting picture seems to be consistent with the findings by Ge Huang *et al.* (2022) and Berwick (2022) in the same days, namely, that FTX allegedly made $10 billion in loans to the crypto hedge fund Alameda using its clients' funds (probably receiving as collateral the FTT tokens it itself issued). Presumably, these loans would have been used to fuel speculative activity or to offset the fund's losses from the market turmoil following the Terra-Luna collapse. Furthermore, this movement of funds appears to have occurred through a "backdoor" that allowed Bankman-Fried to execute commands capable of altering the company's financial records without notifying others (Oliver *et al.*, 2022).

[21] The balance sheet, in a separate line, shows a negative entry of $8 billion named "Hidden, poorly internally labelled 'fiat@' account".

It seems that FTX experienced a classic bank run since investors demanded huge repayments in a few days. The scarcity of liquid assets as well as a sharply bearish market phase likely led FTX to be unable to meet customers' requests for reimbursement of funds and thus to the platform's bankruptcy.

Looking at this episode, another aspect to consider is that the numerous accounting irregularities that emerged do not seem to have been reported by the auditing firms, Armanino and Prager Metis, which were responsible for auditing the results of FTX and its U.S. subsidiary FTX.US for 2021. This may cast shadows on the work of these two companies, which in principle should have served to protect investors and customers.

In the face of these events, policymakers cannot fail to take action. While **we have witnessed the inherent fragility of some crypto-assets such as algorithmic stablecoins**, and the **volatility and speculative use of many others**, evidence shows **growing consumer interest in this asset class, especially in exceptional times**. We have also observed that t**hese assets, from a market perspective, increasingly behave like traditional assets**. This is one more reason to analyze their potential economic functions and features, and how they relate to traditional financial services which are subject to strict regulation across the globe. The events surrounding FTX show **the risks of a lack of regulation on service providers, calling for action to ensure the sector becomes resilient to idiosyncratic shocks and to prevent these from translating into systemic events** with the risk of spillovers to the traditional finance and the real economy.

3. THE ROLE OF REGULATION

The rise of crypto-assets – through *boom and bust* cycles in a largely unregulated setting – may cause significant consumer harm, and poses challenges that regulators and financial supervisors cannot ignore. As traditional finance incumbents start venturing into crypto-ecosystems, their changing risk profile needs careful scrutiny from a prudential standpoint. In a broader perspective, the rise of crypto-assets markets could pose serious risks to financial stability (FSB, 2022a; FSB, 2023 among others), as the line between traditional finance and crypto becomes blurred. However, crypto-assets are only one application of DLTs. **On a broader level, it is acknowledged - by intermediaries and policymakers alike - that DLTs as a general-purpose technology have significant potential for transforming the financial system and**

increase its efficiency. How to tackle the inherent risks without stifling innovation is at the forefront of the policymaking debate (see for instance FSB, 2022b; IOSCO, 2022, IMF, 2023).

Although some types of crypto-assets could have a role in valuable use-cases[22], the road to actually achieve any of their potential benefits is yet to be built. Indeed, stablecoins – which are sometimes depicted as an efficient alternative in the market for cross-border payments – have not proved stable at all. The rise and fall of many crypto-assets, irrespective of their specific nature and potential economic functions, has been mainly driven by waves of speculation. Market manipulation and insider trading have been frequently observed and holders' rights are far from certain, as are the tools for enforcing them. Some unregulated entities acting as the on- and off-ramps[23], to and from the crypto-ecosystem – such as the above-mentioned FTX – have proven unreliable, indulging in old-fashioned forms of misbehavior. Not least, "decentralized finance" remains largely insulated from traditional finance but has experienced the well-known effects of market risk, excessive leverage, liquidity risk and operational risk (IMF, 2022).

Disintermediation alone does not make a compelling case for deregulation: key stakeholders – including developers – are often in the position to extract ownership benefits from supposedly decentralized[24] projects and should be held liable accordingly. In addition, old and new

[22] The opportunities offered by DLTs and crypto-assets are assessed in detail in the European Commission's Impact assessment accompanying the Proposal for a Regulation on Markets in Crypto-assets: *"[...] Crypto-assets could deliver many benefits to the economy. When used as a means of exchange, payment tokens can enhance competition in the payment market and increase the efficiency of payments (especially cross-border) in terms of cost, speed, security and user-friendliness by limiting the number of intermediaries (such as banks). The issuance of utility tokens can represent a cheaper and less burdensome source of funding for start-ups and early-stage companies by streamlining the capital-raising process and not diluting the ownership capital of entrepreneurs. They also have the potential to connect the token issuer with a wide initial customer base. If they were properly regulated, crypto-assets could also widen investment opportunities for investors. In theory, any asset can be tokenised, and rights to such assets can be represented on a DLT. Such tokenisation processes have the ability to make liquid tangible assets (such as real estate) that would otherwise be illiquid or to facilitate the protection and monetisation of immaterial rights (such as intellectual property and software). Some utility tokens and DLT also offer individuals and companies the possibility to manage data flows and usage, making data portability in real time possible, along with various compensation models. Crypto-assets and the underlying DLTs also hold great potential for efficiency gains in the 'traditional' financial sector. This potential stems mainly from two features of the technology: (i) the ability to record information in a safe and immutable format; and (ii) the capability to make this information accessible in a transparent way to all market participants in the DLT network. The tokenisation of securities (shares or bonds) is an example of potential for growth in the near future. This can lead to increased financing for companies through securities token offerings (STOs) and efficiency gains throughout the value chain, by reducing the need for intermediaries and the automation, resulting in faster, cheaper and frictionless transactions*".

[23] By on- and off-ramps we mean the channels through which customers are able to access services related to crypto-assets, by exchanging fiat money with stablecoins or other crypto-assets in the first place, or to leave it by re-converting their crypto-assets into fiat money.

[24] In this context we refer to decentralization as to the core feature of a peer-to-peer network between non-mutually-trusting parties and without any central authority. As we will discuss, not all networks based on Distributed Ledged Technologies are decentralized, insofar decentralized systems are a class of distributed systems but not all DLTs are

centralized intermediaries are likely to maintain a role in this space, at least in the foreseeable future, providing the on- and off-ramps to and from the crypto-ecosystem and offering custody services to those users that are not willing to engage in the self-custody of digital assets. The more closely such services serve payment or investment purposes, the clearer is the case for a "same activity, same risk, same rule" approach by regulators and supervisors.

We discuss here in more detail the main gaps to be filled and the grey areas in need of clarification, focusing on the regulation of "intermediaries" and "infrastructures". In doing so, we clarify the main terms adopted as may be needed, against the background of a heterogeneous taxonomy developing across jurisdictions and standard setting bodies.

3.1 Regulating "Intermediaries" and the other Actors in DLT Ecosystems

The enforcement of existing or novel financial regulation relies on the identification of a range of "intermediaries" performing different functions; some activities (e.g. lending, provision of investment services, etc.) may be reserved to authorized entities subject to a set of conduct and prudential rules. "Activity-based" rules as well need a hook to be applied and this is always a clearly identifiable entity holding some form of liability. Against this background, **the very idea of decentralization – implying the anonymity of relevant parties and the lack of central governance structures – seems at odds with the traditional setup of financial services regulation and stands out as an overarching challenge for policymakers and supervisors. Thoroughly grasping and demystifying the several facets of "decentralization" is therefore a pre-condition to reflect on the relevant policy issues**[25].

Indeed, the delivery of financial services through a DLT can leverage different layouts with varying degrees of decentralization. A basic distinction to be made is between i) the decentralization of the underlying technological infrastructure (i.e. the blockchain as a

"decentralized". Decentralization is often considered the core of DLT's value proposition, being the foundation of censorship-resistance and paving the way for "cutting out the middlemen", a key promise of blockchain technology. Security and scalability, the other two vertices of the well-known "trilemma" proposed by Buterin, are on the other hand binding conditions to deliver reliable, real-world implementations (Hafid *et al.*, 2020).

[25] We leave in the background the overarching issue concerning the extent to which permissionless networks are *actually* decentralized. Very interesting technical works have dealt with the topic (see for instance Campajola et al., 2022). For the sake of defining a conceptual framework, we will simply assume that some degree of decentralization is possible both in the workings of a network and in the provision of services: this is enough to challenge well-established regulatory approaches and require fresh thinking.

settlement/execution layer) and ii) the decentralization in the operation of applications (e.g. protocols) running on the infrastructure. **Different configurations therefore pose different challenges in order to deliver a comprehensive regulatory approach (see Table 1), as described in the following sections**.

TABLE 1 – *Synoptic Table of Different Set-Ups and Related Challenges*

Setup	**Example**	**Main features and issues**
Centralized actors relying on centralized infrastructures	Bank-led private permissioned blockchain for tokenized assets transactions	DLT-based "rewiring" of existing activities by regulated institutions; largely covered by existing standards and implementing legislation, which may need amendments to ensure technological neutrality; residual uncertainty often rooted in private law (e.g. framing the tokenization of assets).
Centralized actors relying on decentralized infrastructures	Centralized exchanges, stablecoin issuers, custodians, trading platforms (regulated or unregulated) dealing in crypto-assets	Both unregulated newcomers and regulated incumbents may engage in the provision of services dealing with a wide range of crypto-assets issued and transferred over permissionless networks; services (and risks) may be "equivalent" to traditional financial services or present distinctive features; policy options range from complete ban to fully fledged regulation under a "same activity, same risk, same rules" approach.
Decentralized services over decentralized infrastructures	DeFi protocol deployed over permissionless network	Typically unregulated, based on smart contracts deployed and maintained by developers (sometimes anonymous) and/or open communities; actual decentralization and governance mechanisms vary; difficult to address under existing regulation; an updated private law substrate framing DAOs is a pre-condition to introduce basic prudential (e.g. on governance) and conduct requirements.

Centralized actors relying on centralized DLT-based infrastructures – Traditional financial institutions, such as banks and asset managers, have started exploring the potential of DLTs through the deployment of **proprietary, permissioned networks**[26], often with a focus on the provision of financial services at the institutional level[27]. Access to these networks is typically vetted by the owners – the financial institutions themselves – that may also develop the applications to be deployed over the network[28]. In similar layouts, decentralization is largely renounced in favor of accountability, scalability and transaction finality[29] standards, in line with the needs of financial institutions and applicable regulation. This seems to confirm that DLT-based use cases could be valuable for the financial sector also when renouncing decentralization. Atomic settlement[30] and programmability[31] are indeed examples of the other important features which can be leveraged once assets are tokenized (i.e. represented as ledger's entries; see OECD, 2020, for a detailed account on the implications of asset tokenization[32]).

The owners/operators of permissioned corporate networks are clearly identifiable, as well as the developers of applications and the allocation of liability across parties is contractually defined. Likewise, users are identified and can be subject to Know Your Customer (KYC) procedures. What we observe is the "rewiring" of activities by using DLTs, building on asset tokenization and smart contracts. There is no ambiguity on the fact that compliance with the relevant conduct and prudential rules must still be ensured, even though these rules might not be DLT-specific.

[26] As regards blockchain technology, we can basically distinguish between two categories: permissionless and permissioned networks. In the former, anyone who is able to access the ledger can also participate in consensus and write the ledger; no authorization is required to validate transactions; in a permissioned setting, on the other hand, nodes are not peers: specific roles are assigned, and authorization is required to participate in consensus, validate transactions and write to the ledger. Permissionless networks are often "public": anyone who is able to access the ledger can also read its content; on the other hand, in "private" networks only identified and authorized nodes are able to read the ledger (or part of it); the term 'private' is often used interchangeably, albeit imprecisely, with "permissioned".

[27] Examples of well-known commercial platforms to implement permissioned DLTs include Hyperledger Fabric and Corda.

[28] An example in this regard is the Onyx Digital Assets platform run by J.P Morgan, which currently powers intraday repo and asset tokenization solutions, leveraging on a permissioned, DLT-based payment rail (JPM Coin) as well.

[29] We refer to the fact that permissioned networks normally rely on deterministic consensus algorithms which deliver higher throughput, instant finality and do not allow for forking. This is possible in a context where validators know each other. On the other hand, "probabilistic finality" is normally observed in permissionless networks based on proof of work or proof of stake consensus mechanism. Nonetheless, "probabilistic finality" is an umbrella term for a wide range of performances, with some permissionless DLTs now able to achieve near-instant finality.

[30] We mean the instantaneous exchange of two assets where the transfer of one asset occurs if and only if the transfer of the other asset occurs.

[31] We refer to the use of smart-contracts, i.e. software which executes some operations when pre-specified conditions are verified, to automate business processes.

[32] For a "contrarian" view: Low (2022).

Nonetheless, **some areas may deserve further efforts by legislators and financial regulators**. First, only **few jurisdictions have updated** their laws **to comprehensively frame asset tokenization and allow distributed ledgers to have any evidential value in establishing assets' ownership**. Sandbox approaches may prove especially useful to gather knowledge on the actual risks of new activities and to pave the way for legislative evolution.

Second, **the peculiarities of DLTs and smart contracts need to be taken into account to ensure proper management of operational risks – in the form of new shades of IT and cyber risks**. In the last years, both the banking and securities' markets standard setters, the Banking Committee on Banking Supervision (BCBS) and the International Organization of Securities Commissions (IOSCO), have released updated principles on operational resilience and cyber-security (BCBS, 2021a; BCBS, 2021b; IOSCO, 2021), which remain valid also for DLT-based solutions. At the same time, the standard setters may consider delivering more tailored guidance, e.g. on the use of smart contracts for the delivery of financial services.

Centralized actors relying on decentralized infrastructures – Challenges become harder when **identifiable actors – mostly unregulated, "crypto-native" providers but also established financial institutions – engage with public permissionless networks to create, hold, transfer and trade crypto-assets in order to provide services to their customers.** Centralized exchanges – such as Binance or Coinbase, to mention two of the most known – provide the main on- and off-ramps to and from the crypto-ecosystem; the same entities provide custody services in the form of custodial wallets[33]. Centralized entities such as Circle and Tether issue the largest and most used asset-backed stablecoins. At the same time, incumbent financial institutions – including banks – are increasingly driven by clients' demand to consider the business opportunities in the same areas (i.e. custody, exchanging, trading), not least to defend their competitive position in a forward-looking perspective. They could also consider using public DLTs to innovate the provision of services through the deployment of smart contracts. Against this background, the challenge is manifold.

[33] With a custodial wallet, a party other than the user/owner controls her private keys. Major blockchains are based on an asymmetric cryptography that that uses pairs of (alphanumeric) keys (public and private). Private keys are to be known only by their owner as they grant access to the funds on the wallet. Using a custodial service users trust a third party to secure their funds; the alternative is to rely on self-custody, which in its most basic form is exposed to the risk of losing the private keys and hence the funds irretrievably.

First, authorities **must protect a level playing field, and ensure that technology is not leveraged to exploit regulatory arbitrage and provide financial or payment services outside of the regulated environment**. Initial Coin Offerings (ICOs), which briefly rose to prominence in 2017, can be mentioned as an example of arbitrage since they were often used to gather capital while circumventing the relevant market regulations (or, in the worst cases, to run outright scams). The enforcement of already existing rules – when applicable in the domain of crypto-assets – is the first tool available to financial authorities. The US Securities and Exchanges Commission (SEC) has repeatedly made headlines by prosecuting unregistered token and crypto-based investment services offerings. In Europe, the European Banking Authority (EBA) and the European Securities Markets Authority (ESMA) have thoroughly analyzed the grey area between financial services regulation and crypto-assets (EBA, 2019; ESMA, 2019) concluding that a significant portion of activities involving crypto-assets does not fall within the scope of current financial services legislation. An additional source of complexity is that existing regulation – even when applicable in theory – may be difficult to enforce in practice. The technical peculiarities of DLTs and crypto-assets can require spelling out some rules in different ways; both to remove obstacles to the provision of services and to properly tackle the related risks (see the above-mentioned example concerning the European Union Pilot Regime for DLT Market Infrastructures).

Second, legislators have to decide **whether to define a regulatory framework for those crypto-assets and related services that do not fit any existing regulatory classification**. Such crypto-assets are very different things, ranging from backed crypto-assets – such as collateralized stablecoins – to unbacked ones like Bitcoin, native tokens of programmable blockchains, utility tokens, protocols' governance tokens, and outright Ponzi schemes. Whether to regulate or not – with varying levels of intensity – activities such as the issuance, custody and exchange of crypto-assets is a non-trivial choice. It can't be disentangled from the very nature of the tokens and their expected functions, which may justify the introduction of rules to protect consumers and investors, the safety and soundness of institutions themselves, financial stability and monetary sovereignty issues, or simply market integrity. **There is no *one-size-fits-all solution:* some products and services might perform functions which are equivalent to existing products and services (e.g. fiat-collateralized stablecoins could be a potential payment instruments)**

and therefore trigger the "same activity, same risks same rules" approach[34]; other may not clearly serve payment or investment needs, but their trading may deserve minimum requirements in the public interest, i.e. to prevent money laundering[35]; frauds should just be prosecuted under criminal law. For crypto-assets apt to serve users' financial needs, proper regulation can support the development of effective use cases that may render the financial system more efficient and competitive. In this case, the risk drivers to be managed are not substantially different from those affecting traditional financial services (see FSB, 2022b for a detailed mapping of the risks inherent in different activities) although their relative weights may vary. New rules for crypto-assets issuers and services providers can therefore largely borrow from already established principles of financial regulation and implement them in a way that is consistent with the underlying technology. The FTX case (see Section 2, *supra*) for example, has shown the consequences of having no internal controls and risk governance, and the consequences of unaddressed conflicts of interest; this would have hardly happened on a comparable scale to any regulated financial intermediary. Likewise, the soundness of issuers of stablecoins could greatly benefit from the enforcement of liquidity risk management standards in line with those already applicable to financial intermediaries.

In the European Union (EU), this has led to the 2020 Commission's proposal on a bespoke regulatory regime for crypto-assets other than e-money or financial instruments, the so-called Markets in Crypto-Asset Regulation (MiCAR), which is expected to shortly receive the final greenlight after a long negotiation among Member States[36]. In line with the "layered" approach we have described, MiCAR introduces basic transparency requirements for the issuance and offering of a broad range of crypto-assets, but stricter prudential requirements only for the issuers of well-identified categories of stablecoins (see Section 4, *infra*) [37].

[34] In a slightly more sophisticated version, an "equivalent activity, similar risks, tailored approach building on existing regulation and amended to account for DLTs technical peculiarities" approach.
[35] In this regard, the scope of money laundering regulation seems naturally broader, since even the crypto-assets that serve no financial purposes could be exploited by money launderers.
[36] A clear delineation between crypto-assets covered by MiCAR and financial instruments remains nonetheless an issue in the EU, and the final text of the MiCAR mandates ESMA to publish guidelines on criteria and conditions for the qualification of crypto-assets as financial instruments. In the meanwhile, the approaches of national authorities may not be totally harmonized. Some have already taken position on these issues, most recently the Belgian Financial Services and Markets Authority (FSMA). The FSMA's statement is available at:
https://www.fsma.be/sites/default/files/media/files/2022-11/fsma_2022_25_en.pdf
[37] We refer to the e-money tokens (EMT) and asset-referenced tokens (ART). MiCAR does not explicitly define the concept of stablecoin. The regulation will also introduce prudential requirements for service providers.

Third, a comprehensive approach to crypto-assets regulation **must clearly define the role that traditional financial services institutions, such as banks, can have in the crypto space, i.e. what level of engagement is acceptable or even desirable**. The issue arises for those activities that are not already covered by existing regulation and do not represent a "rewiring" of existing services. This is a **grey area in many jurisdictions, where approaches range from the case-by-base approval of new activities to outright bans preventing regulated financial institutions from engaging with crypto-assets**. It could be argued that as long as DLT-based use-cases, including those leveraging on forms of crypto-assets, serve traditional financial needs, such as making payments, borrowing money, investing in securities, the case for "insulating" regulated incumbents would be less clear, not least for competitive reasons.

In addition, financial players that are already regulated and supervised can rely on established risk management capabilities, robust governance arrangements and internal controls and could therefore be a trustable gateway for most customers. Nonetheless, regulated incumbents venturing into the crypto-assets space will have to manage evolving risks (starting from new nuances of IT and cyber-risks) and their involvement in the market would contribute to blur the boundary between crypto and traditional finance, creating potential "contagion" channels between the two – yet to be fully analyzed. The EU has opted for allowing incumbents into the "crypto-sphere", and banks – among others – will be able to issue some categories of crypto-assets and provide a wide range of services to customers. In order to promote competitiveness, the harmonization process fostered by MiCAR will overwrite fragmented national rules and supervisory approaches; at the same time, it will require to substantially step up supervisory efforts and ensure effective coordination between micro and macroprudential supervisors.

The **very detailed prudential and conduct rulebook already applicable in most jurisdictions will have to be updated to account for the peculiarities of new services and the related risks**. As an example, the BCBS has been preparing for the entrance of internationally active banks in the field by updating its prudential rulebook with tailored capital requirements for crypto-assets exposures, guidance on the application of the liquidity requirements and clarifications on operational risks[38]. Likewise, the IOSCO (2020) delivered a detailed assessment on the application of its Principles and Methodology to the issues and risks arising in the new market,

[38] The standard, which the Committee has agreed to implement from 1 January 2025, was released on 16 December 2022. Available at: https://www.bis.org/bcbs/publ/d545.htm.

with a focus on crypto-assets trading platforms. Both standard setters could engage in further work if necessary, also on the basis of FSB's advice. Additional, coordinated efforts seem **essential, in particular, to comprehensively tackling the risks – most notably the conflicts of interests – stemming from the vertical integration of different activities** within the same entities (e.g. custody, trading on clients' account, market making, issuance of stablecoins). Other **key areas – where new standards and more specific guidance on supervisory expectations may prove useful – include the custody of digital assets, IT and cyber risk-management, the prevention of widespread forms of market manipulation and abuse exploited by blockchain validators, like front-running** (see for instance Auer *et al.*, 2022), **and the management of third-party dependencies. The latter seems particularly challenging, and as of now it is far from straightforward i) whether and how permissionless DLTs should be treated as service providers or – in specific cases – as market infrastructures (see Section 3.2) and ii) how to enforce the applicable regulation when the "provider" is a possibly decentralized network operating globally through a network of anonymous nodes.** Addressing this issue is of the utmost importance since intermediaries may increasingly rely on these external settlement layers, and this form of outsourcing should be properly framed. This quest for accountability should also extend to single DLTs' node operators and other key actor of blockchain ecosystem, such as oracles, being themselves new categories of service providers.

Decentralized services over decentralized infrastructures – At the other extreme of the spectrum, there is the delivery of financial services through decentralized applications (dapps) running on permissionless networks such as Ethereum. Dapps (or "protocols") are set of smart contracts, which are normally not operated by a clearly identifiable corporate entity, or at least not by a traditional, supervised financial intermediary. Dapps developers may create and distribute governance tokens, which confer rights – e.g. related to the governance of the protocol – to their owners, to be exercised within novel forms of organization such as Decentralized Autonomous Organizations or DAOs. Protocols providing users with lending, trading or investment services on decentralized network are the essence decentralized finance, or DeFi, which therefore leverages two distinct facets of "decentralization".

Although there is no commonly agreed definition of DeFi, its key features have already been analyzed in a number of valuable works, starting from Schär (2021). The OECD (2022) identifies the non-custodial nature of DeFi protocols, their community-driven governance and

composability (i.e. the possibility to combine different smart contracts and digital assets to create novel applications and services) as the main, distinctive features compared to traditional finance. The IMF (2022) focuses on automation and decentralization of "record keeping, risk-taking and decision making within the crypto ecosystem". In addition, it should be emphasized that the protocols themselves can be permissionless, implying that anyone can make use of them, and uncensorable, i.e. there is basically no way to enforce sanctions of any kind and prevent someone from executing transactions.

Whereas it is acknowledged that Defi primitives such as smart contract automation, atomic settlement and transparency[39] have in theory the potential to improve financial systems' efficiency by allowing fast value transfers with limited execution risk and less intermediation layers (OECD, 2022) , it has shown so far few real-world uses. It has remained so far confined in a deregulated, self-referential experimental limbo, and protocols have not been immune from the market, liquidity and operational risks that affect traditional finance (IMF, 2022; FSB, 2023). Regulators and supervisors can play an important role to allow the financial system explore the potential advantages of DeFi by acting on different levels, in order to support innovation without paving the way for substantial financial stability risks.

A first challenge is **debunking the "decentralization illusion" (Aramonte, 2021) by bringing to light that** most **protocols have core stakeholders (i.e. being developers or large holders of governance tokens) which may be anonymous but are able to steer the operations and potentially extract ownership benefits; such projects should be brought back to traditional, accountable business structures as a pre-condition for operating in the regulated financial sector.** On the other hand, there are interesting examples of DAOs collectively managing protocols through on-chain governance mechanisms operating in open communities. Although it is still to be proved that such arrangements can be a practical and effective way to operate businesses**, a workable legal framing of such arrangements is necessary. The applicable liability regime and the definition of token holders' rights are among the main issues to be tackled** (see Borgogno, 2022). These are pre-conditions in order to enforce basic incentives towards effective governance in the context of "self-driven organizations" and belong to the

[39] We refer to both protocols' code transparency (i.e. Open source nature, implying auditability) and transactions transparency. Supervisors could themselves rely on this distinctive feature of permissionless DLTs to automatically monitor risk-taking and compliance with rules and parameters in decentralized settings by directly reading the ledger (see for instance, Auer, 2022 on "embedded supervision").

layer of corporate and securities law rather than prudential regulation. A sensible legal framing of DAOs may also be beneficial to improve the accountability and governance of the DLTs themselves, along the lines discussed above.

The identification of stakeholders and the definition of their rights and liabilities are stepping-stones to introduce adequate governance mechanisms in the word of DeFi, without solely relying on market discipline and self-regulation. Nonetheless, the transition towards a regulatory regime may benefit from new forms of public-private cooperation, such as the shared definition of disclosure standards and best practices concerning the technical features of DeFi protocols, also to enhance their operational resilience and security[40]. In addition, **the possibility to hard-code binding constraints and monitor dynamic parameters in order to limit risk-taking or build capital and liquidity buffers should be explored; looking forward, such prudential requirements could be made binding for protocols operating in regulated activities** (e.g. the exchange of crypto-assets).

Equally important – to preserve the integrity of the financial system and contrast money laundering – is to ensure proper identification of the users and funds deployed, through KYC procedures. The diffusion of Self-Sovereign Identity (SSI) models could favor the automation of such compliance processes and still offers a higher degree of data privacy compared to the "Web2" economy[41], which might be appealing to a broader range of users.

Finally, **a robust, risk-based regulation of stablecoins ensuring the prevention of "runs" on their issuers is a necessary condition to reduce the fragility of the DeFi ecosystem, given the prominent role of this asset class in decentralized finance** (see IOSCO, 2022, for a detailed assessment). It is crucial that policy interventions on stablecoins and DeFi are well synchronized since the diffusion of stablecoins – which could be driven by regulation itself – is likely to spur new waves of DeFi innovation and increase the interconnection between traditional and decentralized finance. Nonetheless, regulated asset-backed stablecoins are not the only option to bring money on-chain and support the creation of new use cases: alternative

[40] The memorandum of understanding signed in 2022 by Banca d'Italia and two Italian universities for the definition of smart contracts standards for financial services may be considered an example in this regard. See also https://www.bancaditalia.it/media/notizia/smart-contracts-memorandum-of-understanding-between-the-bank-of-italy-universit-cattolica-del-sacro-cuore-and-roma-tre-university/

[41] According to Marchetti (2022), "*Web2 marked the shift from static webpages and hyperlinks towards dynamic platforms where users soon started to interact and publish content*".

forms of private money – such as tokenized bank deposits – may come into the picture. Most importantly, should DLT-based CBDCs be delivered they could play a significant role in the context of DeFi, whose implications need however to be thoroughly assessed.

3.2 Infrastructures

We have so far used the term "infrastructure" meaning DLTs, as one example of the information and communication technology components, which are supplied by non-financial service providers (e.g. specific hardware and software, messaging and processing services, datacenters, cloud computing services) to make financial transactions possible. The same term is also generally used to evoke financial market infrastructures (FMIs), i.e. financial entities (central counterparties, central security depositories, payment systems), which perform specific economic functions crucial for the exchange, clearing and settlement of financial assets. **Decentralized networks have the capability to blur both the distinction between the economic functions performed by different kinds of FMIs, and the distinction between FMIs and supporting technology providers**: the lack of an identifiable central responsible authority and the integration of functions performed by a network of nodes may defeat the attempt to qualify such network according to the well-established taxonomy adopted by financial regulators.

In fact, as hinted at above, crypto ecosystems can be pictured as complex arrangements comprised of many integrated components and functions, often disintermediated and thus not necessarily attributable to an entity, or clearly linked to a single jurisdiction: technology has the intrinsic capability to cross geographical and sectoral borders, with the lack of a central responsible legal entity, established in a specific country, further weakening the ties to a specific jurisdiction.

Nonetheless, in the realm of financial regulation, **a landmark initiative of central banks and securities regulators to capture such complex ecosystems is the CPMI-IOSCO[42] work on the applicability of the relevant international oversight standards, the Principles for Financial**

[42] In July 2022 the Committee on Payments and Market Infrastructures (CPMI, formerly CPSS, Committee on Payment and Settlement Systems) and the International Organization of Securities Commissions (IOSCO) published a report on the "Application of the Principles for Financial Market Infrastructures to stablecoin arrangements", which provides guidance as to whether and how such Principles, and a specific subset thereof, apply to the new arrangements. This is part of a broader work underway, also in liaison with other standard setters.

Market Infrastructures (PFMI, 2012), to the so-called "stablecoin arrangements". This work mostly focuses on arrangements for the transfer of a specific subcategory of asset-backed stablecoins, referred to as "single-currency stablecoins", which are referenced or pegged to a single fiat currency and used for payment purposes.

Within a stablecoin arrangement, the CPMI-IOSCO identify three main functions: (i) *issuance, redemption and stabilization of the value of the coins*; (ii) *transfer of coins*; (iii) *interaction with coin users for storing and exchanging coins.* Governance is the fourth overarching function that enables all the others. A key role is played by the second function, the so-called "transfer function", because it is this function that allows a stablecoin arrangement to be considered as an FMI and, more precisely, a payment system given that this work covers in particular single-currency stablecoins used for payment purposes.

Stablecoin arrangements and their governance – **The assimilation of the transfer function to that of a payment system implies that, for stablecoins arrangements deemed systemic, the PFMI represent valid standards. Insofar as it is systemic, the whole arrangement should comply with the PFMI.** The guidance focuses on four principles: governance, comprehensive risk management, settlement finality and money settlements. For such principles, it explores their validity and specific interpretation when applied to stablecoin arrangements. However, all (relevant) principles should be taken into account; this is where the theme of governance becomes an anchor for the practical application of the Principles: the governance of the arrangement should provide for an identifiable ultimate responsible entity, in the absence of which enforceability might not be achieved, and for human intervention, which should take precedence over algorithms. The legal status of a ledger should prevail over the technical status, should divergences occur. Additionally, the issue of enforceability via a responsible entity is strictly linked to that of territoriality. As mentioned, the distributed technology may in itself challenge the clear attribution of a stablecoin arrangement to a single jurisdiction or a closed list of relevant jurisdictions, especially so if there would not be an identifiable governance authority or operator incorporated as a legal entity in a specific jurisdiction.

Stablecoin arrangements and technological neutrality – **The transfer component of an arrangement also has a strong technological connotation. It can be described as the supporting infrastructural component of the stablecoin arrangement, ultimately consisting**

of a DLT network. Here, the concept of technological neutrality, often considered as a foundational principle of financial regulation, may be questioned: would it remain valid e.g. for fully distributed set-ups which, as said, challenge enforceability? A first limit to the interpretation of technological neutrality, stemming from the CPMI-IOSCO guidance on the applicability of the PFMI to stablecoin arrangements, are the governance requirements already mentioned above, namely the need for an identifiable responsible entity and the prevalence of human intervention over algorithms, of the legal status of a ledger over its technical status.

A strictly related issue is whether, or rather how and to what extent, financial regulation should cover non-financial infrastructures that support the crypto ecosystem. On the one hand, the providers of technology in support of an FMI-like arrangement might arguably be well-suited to play the role as critical service providers to such FMI-like set-ups. This would call for a form of indirect oversight, which may rely on the oversight expectations for such providers[43]: the providers would be responsible towards the FMI-like set-up for complying with certain standards, in particular in terms of operational reliability. Absent a responsible entity for such FMI-like set-up, in a fully decentralized stablecoin arrangement, the preconditions for exercising indirect oversight would not be verified, potentially calling for direct oversight: in that case, an authority would oversee the technical provider as such, instead of controlling it through the lenses of an overseen FMI. Yet, the questions when and how to perform such direct oversight would then arise, given the breadth and width of its potential scope, let alone considerations on the boundaries of financial authorities' mandates. Last but not least, the issue of enforceability of standards towards a decentralized network might remain.

Such questions are clear to the authorities involved in the international debate and, focusing on the European regional debate, they inform the latest evolution of the Eurosystem framework for the oversight of the payments ecosystem (ECB, 2021) as well as the regulatory discussion on the prospects for including non-financial providers and services within the scope of payment legislation. The former has specifically been enriched with a Eurosystem oversight framework for electronic payment instruments, schemes and arrangements (so-called "PISA framework"), which includes new technological set-ups facilitating the interaction of financial entities with end-users; the latter will further be modelled after the review of the Payment Services Directive in EU (so-called PSD3). Indeed, with the aim of taking account of the (technical and regulatory)

[43] Contained in Annex F to the PFMI.

changes in the payments market, the PISA framework may extend its scope by including new payment solutions, such as stablecoins (which are included by virtue of a reference to "transfer of value" rather than to the traditional concept of "transfer of funds"). The framework will thus also allow crypto-assets with a payment function and the features supporting their supply and use (e.g. wallets) to be included within the oversight perimeter, with the possibility for central banks to intervene in the processes of drawing up and developing the technological standards used, with the aim of strengthening the necessary risk mitigation safeguards.

The new PISA framework above recalled defines instruments, schemes and arrangements that support the making of payments. Whereas the concepts of payment instrument or scheme are long-established, that of arrangement is a novelty of the PISA framework and it does not coincide with that of the CPMI-IOSCO guidance on stablecoin arrangements. The CPMI-IOSCO refer to the ecosystem, while the PISA framework to functionalities supporting end-user interaction with multiple payment service providers in the use of electronic payment instruments. PISA focuses on the applicability of the PFMI to instruments, schemes and arrangements, and concludes that 16 principles may apply, while leaving it to the overseers to apply (a subset of) them with proportionality.

All the above assumed the deployment of new infrastructures – be they financial or non-financial in nature – that allow transferring crypto-assets. What if crypto-assets were used by traditional FMIs, in particular as their settlement asset? Of course, the PFMI contain requirements for the settlement assets that may be used by traditional FMIs, but the issue remains to be addressed in more depth. Such issue pertains to the broader debate on the interplay between traditional and innovative finance, and may find different responses in different jurisdictions.

4. Regulatory developments at the international level

Regulators have been attentive to developments in crypto markets since their inception, which may be traced back to the launch of the Bitcoin project in 2009. With the evolution of fintech entities and the advent of various stablecoin initiatives, the regulatory response has entailed continuous monitoring of the market, mapping of existing regulations and gap assessments

aimed at gauging the actual need for new tailored regulatory intervention vis-à-vis new crypto initiatives.

The regulatory response has not been homogeneous, mirroring the complexity of the emerging crypto markets and their novel features, capable of defying the traditional categories of financial activities.

The heterogeneous approach taken across jurisdictions in regulating and supervising the phenomenon ranges from no regulation at all, to adaptation of existing regulation (often complemented with interpretative guidance), adoption of tailored rules, or – at the extreme end of the spectrum – outright banning. Each solution has distinct pros and cons (see for instance Aquilina *et al.*, 2023) and the resulting regulatory landscape will most likely be a combination of all of the above.

Among the jurisdictions that have opted for new tailored regulation, some have focused on a subset of crypto-assets, namely single-currency stablecoins Other regulatory interventions have embraced a broader array of crypto-assets, including those referenced to a basket of assets (currencies, financial instruments, commodities, other crypto-assets), those stabilized via algorithms, or even those purely speculative in nature, not aiming at relative stability of value over time, nor backed by reserves (see Table 2 for some examples).

TABLE 2 - *Regulatory Approaches to Stablecoins and Crypto-Assets: Selected Examples*

Measures	Country	Description
No regulation	India	In 2018, the Reserve Bank of India barred banks from holding crypto or facilitating crypto transactions, but in 2020, the Supreme Court ruled that the prohibition was unconstitutional.
Update of existing regulation	UK	In October 2022, the House of Commons voted to give HM Treasury the power to make crypto-assets a regulated financial instrument. The new legislation is included in the Financial Services and Markets Bill 2022 (FSMB), which also covers measures to bring stablecoins under the existing financial services legislation.
New regulation	European Union	The Markets in Crypto-Assets Regulation (MiCAR) is a harmonised regulatory and supervisory framework for crypto-assets. MiCAR is expected to take effect in 2024, after the final approval by the European Parliament in 2023.
Complete ban	China	• 2013: ban on financial institutions from providing Bitcoin-related services to customers • 2017: ban on 1) crypto-exchanges from providing services and 2) raising funds through Initial Coin Offerings (ICOs) • 2021: ban on crypto mining and trading

Source: authors' elaboration based on PwC (2022).

The above overview shows that consolidated experience can be leveraged off by regulators, aiming at striking the right balance between embracing innovations and safeguarding security, but it acknowledges that there remain potential gaps[44]. Despite the heterogeneity of possible

[44] In June 2022, for example, the Italian central bank issued a Communication on Distributed Ledger Technologies in Finance and Crypto-assets, which is intended as a reference for users, intermediaries, technology providers, administrators of schemes, digital infrastructures and portfolios operating in crypto-assets, both before the evolving European regulatory framework has been completely defined and afterwards; indeed, this regulatory framework covers neither the entire chain of the entities mentioned above, nor the full complexity of the technological solutions supporting the ecosystems of crypto-assets. In short, the Communication aims: 1) to remind supervised intermediaries, supervised entities and all those who work in various capacities in decentralized ecosystems, including as users, of the opportunities and risks associated with the use of decentralized technologies in finance and with crypto-asset-related activities and services (issuance, custody, trading, loans, payment services); 2) to highlight a number of aspects that are important for defining, on the part of the abovementioned entities, safeguards to mitigate

regulatory responses, or rather because of it, the coordinated work of international institutions and standard-setting bodies (SSBs) provides a common *fil rouge*.

The role of the Financial Stability Board and Standard Setting Bodies' initiatives – The FSB has been thoroughly analyzing the threats that the crypto-asset market could pose to financial stability and advocating the need for regulatory intervention at the global level. In October 2022, i) it published its recommendations to promote the consistency and comprehensiveness of regulatory, supervisory and oversight approaches to crypto-asset activities and markets and strengthen international cooperation, coordination and information sharing (FSB, 2022b); and ii) revised high-level recommendations for the regulation, supervision, and oversight of global stablecoin arrangements[45] (FSB, 2022c). Overall, the proposed framework advocates a proportionate, risk-based approach that can adequately cover the many components and different morphologies of the crypto ecosystem. The framework is deeply rooted in the "same activity, same risk, same rule" principle. This implies that crypto-assets and intermediaries performing equivalent economic functions to those performed by financial instruments and intermediaries should be subject to equivalent regulation. Such regulation must nonetheless account for the novel features and specific risks of crypto-assets, in order to address the potential financial stability risks arising from the tighter links between the crypto and traditional finance. As regards stablecoins, the FSB's recommendations aim in particular at strengthening redemption rights for users and the robustness of stabilization mechanisms.

As already recalled, the BCBS, IOSCO and CPMI-IOSCO are working along these lines, within their respective remits. Ongoing efforts include the BCBS' continuing work on the prudential treatment of crypto-asset exposures[46] of banks and IOSCO's work on DeFi and crypto-assets, with a focus on market integrity and investor protection. A fundamental contribution from the BCBS' work is the clear distinction of two main categories of crypto-assets for the sake of defining a tailored prudential treatment: tokenized traditional assets and crypto-assets with effective stabilization mechanisms, on one side, the remaining crypto-assets on the other.

the risks associated with the use of decentralized technologies and/or trading in crypto-assets. In this perspective, it is stressed that customers need to be mindful that they could lose some or even all of the capital invested, of fraud and errors, and of the lack of safeguards available to them. The Communication focuses on the fact that that some crypto-assets completely lack any intrinsic value and are not assisted by any redemption rights; such crypto-assets cannot be considered suitable for carrying out a payment or investment function because of their highly risky nature.

[45] Widely adopted stablecoin with a potential reach and use across multiple jurisdictions which could become systemically important in and across one or many jurisdictions, including as a means of making payments.

[46] See footnote 39, *supra*.

Importantly, the proposed classification criteria consider both the features of the assets and those of the underlying DLT; the standard also introduces the concept of "infrastructure risk" and a corresponding prudential add-on, initially set to zero, that that authorities can activate "based on any observed weaknesses in the infrastructure on which crypto-assets are based".

It must nonetheless be recalled that SSBs' guidance does not have legal force and is intended to direct local authorities toward regulation that is as globally harmonized as possible. Since 2020, the European Union has been one of the fastest moving jurisdictions in the world, with a view to seizing the benefits of innovation while properly tackling its risks.

The approach of the European Union – MiCAR[47], the forthcoming EU Regulation on markets in crypto-assets, is an example of regulatory intervention tailored to address the new asset categories and the supervision of the new or traditional providers offering crypto services that do not fit within the existing regulation. Indeed, MiCAR will create a new regulatory and supervisory framework for the crypto-assets activities not already covered by other EU legal acts, i.e. other than financial instruments under MiFID[48], deposits protected by the DGSD[49], funds as defined under the PSD[50]. In particular, MiCAR will spell out the requirements for the offering and admissions to trading of crypto-assets; in addition, it lays down the requirements to be fulfilled by the crypto-asset service providers willing to provide their services in the EU. As regards the issuance of crypto-assets, the Regulation covers with stricter requirements the issuance of: i) asset-referenced tokens (ARTs), i.e. crypto-assets expected to maintain a stable value by referencing to any other value or right, including one or more official currencies; ii) electronic money tokens (e-money tokens, EMTs), i.e. crypto-assets expected to maintain a stable value by referencing one official currency. These two categories of assets fit within our (non-legislative) definition of asset-backed stablecoins. E-money tokens will only be issued by credit institutions or e-money institutions. In addition to the forthcoming MiCAR, the EU has

[47] The text as approved by the Council is available at https://data.consilium.europa.eu/doc/document/ST-13198-2022-INIT/en/pdf. The final vote by the European Parliament is expected in the coming months.
[48] Directive 2014/65/Eu of The European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014L0065&from=IT.
[49] Directive 2014/49/EU of the European Parliament and of the Council of 16 April 2014 on deposit guarantee schemes. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014L0049&from=EN.
[50] Directive (Eu) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market [...]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32015L2366&from=it.

already adopted a Regulation introducing a Pilot regime for DLT market infrastructures[51], which will allow testing the issuance and circulation of financial instruments on DLTs by temporarily releasing some regulatory constraints. Its forthcoming application across the EU may require national legislators to amend related rules, including in the realm of private law.

Beyond MiCAR – MiCAR fills a gap in the already intensely regulated financial marketplace. However, it still relies on entity-based rules and will leave some areas unregulated: in particular, it does not fully address the challenges posed by all kinds of decentralized set-ups. The absence of a regulation for DeFi reflects the complexity inherent in the already recalled peculiarities of this segment, such as non-traditional legal entity structures, decentralized governance, and the anonymity of persons in charge. Should an orderly development of this segment be sought, then legislators will have to address these issues in the near future, possibly building on "future-proof" company law and corporate governance frameworks (see also Section 3.1, *supra*), which might prove very challenging to achieve given the lack of substantial harmonization in the field.

5. Final remarks

Recent events have taught us some lessons about crypto-assets, and made a clearer case for policy interventions in this field. Whereas the interest of retail customers seems very often driven by speculative intentions, we have witnessed how some crypto-assets might be perceived as an alternative asset class or even as a store of value in difficult times. In spite of the intrinsic fragilities and weaknesses of this novel market, financial intermediaries and policymakers alike are keen on assessing the potential of its technological underpinnings, with a view to "rewiring" financial services and delivering more efficient and transparent financial markets. The road toward significant, safe use-cases is yet to be built and regulation has a sizeable stake in this venture, in the narrow path between supporting innovation and mitigating its risks.

The crypto ecosystem we have described is a complex, layered combination of operators, arrangements, technical infrastructures, which hardly fits traditional regulatory frameworks. The challenges facing legislators and financial authorities are equally layered and escape *one-size-fits-all solutions*. Faced with policy options ranging from the ban of crypto-assets to a fully-fledged regulatory framing of the sector, the authorities in different jurisdictions have so far

[51] Published in the Official Journal of the European Union on June, 2, 2022. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32022R0858&from=EN.

adopted very different approaches. A common element is that **financial regulation – both at the level of global standards and single jurisdictions – seems to move faster than private law, importantly including companies and securities law.** This is necessary to start deploying a safety net protecting market integrity, customer rights, micro and macro-prudential financial stability, monetary sovereignty.

Nonetheless, decentralization – which is indeed elusive, often an illusion but sometimes a reality – may provide alternatives to long-established forms of entrepreneurship and their legal framing. We may not experience new, credible forms of money, but we are already experiencing unseen ways to provide services, from the DLT networks themselves to the smart contracts they execute. **Reflecting this in the domain of private law is an important pre-requisite to further develop effective financial regulation standards and be able to enforce them, in order to ensure the accountability of all parties, the quality of governance mechanisms, and a clear definition of rights and liabilities.**

In the meantime, **financial sector standard setters and authorities are focused on updating international standards and making them consistent with the adoption of new technologies.** The experience gathered in traditional finance can go a long way in shaping bespoke regulatory approaches for both regulated incumbents and new entrants engaging in activities that currently lie outside of the regulated perimeter. **Key areas where new standards or additional guidance on the application of the existing ones are necessary include the custody of digital assets, IT and cyber risk-management, and the management of new forms of third-party dependency (including those stemming from the reliance on permissionless DLTs), the prevention of widespread forms of market manipulation and abuse, the prevention of conflicts of interest for complex intermediaries engaging in multiple activities at once.**

As far as DeFi is concerned, finding sensible ways to promote the adoption of adequate governance arrangements seems very challenging, and considering to update the relevant private laws may be helpful. Besides, **the possibility to hard-code binding constraints and monitor dynamic parameters in order to limit decentralized protocols' risk-taking or build capital and liquidity buffers seems promising and could enable novel ways to apply prudential requirements.** Likewise, the use of SSIs may contribute to achieve compliance with KYC requirements.

It is important to stress that **not all crypto activities and not all forms of crypto-assets need to be covered or should be covered by financial sector regulation**, in particular where their issuance, trading and holding do not serve customers' financial needs through a payment or investment function. Nonetheless, **the application of minimum requirements to guarantee market integrity, the prevention of money laundering and the financing of terrorism should always be considered** to avoid loopholes in the controls over the origin of the funds entering the market.

Beyond the challenges for regulators, the novelty of this ecosystem has implications also for the institutional architecture of relevant authorities, both within each of them and for their cooperation. Internally, authorities that, like central banks, are entrusted with several institutional functions may leverage off their well-tested cross-functional approach vis-à-vis the crypto ecosystem and its integrated components. Externally, national and international supervisory communities are debating how to devise effective cooperation arrangements to adequately supervise the new ecosystems.

Furthermore, although financial regulation of crypto activities is going live in many jurisdictions, such regulation still relies on entity-based rules and will leave some "gap" or areas unregulated: in particular, it does not fully address the challenges posed by all kinds of decentralized set-ups within the crypto environment, because of the peculiarities of this segment, such as non-traditional legal entity structures, decentralized governance, smart-contracts, and the anonymity of persons in charge. In some cases, the **reliance on soft law** is one option that can be proposed to "**fill the gap**" in the regulatory framework. To this purpose, a policy making approach based on the combination of the national legislation and soft regulation such as the central bank **oversight standards** on payment systems may address this development – with the advantages of flexibility, dynamism, and pragmatism.

For instance, in Europe, stablecoin payments will be regulated under MiCAR but can also be covered by the new Eurosystem oversight framework on payments, known as the PISA framework (Payment Instruments, Schemes and Arrangements), potentially attracting different kind of entities and commercial arrangements operating in crypto ecosystems into the sphere of oversight, regardless of where the governance body of the scheme or arrangement is incorporated. This would imply a "co-regulatory approach", with authorities continuously

engage with technological operators to create shared benchmarks, so that technology can evolve in a manner that is consistent and compatible with the rights and safeguards that deserve to be guaranteed.

Anyway, **the right balance must be sought between efficacy and efficiency in institutional action: all the relevant authorities, across sectors and jurisdictions, should be involved without overly diluting supervisory accountability or hindering concrete action[52].** The degree of representation and formalization of any cooperation arrangement may – and should – vary depending on the features of the crypto ecosystem under consideration, as well as its stage of evolution. Suffice it to think that the digital nature of any such crypto ecosystem makes it potentially borderless: providing that the relevant supporting digital infrastructure would allow for the required scalability, an initially non-systemic or non-global set-up may possibly grow to achieve a systemic or global dimension over a short period of time. This would require that cooperation arrangements should be flexible and scalable themselves, able to swiftly develop from monitoring to applying progressively stringent requirements.

Authorities are well aware of and attentive to the topic of cooperation, and the work underway amongst others by the FSB, BCBS, CPMI and the IOSCO is a case in point.

[52] This cooperation between the various institutions, even at the international level, is advocated by various scholars, including Abate *et al.* (2023) and Savona (2023) in this issue.

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