Institutionalisation of crypto-assets and DeFi–TradFi interconnectedness

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Abstract

This report examines institutional investor participation in markets for digital assets, including crypto-assets and decentralised finance (DeFi). It considers and tests potential drivers of growing supply and demand for such assets by institutional investors, analyses the potential for increasing interconnectedness between traditional finance (TradFi) and decentralised finance and identifies linkages between the two. The report then outlines the risks these growing markets may create, while also examining the potential benefits of the decentralisation of financial services, before putting forward policy recommendations.

Foreword

This report examines institutional investor participation in markets for digital assets, including crypto-assets and decentralised finance (DeFi). It considers and tests potential drivers of growing supply and demand for such assets by institutional investors, analyses the potential for increasing interconnectedness between traditional finance (TradFi) and decentralised finance and identifies linkages between the two. The report then outlines the risks these growing markets may create, while also examining the potential benefits of the decentralisation of financial services, before putting forward policy recommendations.

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Executive summary

Over the past few years, digital assets (including crypto-assets, stablecoins and decentralised finance or DeFi) have increased exponentially. Increased interest and investment in digital assets by traditional financial sector players and institutional investors, coupled with increased supply of products and services providing access to crypto-asset risk, are transforming business models and risk profiles of traditional finance (TradFi). Increased participation of institutional investors in digital asset markets can give rise to investor risks at the micro-level, while it may also create channels of potential contagion between decentralised finance and traditional finance. Given the multitude of potential risks involved in these growing markets for crypto-assets and DeFi, there is a role for policy makers to evaluate such risks and consider policy action to address them. At the same time, growing institutionalisation of digital assets could bring a number of potential benefits to financial markets and their participants which should not be underestimated or overlooked.

Digital assets are one of the most significant developments impacting the financial services industry over the past few years, and will have a prominent role in the digital transformation of the industry in the years to come. There is currently no commonly-agreed definition of digital assets, and the term is used by the financial industry to encompass crypto-assets, tokenised securities or other tokenised assets, stablecoin arrangements, central bank digital currencies (CBDCs), and other blockchain-based instruments (e.g. non-fungible tokens - NFTs). In the US, the term digital asset has been defined in public statements as an asset that is issued and/or transferred using distributed ledger or blockchain technology, including, but not limited to, so-called “virtual currencies,” “coins,” and “tokens.” A particular digital asset may or may not meet the definition of “security” under the federal securities laws (SEC, 2021[1]).

The year 2021 saw a 50-fold increase in the market for decentralised finance (DeFi), with total value locked in Ethereum-based DeFi applications reaching USD120bn and with interconnectedness to the USD3tn market for crypto-assets (as of November 2021). Beyond main crypto-assets, increased stablecoin issuance and usage is noteworthy, both through their usage as DLT-based fiat-backed collateral pledged on DeFi protocols, but also beyond DeFi markets. Total stablecoin supply reached c.USD 183bn (as of March 2021), with Tether, USD Circle and Binance USD dominating issuance. Both DeFi and crypto-asset activity is taking place in markets generally with lack of the traditional safeguards around market integrity, consumer and investor protection and financial stability. At the same time, increased interest in, and adoption of, digital assets by traditional financial sector players and institutional investors has been observed, coupled with increased supply of products and services providing access to crypto-asset risk. Such ‘institutionalisation’ of crypto-assets could merit the attention of policy makers given that part of the activity is happening in a non-compliant manner or outside the perimeter of existing regulatory and supervisory frameworks, exposing participants and the markets to significant risks.[1]

Although there are limited quantitative reports around the exact levels of institutional investor participation in digital assets markets, qualitative evidence based on surveys suggests growing interest and investment in crypto-assets. Investors are moving from the educational phase to the actual investment phase and concentrate their holdings in Bitcoin and, to a lesser extent, in Ether. Anecdotal evidence by financial market participants suggests that dedicated crypto-funds or more risk-tolerant venture capital funds and

hedge funds have a greater propensity to hold digital assets, while family offices and hedge funds represent an important part of DeFi activity driven by the possibility of uncontrolled leverage. More conservative long-term institutional investors, such as pension funds and insurance companies, express a more negative view on holding highly volatile digital assets in their portfolios. Venture capital funds are the most straightforward way for institutional investors to gain indirect access to digital assets without exposing themselves directly to the short-term risks of direct holding of such investments (related to volatility and marking-to-market) and allow them to have such investments approved by investment committees. In other words, venture capital funds and their limited partners (usually institutional investors) can obtain indirect exposure to crypto-assets by investing in companies that support the crypto ecosystem, without directly investing in the crypto-assets themselves. Other indirect ways of investing in crypto-assets include investment in companies holding Bitcoin or deriving their earnings from Bitcoin mining or transacting, or through regulated financial instruments referencing crypto-assets. Net flows into dedicated crypto-asset funds as a whole reached a four-year high of more than USD 2.5bn the first week of October 2021[2]. Interestingly, quantitative evidence around the DeFi market suggests that large-sized transactions in DeFi, used as a proxy for institutional and professional investor participation, represented the largest share of DeFi activity throughout 2021.

Three underlying forces that contribute to driving institutional investor interest in digital assets are being examined in this report. First, the search for yield in a prolonged low-interest rate environment, speculative forces and a fear of missing out, and the high returns resulting from these, are considered as the main drivers of investor interest in this space. Second, the possible use of crypto-assets for diversification and portfolio optimisation given a perceived uncorrelated nature of returns, a hypothesis that is dismissed given the medium-high positive, and rising, correlation of mainstream crypto-assets with traditional asset classes. Third, the perceived benefits of crypto-assets as an inflation hedge, despite empirical analysis that shows that main crypto-assets have not performed as effective inflation hedges.

The supply of financial products referencing crypto-assets has also expanded in the past year, addressing the difficulty of institutional investors to self-custody crypto-assets and their demand for hedging solutions and instruments such as derivatives. Futures and options on crypto-assets and ETFs/ETPs have been launched in many countries and the US saw its first Bitcoin Futures ETF trade in October 2021 (ProShares ETF) become the second most heavily traded new ETF (USD 1 bn traded volume at the end of its launch day). Open interest for Bitcoin contracts on CME stood at c.USD 2.2 bn (as of 8 February 2022).

Increased participation of institutional investors in digital asset markets can give rise to investor risks at the micro-level, while it may also create channels of potential contagion between decentralised finance and traditional finance. Investor risks from digital assets are stemming from the fact that large parts of these assets are not operating within traditional regulatory frameworks that safeguard market integrity, consumer protection and ensure financial stability. Pseudonymity and lack of AML/CFT checks give rise to risk of illicit activity (see more on the AML/CFT risks and the Financial Action Task Force FATF Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers) (FATF, 2021[2]). The extremely high volatility of many of these assets, lack of disclosure and reporting, unclear or untested protocol (internal) governance frameworks as well as the technological and operational risks related to the underlying technology are all examples of emerging risks for investors. Escalating ESG concerns related to mining activity for certain major crypto-assets also deserve a mention, given the possible negative impact on the value of the investment arising from the adverse sustainability impact of digital asset holdings. While banks' exposures to crypto-assets are currently limited, the continued growth in the adoption of crypto-assets could increase risks to the banking system in the future. Therefore, investments in crypto-assets or DeFi products by financial intermediaries and credit institutions raises questions about how these holding should be regulated.

Growing involvement of institutional investors in crypto-asset markets may in the future lead to increased interconnectivity between traditional finance and decentralised finance through many avenues, and risks of spillovers to the traditional financial system and the real economy may emerge. In case of generalised

distress on crypto-assets, investors exposed to losses on crypto-related investments may have to close positions on other parts of their portfolio, propagating the shock through inter alia adverse confidence effects. Volatility spikes in the price of main crypto-assets, coupled with increased use of leverage, can induce massive automatic liquidations (the equivalent of a margin call) in DeFi protocols. On top of these automatic collateral liquidations on DeFi protocols, crypto-asset futures liquidations that are likely to happen simultaneously in a severe market downturn – particularly on unregulated crypto-exchanges – would intensify potential market stress and could have a domino effect on investor holdings across the board, including in traditional financial markets.

Stablecoins constitute the key bridge linking the decentralised finance with the traditional financial markets. They constitute one of the foundational bases of DeFi markets, but at the same time are one of the greatest points of vulnerability of decentralised finance markets. Stablecoins are used to move between crypto-assets or crypto-exchanges, as collateral pledged on DeFi lending/ liquidity mining or as a way to hedge crypto-asset volatility without having to convert to fiat and/or exit DeFi. Stablecoins are associated with a number of important risks related to high concentration in terms of issuers (top two stablecoin arrangements represent 70% of the market as of February 2022), weaknesses around transparency of reserves and lack of credibility, lack of clarity regarding redemption rights of holders as well as operational risks (e.g., cyber risk). For example, stablecoins appear to be increasingly investing in commercial paper as part of their reserves backing the crypto-asset issued, without disclosing what kind of commercial paper is included in such reserves and who the corresponding issuers are.

Any sudden risk aversion to certain stablecoins with significant holdings of short-term debt instruments could, under certain circumstances, cause a liquidity run on the funds and potential significant disruption in US CP markets. In a scenario where a major stablecoin loses its peg due to solvency issues related to the reserves backing the stablecoin or due to its under-collateralisation, decentralised exchanges would go under severe stress and liquidity pools would be forced to mass liquidations, disrupting DeFi markets. Given the composition of major stablecoin reserves, reportedly invested heavily in commercial paper, such liquidations could spill over to debt markets. Potential contagion from spillovers to money market funds (MMF) could also result from sudden mass redemptions of such stablecoin arrangements, affecting the stability of broader short-term credit markets. Any failure or disruption of a large DeFi protocol or trading platform could equally trigger such run on stablecoins.

Another point of possible linkage between decentralised finance and traditional markets include institutional versions of DeFi protocols and the pledging of tokenised assets on DeFi protocols instead of crypto-assets. Institutional versions of DeFi are tailored to the needs of institutional investors for compliance with KYC and AML/CFT regulations. Such DeFi protocols run on permissioned networks with whitelisted participants, allowing participants access to DeFi liquidity pools that consist of known/identifiable parties. Refinancing or leveraged borrowing on the back of tokenised financial securities in DeFi protocols is a prime example of how such interconnectedness could grow to significant levels in the future. Examples of tokenised assets include regulated tokenised securities already issued in traditional markets or assets that are being tokenised with a view to pledge them as collateral in DeFi. Increased interoperability, or even integration, of DeFi protocols in mainstream finance could be another avenue for such growth in the links between the two. Interconnectivity between DeFi and traditional finance can also involve the integration of DeFi protocols in CBDC pilots. The use of CBDCs in the place of stablecoins in DeFi protocols could provide benefits to users by promoting trust in DeFi systems; providing safer settlement of transactions; limiting the risks associated with stablecoins; and enhancing the safety and stability of the DeFi market overall, depending on the design of the CBDC and the specific arrangements underpinning such integration.

Growing institutionalisation of digital assets could bring a number of potential benefits to financial markets and their participants. The possible increased integration of decentralised finance with the conventional financial system could have some beneficial impact on traditional financial markets not only in terms of efficiencies, but also in terms of stronger competition, lower transaction costs and reduced counterparty

risk to the benefit of end users. The emerging ecosystem that is being built around decentralised finance (e.g. interface providers, custodians, wallet providers) is particularly important given the potential network effects in blockchain-based systems. The important transformation that digital assets bring at the infrastructure level of the financial markets should be highlighted as perhaps one of the most important benefit that can be derived from the evolution of the broader digital assets space. Lessons can be drawn from digital assets for the use of DLTs in traditional finance in order to allow for potential efficiency gains in speed and costs associated with financial market transactions (e.g., post-trade processes and financial intermediation). To that end, it may also be beneficial to make a clear differentiation between regulated digital assets that are simply DLT-based forms of regulated financial instruments (e.g., tokenised securities); and those unregulated or non-compliant forms of digital assets (e.g., unbacked crypto-assets). By way of example, the pledging of tokenised assets on DeFi protocols could introduce some level of stability as compared to the use of unbacked crypto-assets with no intrinsic value. Nevertheless, it should be highlighted that there are significant risks if DeFi continues to operate outside of, or in non-compliance with existing regulatory frameworks, including those relating to AML/CFT (FATF, 2021[2]), tax and sanctions compliance, investor protection and market integrity.

Given the multitude of potential risks involved in these growing markets for crypto-assets and DeFi, there is a role for policymakers to evaluate such risks and consider policy action to address them. If crypto-assets' adoption continues to increase, the linkages between the traditional and decentralised finance markets may become stronger, possibly increasing the risk of spillovers to traditional financial markets and the real economy. To that end, it is important to monitor the evolution of the market for digital assets and document points of linkage to traditional finance and channels of risk transmission. Improved data collection and analysis of institutional investment in digital assets, as well as the scale of interconnectedness between the two environments, would improve policymakers' understanding the evolution of this market and its risks.

Regulators could consider providing clarification of the applicable regulatory and supervisory framework around crypto-assets and decentralised finance, and guidance to consider new rules to address policy gaps, to the extent applicable or not already addressed under current law. A large part of crypto-asset activity currently exists outside the regulatory perimeter and/or in many cases in a non-compliant manner where the frameworks are in place (e.g., parts of DeFi activity or DeFi with centralised characteristics). A review of existing regulatory and supervisory tools could at the same time allow policy makers to consider further action as appropriate in order to address emerging risks where gaps are identified in the current frameworks.

When it comes to DeFi, there may be a need for policy makers to rethink some of their policy tools to allow for compatibility with truly decentralised structures that may develop (OECD, 2022[3]). It should be noted, however, that currently observed DeFi activity has centralised characteristics, which allows for the identification of single regulatory/supervisory access points and enforcement action. When it comes to truly decentralised structures, there may be a need to 'recentralise' DeFi in order to get some comfort from a regulatory and supervisory standpoint, without necessarily completely undermining decentralisation, by identifying forms of centralisation that may exist in such networks and which could be considered as potential regulatory access points (e.g. DAOs, majority governance token holders). Other tools, such as regulatory compliance embedded in machine readable format (code) or the audit of smart contracts, could also be examined in the future (OECD, 2022[3]).

Stablecoins are identified as the key bridge between traditional and decentralised finance, therefore policy makers could consider prioritising regulatory focus on the activity in this asset class. Stablecoins constitute one of the foundational bases of DeFi markets, but at the same time are one of the greatest points of vulnerability of decentralised finance markets, with clear links to traditional markets (e.g. short-term debt markets). The ensuing risks of the wider use of stablecoins within and outside the crypto-asset space and their role as linkages between the DeFi and the traditional financial system warrant an appropriate regulatory and supervisory framework and standards that will ensure appropriate protection levels for

investors and financial consumers while supporting financial stability overall. For example, in the US, recent recommendation suggests that stablecoins issuers become subject to the same supervision and regulation as depository institutions in the US (PWG, FDIC and OCC, 2021[4]).

Promotion and encouragement of investor protection disclosures is another possible area of action for policy makers in order to mitigate risks related to the holding of crypto-assets and participation in DeFi. Many investors driven into this market by speculative motives may not be sufficiently aware of the risks related to such investments, and a better understanding of the mechanisms involved, and in particular of the limitations and related risks involved, should be fostered.

Policy dialogue and coordination should be promoted at the national and international levels. At the national level, this involves cooperation of authorities who may have jurisdiction over part of the activity in decentralised finance markets to avoid fragmentation. Cooperation is also needed to apply frameworks and standards for activities that may currently fall outside the regulatory perimeter. Importantly, given the speed and ease at which crypto-assets and decentralised finance participants move geographic location, it is important to ensure cooperation at the international level so as to prevent regulatory arbitrage. Given the inherently global nature of such assets and markets, some level of coordination needs to be encouraged at the cross-border level.

Given the high level of innovation in decentralised finance, policymakers may consider ways to allow for the safe and responsible innovation in a compliant manner, anticipating and addressing emerging risks for participants and the markets. Potential beneficial aspects of the decentralised finance mechanisms and practices could be transposed to traditional markets in order to promote efficiencies in financial market infrastructure and encourage possible productivity gains (e.g. disintermediation in post-trade / clearing and settlement of securities). This is become increasingly relevant given the progress that is being made around CBDC research, pilots, and limited live implementation. It should, however, be noted that DeFi operation outside of, or in non-compliance with existing regulatory frameworks, including those relating to AML/CFT, tax and sanctions compliance, investor protection and market integrity, raises important risks to markets and their participants.

1 Institutional investor demand and/or adoption of digital assets

Although there are limited quantitative reports around the exact levels of institutional investor participation in digital assets markets, qualitative evidence based on surveys suggests growing interest and investment in crypto-assets. Three underlying forces that contribute to driving institutional investor interest in digital assets are being examined in this Chapter: first, the search for yield in a prolonged low-interest rate environment, speculative forces and a fear of missing out; second, the possible use of crypto-assets for diversification and portfolio optimisation given a perceived uncorrelated nature of returns; and third, the perceived benefits of crypto-assets as an inflation hedge, despite empirical analysis that shows that main crypto-assets have not performed as effective inflation hedges.

Despite limited quantitative evidence around the exact levels of institutional investor participation in digital assets markets, qualitative evidence suggests growing investment in crypto-assets. Qualitative evidence based on surveys performed by large financial institutions suggests that institutional interest in digital assets, and crypto-assets in particular, has significantly increased over 2021, moving from the educational phase to actual investment in such assets. However, quantitative evidence around the scale of institutional investor participation in digital assets is still lacking, and there is indication that participation in some parts of these markets (DeFi) even decreased at the end of 2021 due to negative market sentiment (Figure 1.6). The profile of early-adopters in the institutional investor space is different from traditional long-term institutional p digital assets, and particularly mainstream crypto-assets such as the Bitcoin; provides empirical analysis around the effectiveness of such assets in diversification strategies or as inflation hedges; and discusses the dominance of the Bitcoin in the crypto-asset space from an institutional investor perspective.

1.1. Qualitative evidence of growing institutional demand for digital assets

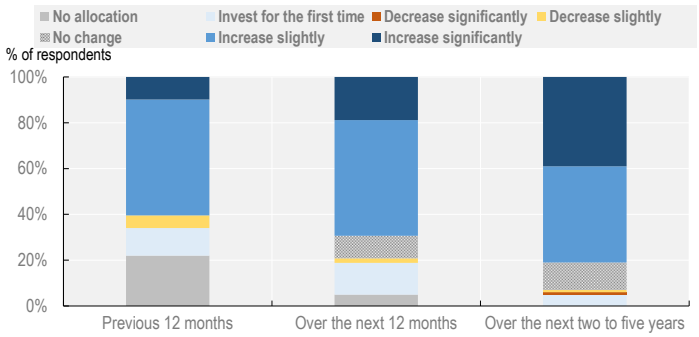
There are limitations in our current understanding of the level of investment in crypto-assets, driven by the lack of quantitative data reporting and well as the direct holding of crypto-assets and their self-custody by investors. Qualitative surveys provide data that allow us to better understand the overall attitudes and behaviour of institutional investors towards digital assets, although hard evidence as to the actual holdings of such assets are scarce as of today. Institutional investors, similar to retail investors, use crypto-exchanges and digital wallets to trade and hold their crypto-assets, making it even more difficult to estimate the level of digital asset holdings by institutional investors. This is driven both by the inherent self-custody nature of some decentralised assets, but also by the unwillingness of regulated financial service providers to hold crypto-assets or custody them on behalf of their clients given perceived regulatory uncertainty (see Section 3.2.4).

The types of institutional investors recording the largest rates of investment in crypto-assets are dedicated crypto-funds, venture capital funds and hedge funds, given greater risk tolerance and fewer asset class constraints. Net flows into dedicated crypto-asset funds reached USD 2.5bn the first week of October 2021, as reported by data provider EPFR (FT, 2021[5]). Interestingly, such funds can allow investors to hold such risk indirectly either by investing in companies whose assets are majority bitcoin or who derive the majority of their earnings from bitcoin mining, lending or transacting (FT, 2021[5]). Hedge fund participation in markets for crypto-assets has also been showcased in the case of the DeFi market, where hedge funds or family offices are reportedly an important part of the decentralised finance ecosystem. Based on a recent market survey by Intertrust, hedge funds expect to shift 7% of their assets to crypto in the next 5 years (FT, 2021[6]). Based on estimates about the total size of the hedge fund industry, this would equate to a total of about USD 312bn of crypto-assets held by hedge funds, if this were to materialise.[3]

Traditional long-term institutional investors such as pension funds and insurance companies express a more negative view on high volatility digital assets (Figure 1.3) although anecdotal evidence suggests they are becoming increasingly interested in holding such risk (Pensions & Investments, 2021[7]). Based on a qualitative survey, pension funds managing defined benefit plans expressed the most negative view on digital assets across all institutional investor respondents, given the more conservative, risk-averse profile of such investors and their preference for long-term growth and low volatility assets (Fidelity, 2021[8]). In practice, the institutional arrangements of such investors and their fiduciary duty towards pension beneficiaries would make it difficult to allow such investment holdings, while increasing concerns around the environmental impact of Bitcoin mining would preclude any investment in this particular asset given increasing ESG considerations in asset allocation by such entities.

Institutional investment in digital assets has grown over the past year, while investors report their intention to increase their portfolio allocation in digital assets in the years to come. According to the Fidelity Digital Assets survey conducted based on 1 100 total respondents[4], 52% of respondents surveyed shared they are invested in digital assets at various degrees. Nearly 80% of institutional investors surveyed felt digital assets have a place in a portfolio, and half of them would identify digital assets as part of the alternative asset class (Fidelity, 2021[8]). A similar survey of 300 institutional investors by State Street and Oxford Economics reported that only a slim majority has increased their investments to digital assets in 2021, but over 70% of respondents plan to increase their allocation in digital assets in the next year and 81% over the next two to five years (State Street, 2021[9]). Investors surveyed who have an allocation to digital assets increased annually in all regions, with Asia reporting the highest adoption rate, with 71% of investors surveyed currently invested in digital assets (Fidelity, 2021[8]). This is in line with the greater and earlier adoption of digitalisation in finance experienced in the Asian region (e.g. in China, 32.7% of point-of-sale payments are made via mobile, double the UK (15.3%) and US (15.0%) (OMFIF, 2020[10])). Future purchase intent for U.S. & European investors has also grown year over year, with 71% of those surveyed in these regions planning to buy in the future, compared to 59% the year before (Figure 1.1).

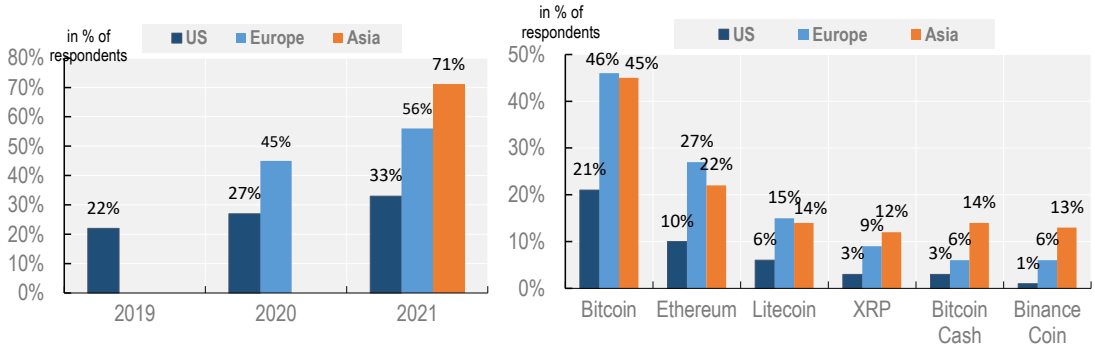
Figure 1.1. Change in digital asset allocation



Source: (State Street, 2021[9])

Based on both surveys, current ownership of digital assets is largely dominated by the two leading cryptocurrencies, Bitcoin and Ether. 37% of investors surveyed by Fidelity own Bitcoin in their (or a client's) portfolio, while 20% own Ether. Fifty-three percent of respondents to the State Street survey reported interest in investing in Bitcoin, 40% in Ether and 21% in other crypto-assets.

Figure 1.2. Adoption of digital assets by region (overall and by digital asset)



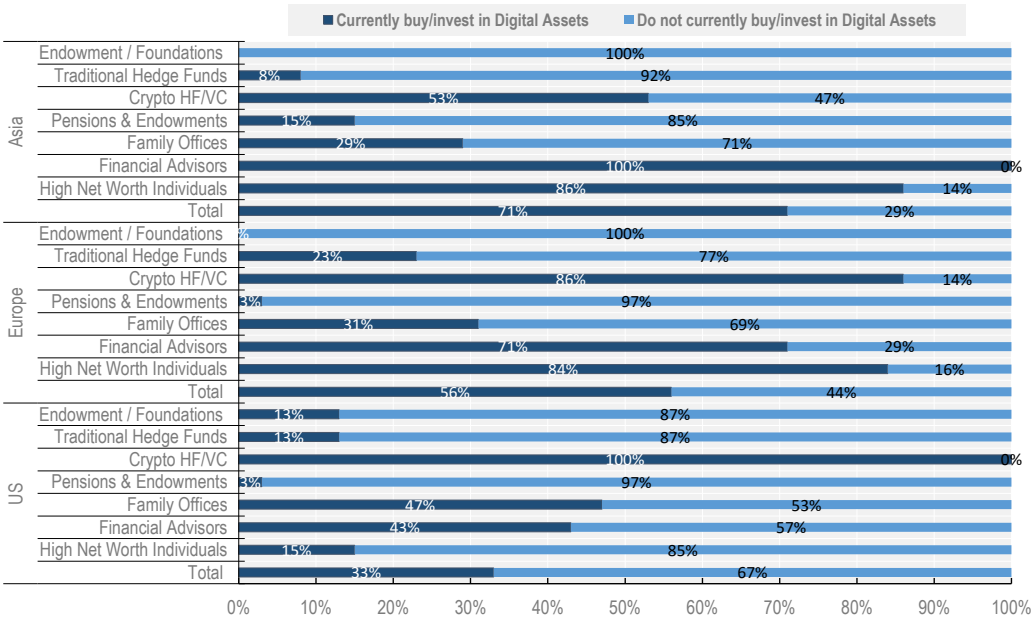
Note: Based on a survey of 1,100 respondents by Fidelity.
Source: (Fidelity, 2021[8]).

In terms of global adoption of crypto-assets by all types of users, the 2021 Global Crypto Adoption Index of Chainalysis records an increase in worldwide adoption by over 880%, with P2P platforms driving crypto-asset usage in emerging markets. Several countries in emerging markets, including Kenya, Nigeria, Vietnam, and Venezuela rank high on that adoption index in large part because they have huge transaction volumes on P2P platforms when adjusted for PPP per capita and internet-using population (Chainalysis, 2021[11]). P2P cryptocurrency exchanges are used in emerging country economies mainly by retail investors as the primary entry into the crypto-asset space, often because they don't have access to centralised exchanges.

On the supply side, financial institutions are increasingly offering regulated products referencing crypto-assets (see Section 2). This is mainly driven by the growing demand of institutional investors for such products (indicatively, 84% of U.S. & European investors surveyed by Fidelity indicated they would be interested in institutional investment products that hold digital assets). What is more, in the U.S., surveyed investors increasingly prefer investment products over direct purchases of digital assets. While investment

products are popular in Europe and Asia, surveyed investors in these regions preferred buying digital assets directly.

Figure 1.3. Adoption of digital assets by investor segment

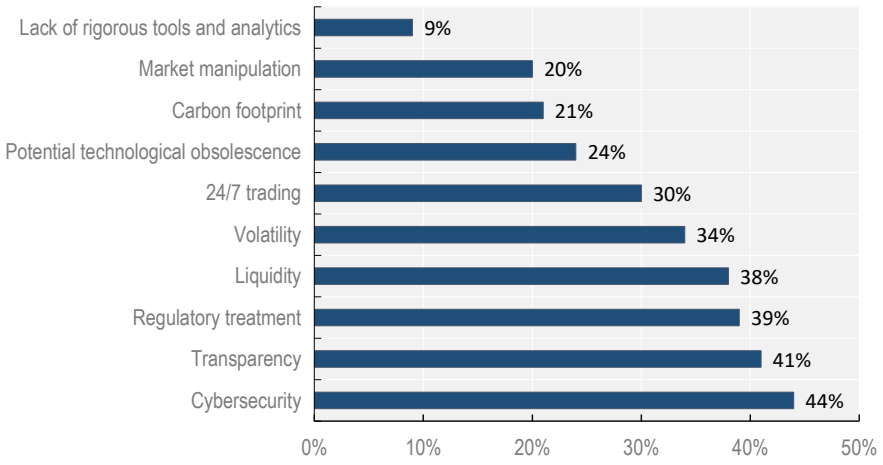


Note: Based on a survey of 1,100 respondents by Fidelity.
Source: (Fidelity, 2021[8]).

At the same time, traditional financial service providers have increasingly been setting up digital asset departments in their organisations and have been releasing a number of financial products allowing sophisticated investors to get indirect access to crypto-asset risk. It appears that this development comes in response to growing institutional investor interest but it also allows financial service providers to encourage digital asset adoption for the existing client base, as a new line of business for financial institutions. Such newly-established desks also play an educational role for their clients when it comes to the technology underlying digital assets and the characteristics of such assets. In parallel, anecdotal evidence by the industry suggests that financial service providers are investing in distributed ledger technology (DLT)-based infrastructure and experimenting with it for the purposes of blockchain-based regulated financial services and products, such as tokenisation.

When it comes to barriers to greater institutional adoption of digital assets, investors mention cyber risk, transparency and regulatory uncertainty as the main impediments to their participation in crypto-asset markets. Other concerns about investing in such assets include liquidity, volatility, as well as the carbon footprint of these assets (Figure 1.4) (State Street, 2021[9]). In a recent survey of institutional investors, 64% of respondents said that greater regulatory clarity would accelerate investment in digital assets or potentially change their approach and become more involved (State Street, 2021[9]). On the supply side, technological weaknesses or uncertainties (e.g. scalability) underlying digital assets will need to be addressed for conventional financial services providers to gain confidence in this market. The risk of future potential technological obsolescence is also a concern that relates to the operational aspect of the underlying technology of crypto-assets. Moreover, there is currently little connectivity or interoperability between DLT-based markets and legacy financial systems, which creates downsides for holders of such assets at the day-to-day operational level (e.g. impossible to have an aggregated risk view or cross-collateralise positions, which is not capital efficient from the investor viewpoint) (see Section 3.2.4).

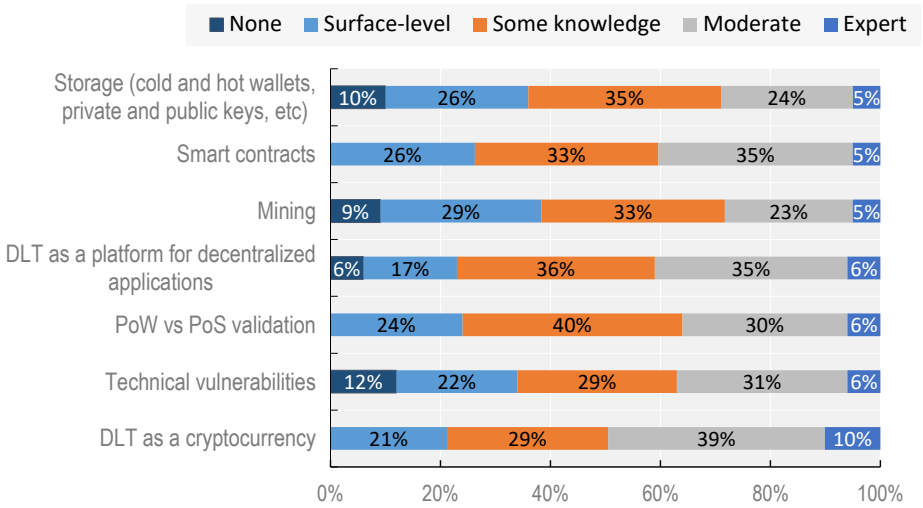
Figure 1.4. Concerns about crypto-asset investing by institutional investors



Note: Based on a survey of 300 institutional investors by State Street and Oxford Economics.
Source: (State Street, 2021[9]).

One of the important challenges for the participation of institutional investors in markets for crypto-assets relates to the lack of understanding and knowledge around DLT infrastructures underlying crypto-assets, validation mechanisms and smart contracts, storage and custody of those assets (see Figure 1.5). This involves basic understanding of the technology underlying digital assets, the characteristics of crypto-assets, the tools for self-custody of assets, validation mechanisms etc. The lack of solid and credible data sources and analytics adds to the difficulty in managing such investments, and so does the difficulty in evaluating crypto-assets using traditional valuation techniques and methodologies.

Figure 1.5. Knowledge of the concepts and terms related to digital assets

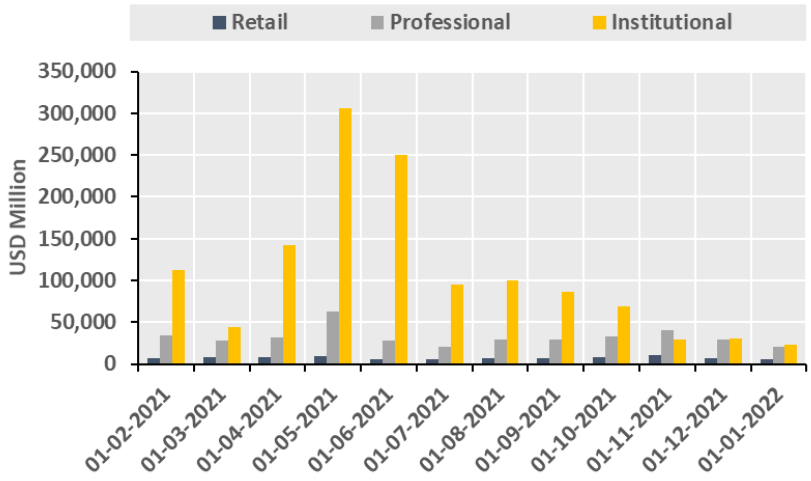


Note: Based on a survey of 300 institutional investors by State Street and Oxford Economics.
Source: (State Street, 2021[9]).

1.2. Quantitative evidence of institutional investor participation in DeFi

Quantitative evidence suggests that large institutional investors have been active in the DeFi market; large-sized transactions, used as a proxy for institutional investor participation, represented the largest share of DeFi activity during most part of 2021 (Figure 1.6). Institutional participation declined towards the end of the year following the crypto-asset sell-off that started in November 2021. Institutional transactions, represented in this analysis as those executing transactions above USD 1 million, peaked in May-June 2021, when they accounted for 80-90% of total transactions in DeFi. Large institutional transactions above USD 10M accounted for over 60% of DeFi transactions in Q2 2021, compared to under 50% for all cryptocurrency transactions (Chainalysis, 2021[11]). Interestingly, a breakdown by geography of these institutional investors showed that countries with the historically largest institutional and professional markets are driving the most DeFi activity (Chainalysis, 2021[11]).

Figure 1.6. Transactions volume flowing into DeFi, broken down by transaction size

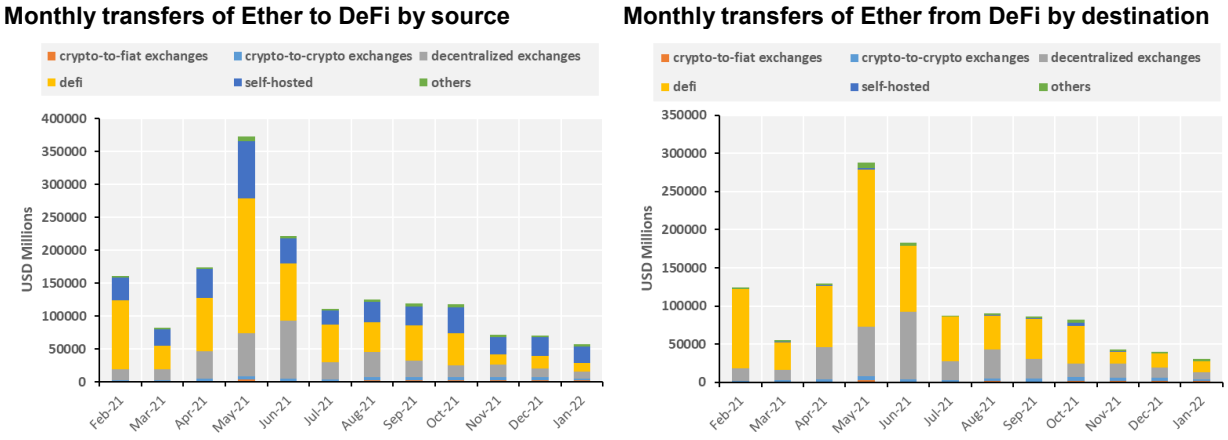


Note: Institutional transactions representing those above USD 1 million, professional transactions representing those between USD 10K and USD 1 million, retail transactions representing those below USD 10K.
Source: OECD based on data by Chainalysis.

Analysis of data flows into DeFi and outflows from DeFi (Figure 1.7) reveals heavy recycling of funds within the DeFi space, and points to the increased use of leverage within the decentralised finance system. In particular, data suggests that much of the flows into DeFi are originating from within the DeFi space itself and only a very small share of inflows comes from fiat converted into crypto-assets. The large share of DeFi inflows and outflows that are rolled over to the DeFi world might indicate the high use of leverage of DeFi participants, who re-use assets borrowed as collateral multiple times for further lending. These flows could also be explained by the fast recycling of profits from one protocol to another, the opportunistic shift from one platform to another given discrepancies in rates between platforms, or the shift to tokens and protocols depending on the yields offered at any point in time.

Based on the size of crypto-asset holdings by investors, there seems to be a divergence in the type of investors holding Bitcoin and Ether, with retail investors prevailing in Bitcoin and wealthier investors dominating Ether holdings (Figure 1.8). In particular, wealthy holders with more than USD 10K of Ether in their portfolios hold 70% of the entire Ether market cap. In contrast, such large holders are much less common in Bitcoin, where they hold only 20% of the entire market cap. Interestingly, almost 40% of total Bitcoins is held by owners of less than USD 100 each.

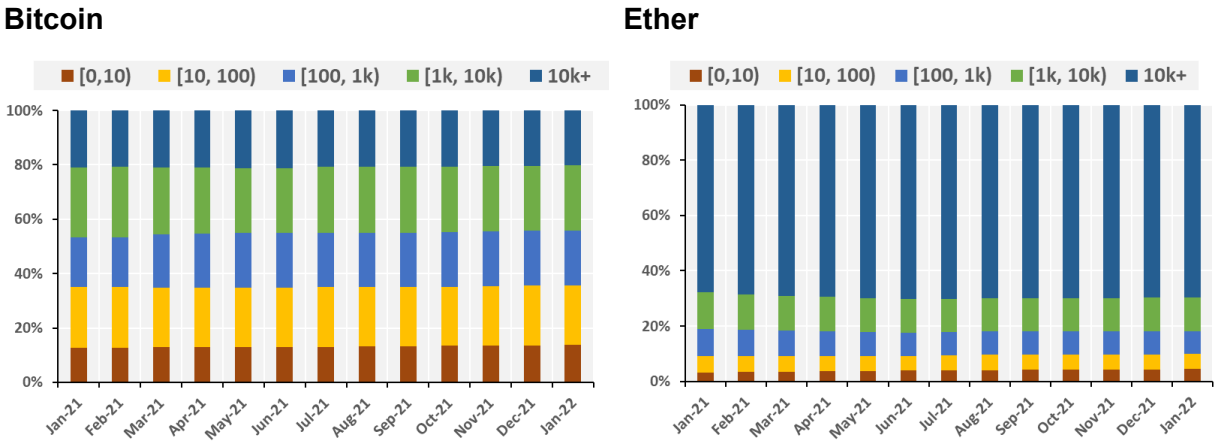
Figure 1.7. Inflows to DeFi by source and outflows from DeFi by destination



Source: OECD based on data by Chainalysis.

The increased involvement of large or wealthier investors in Ether could be related to the DeFi market or to the staking opportunities in Ether and the change in consensus mechanism of the Ethereum blockchain to proof-of-stake. As DeFi applications are mainly built on the Ethereum blockchain, the role of Ether has been important in the DeFi market and the disproportionate holding of Ether by larger investors (compared to Bitcoin) could point to the increased attractiveness of, and participation in, DeFi by larger investors. At the same time, the transition of Ethereum from proof-of-work[5] to proof-of-stake[6] allows holders of Ether portfolios beyond a certain size to participate in the validation mechanism of transactions that they do not initiate and to earn passive yield on their holdings.[7]

Figure 1.8. Distribution of Bitcoin and Ether holdings by wealth of holder



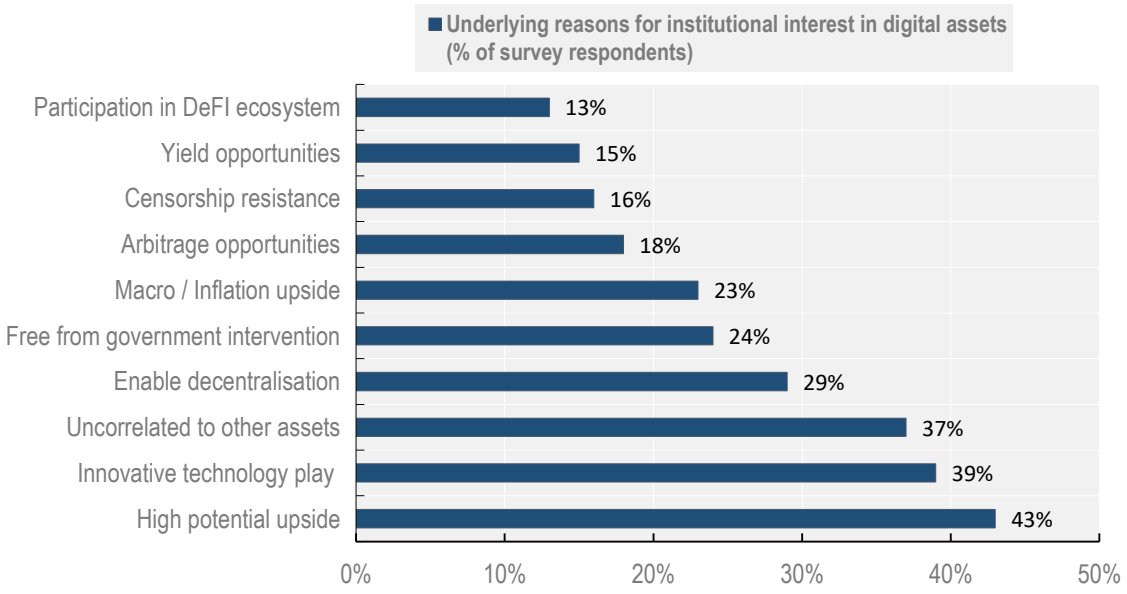
Note: The distribution displays average monthly holdings. Wealth categories are in asset amount held.
Source: Chainalysis.

1.3. Underlying drivers of institutional investor demand for crypto-assets

A growing number of institutional investors believe that digital assets should be part of their investment portfolio but it remains unclear whether such holdings will constitute structural allocations set for a long-

term horizon or tactical allocations that aim at taking advantage of recent market trends. It appears that the upside potential for yield in crypto-assets has attracted the interest of institutional investors, similar to private investors, as a vehicle for speculation and for fear of missing out. For example, the most appealing attribute of digital assets for institutions surveyed by Fidelity in 2021 was the high potential upside returns (Fidelity, 2021[8]). In a similar survey by State Street, institutional investors reported the potential for outsized returns as the most important motivation for having exposure to Bitcoin as a speculative asset (State Street, 2021[9]). The difficulty in valuating crypto-assets adds to the complexity of decision-making around asset allocation in such assets.

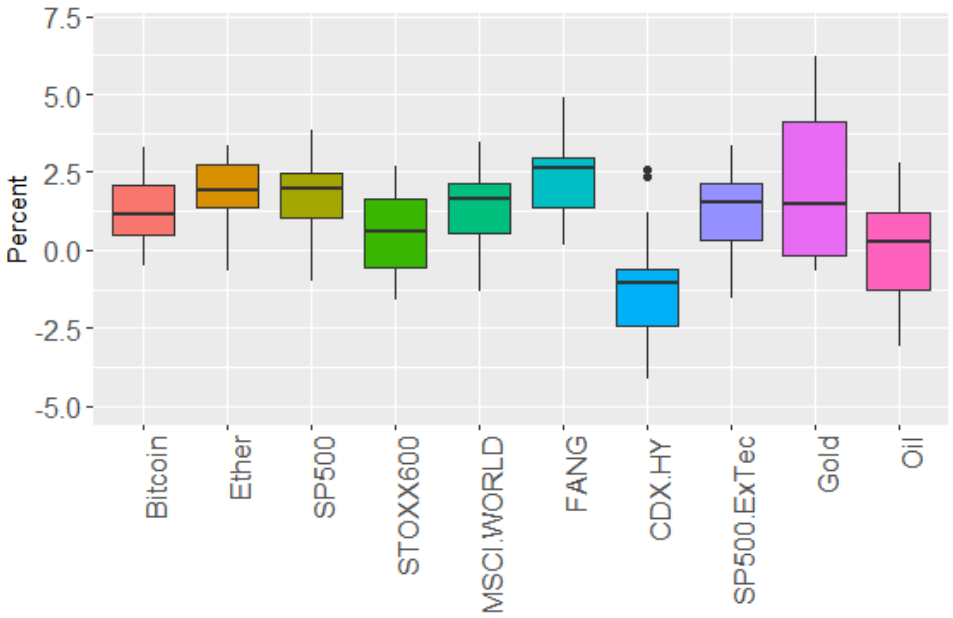
Figure 1.9. Drivers of institutional investor interest in digital assets



Note: Based on a survey of 1,100 respondents by Fidelity.
Source: (Fidelity, 2021[8]).

The search for yield in the prolonged low-interest rate environment is one of the main drivers of institutional investment in this space. The persistent high volatility of the main crypto-assets offers such opportunities for high returns and performance relative to traditional asset classes, even for small positions (and equally high losses). Naturally, such positions have a high probability to experience loss of capital. In the past several years, the price of the main crypto currencies – Bitcoin and Ether - against USD has experienced considerable price movements, resulting in very high volatility. It has also offered high returns, especially to lucky investors with fortunate market timing. Analysis of the risk-adjusted returns of Bitcoin and Ether compared against those of leading equity and indices and commodities shows that crypto currencies have not yet proven to be a superior investment (Figure 1.10. The difficulty in understanding the underlying drivers of crypto-asset prices and the lack of (structured) data and reporting in the markets for digital assets adds a layer of complexity for such kind of investment strategies, when compared to traditional financial instruments.

Figure 1.10. Distribution of yearly risk-adjusted returns for Bitcoin, Ether and traditional financial assets, 02/2020-01/2022



Source: Refinitiv and OECD calculations

Note: The boxes extend from the lower quartile to the upper quartile. The vertical lines, known as "whiskers", extend to one and a half times the interquartile range, but then they are limited to reaching actual data points. The horizontal line within the box is the median. Risk adjusted returns were calculated according to Sharp ratio methodology, by subtracting the Federal Funds rate and dividing by the previous year standard deviation of returns.

Some institutional investors perceive investment in digital assets to have a diversification potential for better portfolio optimisation and have positioned the “uncorrelated” nature of returns on digital assets high among the motivations for their interest in this asset class (Figure 1.9). Nevertheless, major crypto-assets exhibit positive correlation with traditional asset classes (see next sub-section) and therefore de-facto have little diversification benefit. The possible hedging potential of major crypto-assets against inflation or macro risks is another reason reported by market participants as potential driver of demand for these assets.

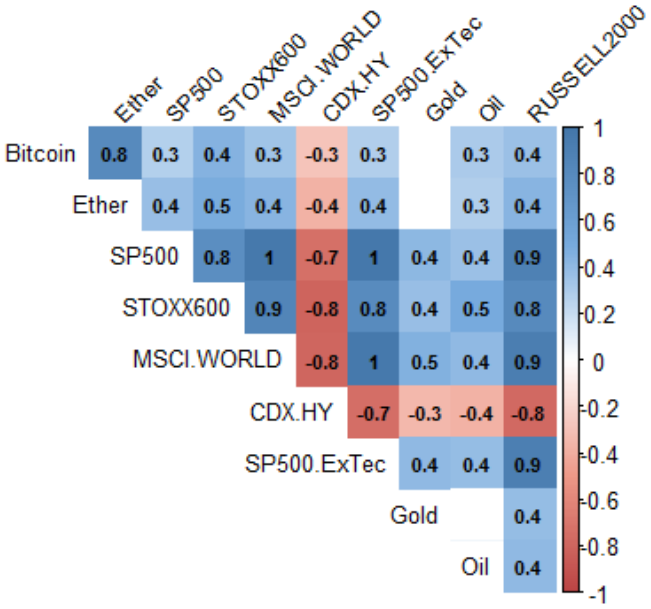
1.3.1. Correlations with major traditional asset classes

Bitcoin still dominates the market for digital assets although its market share has declined, accounting for 40% of a total market capitalisation of the crypto-asset market of USD 2.1 tn as of 05 January 2022 (compared to c. 65% of the market a year ago). Ether is the second largest crypto-asset in terms of market share accounting for almost 19% of the total market as of the same date. In terms of crypto-asset picking, anecdotal evidence suggests that institutional investors concentrate on the few high-profile crypto-assets.

Correlation analysis that spans over the last two years indicates that both Bitcoin and Ether weekly continuously compounded returns have been modestly positively correlated with some of the major world equity indices as well as with each other, and negatively correlated with high yield debt returns (Figure 1.11). This implies that Bitcoin and Ether recent behaviour has been pro-cyclical, which in turn undermines their suitability to hedge the risk of equity markets, and supports the claim that investment is affected by general market sentiments and the search for yield. Research findings suggest that compared to pre-pandemic years (2017-19), the trading dynamics of crypto assets and traditional financial assets have grown more similar - the intra-day price volatility of Bitcoin and Ether is now about 4 to 8 times more correlated with the price volatility of the main US equity market indices S&P500, Nasdaq and Russell 2000.

In addition, correlation of daily returns for those assets have increased significantly over time, though the increase has been particularly pronounced for Bitcoin[8]. Further, Vector Autoregression analysis indicates that spill overs from Bitcoin returns to the S&P500 and MSCI EM indices returns have increased by about 8-10 percentage points since the onset of the COVID-19 pandemic (Iyer, 2022[12]).

Figure 1.11. Correlation of returns on Crypto-assets, equity and other assets 02/2020-01/2022



Note: This figure illustrates the correlation between the two major crypto currencies – Bitcoin and Ether and prominent market indicators. The colour represents the sign and magnitude of the correlation. The numerical value represents the correlation coefficient. Correlation coefficients with p value greater than 1% were left blank. All indicators are represented in weekly returns. Bitcoin and Ether are the returns of the exchange rates of the Bitcoin and Ether against the USD respectively; S&P500 is the return of the equity index for the largest 500 corporates listed on stock exchanges in the United States; STOXX600 is the return of 600 large, mid and small capitalization companies across 17 countries of the European region; MSCI.WORLD is the return of the MSCI World equity index for advanced and emerging economies; CDX.HY is the credit default swap (CDS) of 100 liquid North American entities with high yield credit ratings as published by Markit; SP500.ExTec is the return of the S$P500 index excluding the information sector. Gold is the return of the Gold Bullion LBM USD per Troy Ounce. Oil is the Europe Brent spot price FOB published by EIA; Russell 2000 Index is a small-cap stock market index that makes up the smallest 2,000 stocks in the Russell 3000 Index.
Source: Refinitiv and OECD calculations.

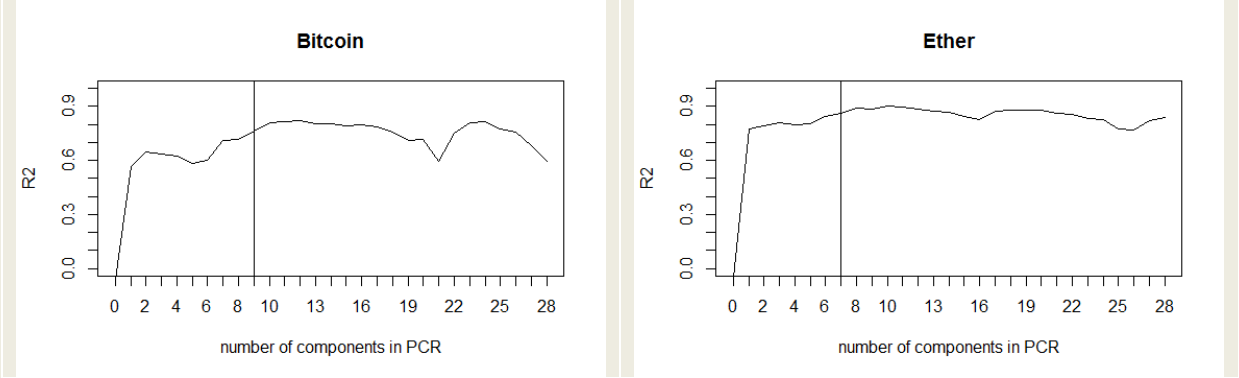
Box 1.1. Crypto-asset returns and their drivers over time

It is interesting to delve deeper into the behaviour of the returns of crypto-assets in recent years, and possibly get a better understanding of the drivers of changes in the returns over time. As evident from the correlation plot (Figure 1.11), crypto-assets and other financial indicators, as well as the indicators among themselves, have shared trends. We thus use a Principal Component Regression (PCR), supplementing the variables from Figure 1.11 with additional financial indicators[9], to assess to what extent are the returns of crypto assets associated with all of these financial factors. A PCR approach allows us to avoid overfitting caused by having many variables and avoid multi-collinearity as the predictors are correlated. However, using PCR makes it impossible to point out the actual underling drivers of the variation.

For clarification, we do not claim that this statistical analysis implies anything about what is causing the movement of crypto-assets prices, rather only how much of the variation in returns is shared with other financial assets. We do assume that there is no causality present in the opposite direction, from crypto-assets to other financial indicators, which seems reasonable given the fact that crypto-assets market value is still small relative to large asset classes.

The PCR analysis implies that traditional market indicators account for a significant part of the variability of returns of Bitcoin and Ether in the past three years. However, about 30% of variation in returns of Bitcoin seems to be unrelated to other financial indicators for the optimal component number suggested by the model in order to avoid over estimation (see note in figure explanations). This suggests that a lot of speculative trading is involved or that there have been different factors/events gaining more importance at certain points in time but not having a constant effect. For Ether, larger portion of the variability in the price, about 90 percent, corresponds to other financial factors used in the estimation. Therefore, there is perhaps less speculation associated with the trade in this asset.

Figure 1.12. Percentage variation in the returns of crypto-assets that is explained by applying a PCR, as a function of components used, 02/2019-01/2021

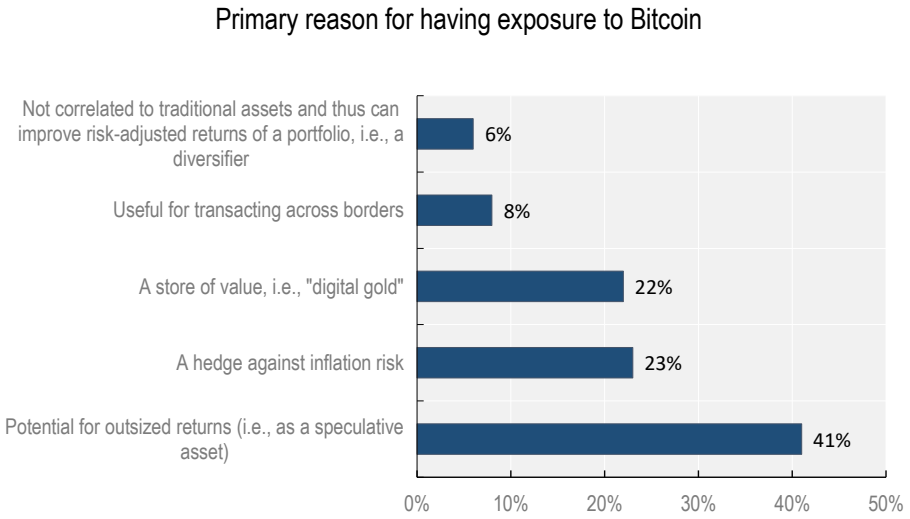


Note: vertical lines represent the optimal components number. This was selected using function selectNcomp in R applying onesigma method.
Source: Refinitiv, FRED and OECD calculations

1.3.2. The inflation hedge conundrum

Market participants may perceive the main crypto-assets as inflation hedges (Figure 1.9), and the surge in the price of the Bitcoin in Q3 2021 could be partly attributed to such motivations of investors given growing inflation expectations in the markets. Often in the past years, investors suggested that an investment in Bitcoin shares similarities with investment in gold and might protect against inflation surge. It is true that the Bitcoin has scarcity characteristics similar to those that make gold a good store of value. The advantages of anonymity may be perceived as a way to escape any form of political or financial repression (Fortune, 2021[13]). However, Bitcoin does not currently enjoy the legal status of gold. Unreported statistical analysis shows that Bitcoin and Gold prices have not portrayed similar trends in the past several years.[10]

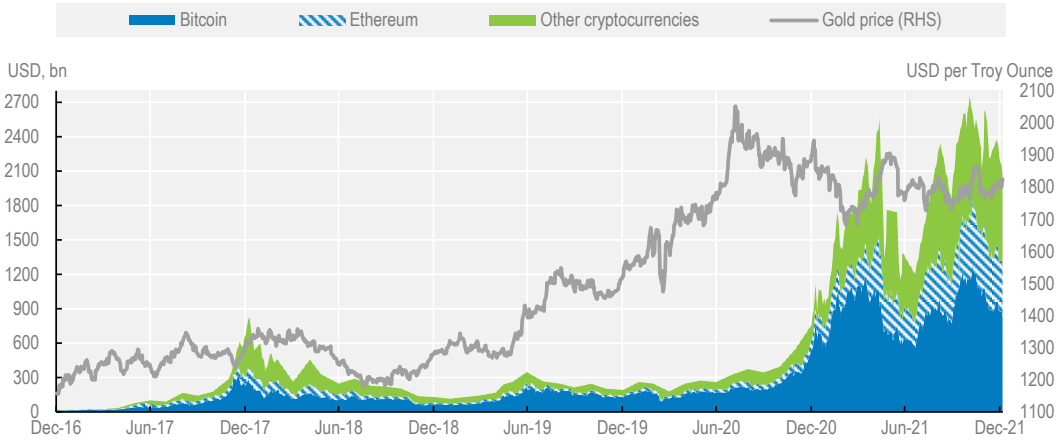
Figure 1.13. Bitcoin exposure perceived by institutional investors as an inflation hedge



Note: Based on a survey of 300 institutional investors by State Street and Oxfords Economics.
Source: (State Street, 2021[9]), as of October 2021.

The suitability of crypto assets to hedge inflation risk should be examined over a long period of time. Given the short history of crypto-assets and their existence overlapping a period characterised mostly by stable inflation expectations, it is hard to be conclusive as to whether crypto-assets are effective inflation hedging tools. Though gold is considered a good inflation hedging investment, it will not necessarily produce high returns during short periods of elevated inflation. Correlation analysis against the yearly change in US Consumer Price Index displays insignificant correlation with the yearly return on Bitcoin and weak positive such relation for Ether for the last two years. However, during the analysed period, yearly change in the Consumer Price Index also portrays positive correlation with return on equity and negative correlation with the return on gold, both in contrast to financial theory predictions for the long-term relationship between these factors.

Figure 1.14. Gold price versus global market capitalization of cryptocurrencies

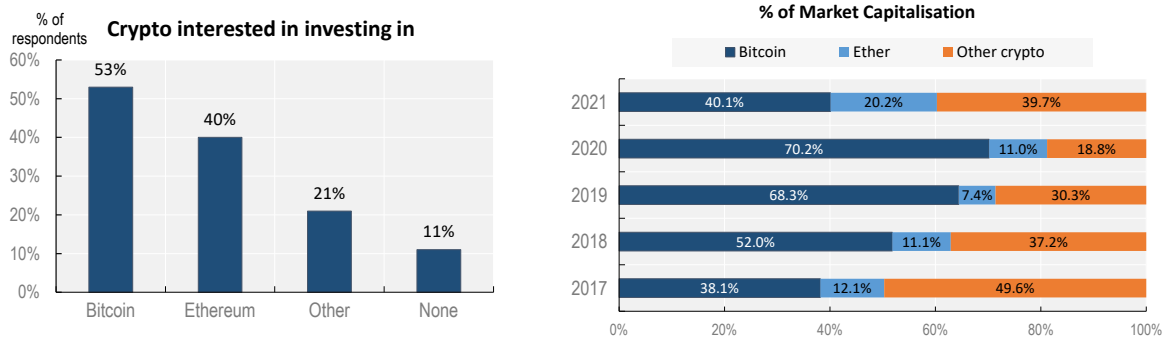


Source: Financial market trends presentation, February 2021, Refinitiv.

1.3.3. The persisting dominance and increasing resilience of the main crypto-assets (Bitcoin and Ether) and large stablecoins (USDT, USDC)

While the discussion around institutional investor participation encompasses all digital assets, in reality, interest and adoption by investors is dominated by the two main crypto-assets, namely the Bitcoin and Ether, as well as by the largest stablecoins (Tether's USDT and Circle's USDC). Bitcoin and Ether persist in terms of dominance despite the myriad new coins that are issued in the market for digital assets and have yet to be overtaken in terms of market cap by other more innovative crypto-assets in spite of the rapid pace of innovation in this space (Figure 1.14). For Ether in particular, the key role of Ethereum in the development of DeFi protocols and the important growth levels of NFTs[11] in 2021 supported the popularity of Ether since H2 2020.

Figure 1.15. Institutional investors still primarily interested in investing in Bitcoin, although it has been losing ground in 2021



Note: Based on a survey of 300 institutional investors by State Street and Oxfords Economics.[LHS], data as of 31 December of each year [RHS].
Source: (State Street, 2021[9]), CoinMarketCap, Coindesk.

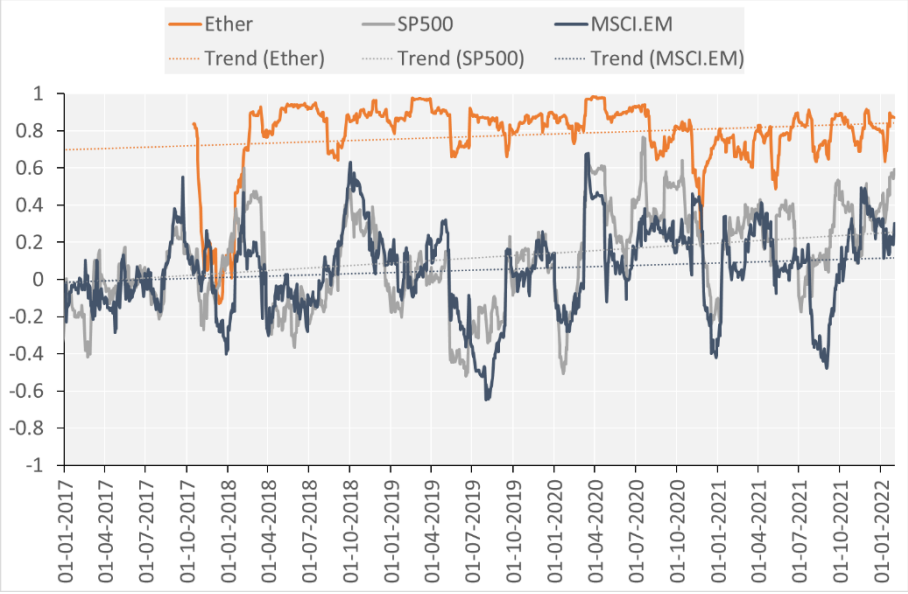
The underlying reasons for Bitcoin's dominance may relate to its first-mover advantage and notoriety, as well as its greater relative accessibility and liquidity. Bitcoin enjoys the most extended ecosystem in the crypto-asset universe, as most exchanges and wallets allow for its holding and trading. Easier accessibility

increases its attractiveness for crypto-asset adopters. The extended development of the ecosystem around it improves the liquidity levels of the Bitcoin, too, while it also allows for the materialisation of network effects for these constructs.

Similar reasons could explain the dominance of Ether, the native coin of the Ethereum blockchain. Its attractiveness could be associated with the extent of the ecosystem built around it, which includes the vast majority of DeFi applications. The prominent role of Ether for transaction compensation within the ecosystem (referred to as 'gas') is another possible factor explaining its popularity. Execution of transactions and any other interaction with networks built on the Ethereum blockchain require the use (and burning) of Ether.

The strong correlation of the top 10 crypto-assets, which reduces diversification benefits within the crypto-asset segment, may also explain investors' focus primarily on the Bitcoin. The short term correlation of returns of Bitcoin and Ether has been close to one ever since Ether was launched (Figure 1.16). Empirical evidence suggests that the most important cryptocurrencies are moderately positively correlated with each other over time, when daily and weekly returns are considered, and that the correlation strength increases significantly during downturns, when most cryptocurrencies strongly correlate with each other (Lahajnar and Rožanec, 2020[14]). Such strong correlation during downturns prevents the effective diversification of crypto-asset portfolios and may partially explain the lack of motivation by investors to diversify their crypto-asset exposure at this stage. Short term correlation of Bitcoin returns seems to increase with that of equity markets during general market downturn periods as well, for example during 2020Q1, the first COVID wave of infections, and again at the end of 2021 during the latest equity turbulence (Figure 1.16). Figure 1.16 also shoes that correlation of Bitcoin with equity markets has been increasing over time as was mentioned earlier.

Figure 1.16. 30-days moving correlation of returns of Bitcoin against Ether, S&P500 and MSCI.EM

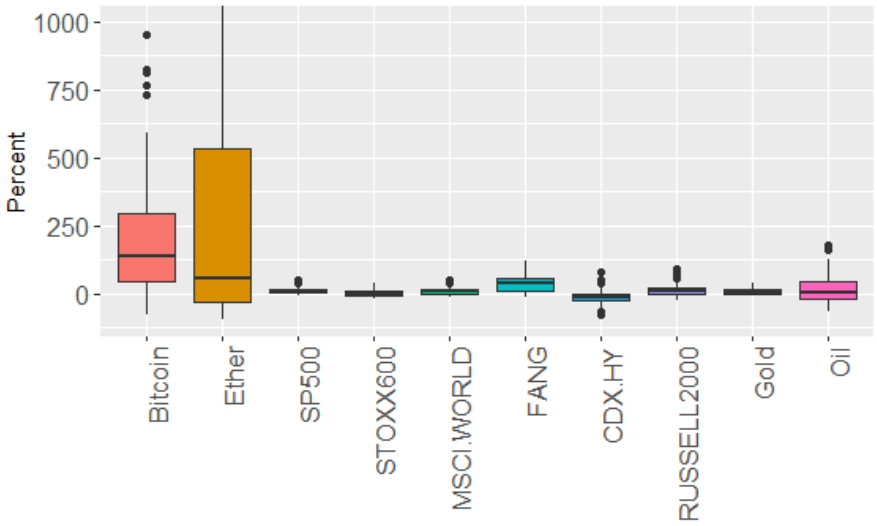


Source: Refinitiv and OECD calculations

As the Bitcoin is the crypto-asset with the longest history and renown, it may inspire more investor confidence for having stood the test of time in the short life of crypto-markets. Both mainstream crypto-assets have survived a couple of very deep bear markets, and both the Bitcoin and Ether have managed to recover from such corrections (Figure 1.16). For example, the crypto-asset market turmoil of 2017-18 (a period defined by the ICO exuberance) lasted for approximately one year, with the Bitcoin declining

peak-to-trough by 84%, following a prior rally of nearly 2,500% over the 12 months prior to that crash. Following the trough, prices doubled over the following 12 months, but the Bitcoin reached its prior peak only three years later (Ether followed a similar trend). These kind of repeated cycles may give some level of anticipation to investors that despite high volatility (Figure 1.16) and extreme price depreciation, crashes are to be followed by recoveries and price rallies. Similarly, the DeFi market, which is very much linked to the two mainstream crypto-assets has come out of such cycles without any protocol failures.

Figure 1.17. Volatility comparison - distribution of yearly returns for Bitcoin, Ether and other financial assets, 02/2016-01/2022



Source: Refinitiv and OECD calculations

Note: The boxes extend from the lower quartile to the upper quartile. The vertical lines, known as "whiskers", extend to one and a half times the interquartile range, but then they are limited to reaching actual data points. The horizontal line within the box is the median. For Ether the distribution of returns is for the period 09/2018-01/2022 due to later appearance.

Similar concentration is observed in the stablecoin market, with Tether, USD Circle and Binance USD dominating issuance (see Section 3.2.1). These three stablecoins are fiat-backed stablecoins, while DAI, MakerDao's stablecoin, is a crypto-collateralised stablecoin. Increased concentration of stablecoin activity in the top three stablecoins, and in turn to the three issuers of these coins, increases the risk of major losses and generalised disruption in the market for such assets. The key role of stablecoins as the link between traditional and decentralised finance aggravates the potential repercussions of such concentration risk (see section 4.1.1).

2 The growing supply of regulated financial products referencing digital assets

The supply of financial products referencing crypto-assets has also expanded in the past year, addressing the difficulty of institutional investors to self-custody crypto-assets and their demand for hedging solutions and instruments such as derivatives. Global financial institutions have also been providing vehicles for indirect exposure to crypto-assets via dedicated investment funds or other types of vehicles.

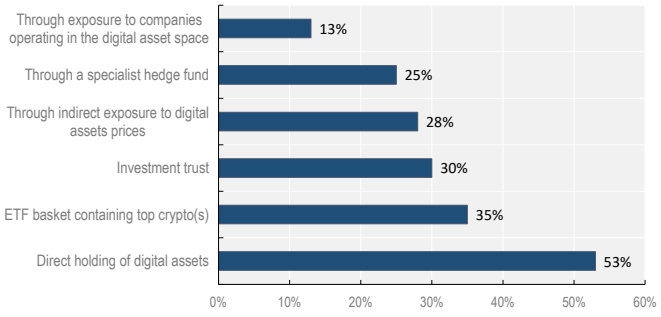
Institutional investors wishing to adopt digital assets, and crypto-assets in particular, may not be willing or capable to have direct holdings of these assets given practical and regulatory/supervisory considerations. Potential lack of regulatory compliance or the perceived by investors lack of clarity around the regulatory and supervisory framework of digital assets may discourage the direct holding of such assets by institutional investors. The potential lack of development of the infrastructure related to the custody or trading of such assets by traditional financial service providers and custodians adds to such reluctance. Instead, many investors choose to indirectly hold such risk.

This section examines the evolution of the different types of indirect exposure that institutional investors can have to crypto-assets and recent trends in the issuance of regulated financial instruments referencing crypto-assets (e.g. futures, exchange traded funds (ETFs)/exchange traded products (ETPs); different types of specialised or venture capital funds that provide such exposure, and indirect exposure through corporates with activity related to mining or crypto-asset trading or through entities holding large amounts of crypto-assets. The objective of this analysis is to underline some of the possible indirect channels of interconnectedness between traditional financial markets and decentralised finance in the broad sense, including crypto-assets.

2.1. Derivatives referencing crypto-assets and ETFs/ETPs

Adding crypto-currency exposure to a portfolio through direct holding poses regulatory obstacles for institutional investors, and accessibility and custody of crypto-assets may be cumbersome. In addition, the high volatility of crypto-currencies' prices exposes those holding crypto-assets in their portfolio to large fluctuations, creating demand for hedging solutions and instruments such as derivatives to substitute or supplement direct holding. In recent years, the options to invest in digital assets through regulated investment tools have expanded, mainly through futures, options, and ETFs/ETPs. Such products offer in addition ease of use to investors, as they require only traditional brokerage accounts and do not involve crypto-wallet holdings or self-custody.

Figure 2.1. Optimal way(s) to gain exposure to digital assets from an overall risk/return perspective



Note: Based on a survey of 300 institutional investors by State Street and Oxford Economics.
Source: (State Street, 2021[9]).

In the end of 2021, several ETFs launched in the US (under existing listing standards) that track Bitcoin futures contracts traded on the Chicago Mercantile Exchange (CME). On 19 October 2021, trading began on the ProShares Bitcoin Strategy ETF (BITO), the first Bitcoin Futures ETF in the US market[12]. ProShares ETF was the second most heavily traded new ETF (USD 1 billion traded volume at the end of its launch day) and has experienced quick growth in AUM, reaching USD 1.4 billion a month after it started trading, indicating large demand for regulatory approved investment tools. As of the end of January 2022, the AUM of all US based Bitcoin-futures benchmarked ETFs is close to USD 1 billion.

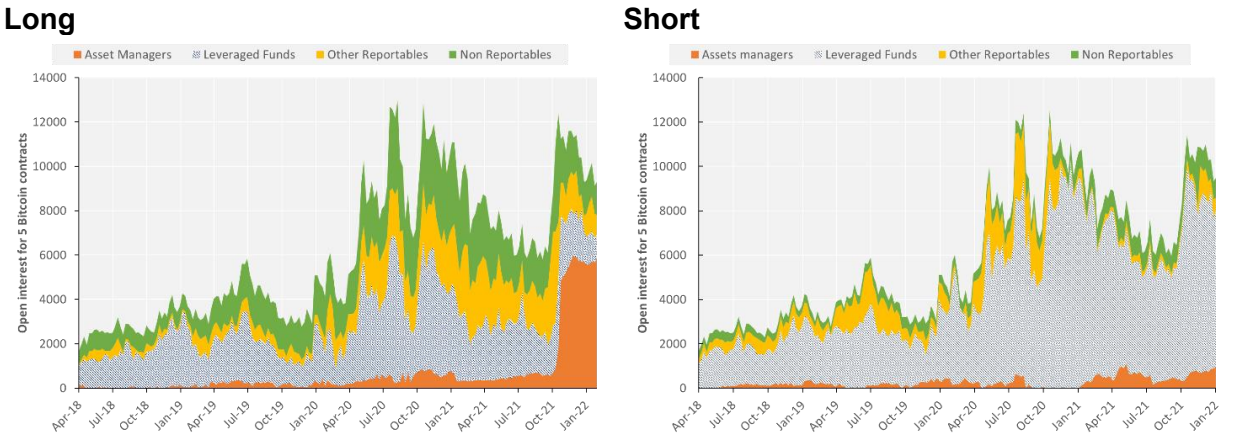
Spot Bitcoin ETFs exist in markets outside the US. Holders of such ETFs include large institutional investors[13]. Europe - Sweden, Germany, Switzerland, Jersey and Liechtenstein - have 37 crypto-ETFs trading with USD 11.4bn of AUM (TrackInsight, FT, as of 2 December 2021). Similar products have been recently approved in France (Melanion Capital ETF), Australia (spot ETF) and Singapore (Fintonia Group's spot ETF).[14] Investors seem to have a preference for spot vs. futures crypto-ETFs in markets where both are avilable[15]. The first DeFi ETF is expected to be issued in Brazil in Q1 2022, investing in tokens issues by eight DeFi protocols. Investors are also able to invest in ETFs that claim to focus on companies that develop or operate with blockchain technologies[16]. Such ETFs market value amounted to USD 1.6 billion as of 16 February 2022 (Refinitiv data).

Crypto-asset options and futures, as well as perpetuals, are mostly traded on non-regulated exchanges in terms of volume. November 2021 average Bitcoin futures volumes were USD 1.4 trillion, when aggregated across all major exchanges, with about 93% (USD 10.9 billion) of open interest market share centred on Deribit, an unregulated exchange. Trade in Ether futures amounted to USD 25 billion daily average in November 2021 (The Block Research, 2021[15]). It has to be noted, however, that the trading volumes reported by unregulated exchanges cannot be considered trustworthy as unregulated exchanges could

report higher than real volumes in order to attract new business (e.g. token issuance) and/or can be involved in wash trading.

Data around participation in the CME futures market illustrate growing participation of institutional investors in Bitcoin derivatives. Bitcoin futures have been available on CME[17]. Since 2021 such contracts on CME are available for Ether as well. CME also offers a micro futures venue for both crypto currencies to attract retail investors (CME, 2021[16]) . In mid-2020, activity in Bitcoin futures on CME has picked up following increased participation by hedge funds (Figure 2.2). Such funds have continued to dominate the short side of the market. In the last months of 2021 activity picked up again in the futures market with significant entry by institutional investors on the long side of the market. As of 8 February 2022, open interest for Bitcoin contracts on CME stood at 10,218, equivalent to USD 2.2 bn considering Bitcoin concurrent price.

Figure 2.2. Long and short open interest on Bitcoin CME futures contracts, by holder type



Note: The graph is based on the "Traders in Financial Futures Report" (TFF) published weekly by the Commodity Futures Trading Commission (CFTC). The TFF report provides a breakdown of each Tuesday's open interest for markets in which 20 or more traders hold positions equal to or above the reporting levels. That data is separated into the four categories: 1) Dealer/Intermediary, 2) Asset Manager/Institutional, 3) Leveraged Funds, and 4) Other Reportables. CFTC staff use Form 40, conversations with traders and other data available to the Commission regarding a trader's market activities to make a judgment on each trader's appropriate classification. The long and short positions are residuals after deducting offsetting long and short positions held by a trader. Each Bitcoin contract on CME is for 5 Bitcoins.
Source: Commodity Futures Trading Commission (CFTC)

Academic research using regulatory data with identifiers from CME sheds light on who trades Bitcoin futures, revealing that the market is largely comprised of two types: concentrated smaller traders that hold almost their entire portfolio in Bitcoin futures and diversified large traders that hold on a very small fraction (Ferko et al., 2021[17]). The analysis observes an increase in the presence of diversified traders in spring of 2020, at the time COVID crisis was at its peak, accompanied by an increase in the share of short interest held by these traders. This adds to the evidence that large sophisticated investors have increased their presence in the crypto futures market.

Derivatives' trading has potentially a beneficial effect on preventing overoptimistic and speculative growth in the prices of crypto assets. Several papers have found the effect of derivatives trading as contributing efficiency to the process of price discovery (Hung, Liu and Yang, 2021[18]) (Alexander and Heck, 2020[19]) although the literature is inconclusive on this question. Academic literature has claimed that insufficient participation of pessimistic traders and institutional investors was among the drivers of the overvaluation of Internet stocks at the end of the 1990s, before the burst of the Dotcom bubble (Ofek and Richardson, 2003[20]). Figure 2.2 affirms that hedge funds are mainly positioned on the short side of the crypto derivatives market. Short selling is possible for crypto assets in unregulated crypto exchanges, and through

brokers, but given the high volatility of crypto assets, it is reasonable to assume that margin ratios for this activity are high. The regulated exchange CME currently requests 50% margin for Bitcoin futures and 60% for Ether future (CME Group, 2022[21])

2.1.1. Economics of derivative holdings vs. direct holding of crypto

Although derivatives are often a more efficient way of investing, due to high liquidity and thus cheaper trading prices, many of the crypto-asset derivatives involve inefficiencies that may render them more expensive than direct holding of the crypto-asset. As a structured product that follows the price of a reference asset, Bitcoin futures ETFs are a more expensive and less efficient way to hold Bitcoin risk than direct holding of the crypto-asset, and are more expensive than spot ETFs given the need to roll into new futures at each expiry. The annual fee of the ProShares Bitcoin Strategy was one per cent, compared to c.10 basis points for a Russell 3000 ETF. As such, ETFs are based on exposure to short-term Bitcoin futures, they involve the rolling over of expiring contracts for new longer-term, in addition to standard fees. This hurts the instrument's performance compared to direct holding of the crypto-asset especially when investors expect the crypto-asset price to rise (contango). Similarly, the indirect holding of crypto-assets through investment vehicles and funds may entail a discount to the NAV of the fund, which could have been avoided in the case of direct crypto-holding (e.g. Grayscale Bitcoin trust trading at 25% discount to NAV upon announcement of approval of a Bitcoin futures ETF in the US). Inefficiencies may also relate to potential discrepancies between the futures prices and the price of the underlying crypto-asset, given doubtful transparency levels of crypto-exchanges and potential price divergence between different exchanges for the same underlying asset (especially in crypto-exchanges), in what is still a rather inefficient market. Such inefficiencies can be expected to be reduced as the markets for derivatives referencing crypto-assets become more liquid.

Although spot ETFs may track the price of the underlying with more accuracy than futures ETFs and at a lower cost, they also expose participants to much higher risks as they are holding unregulated products (through custodians). Indirect exposure to Bitcoin through safer regulated futures instruments offer a higher level of transparency, accessibility and convenience to investors. Investment in derivatives referencing Bitcoin that are traded in regulated venues such as the CME allows institutional investors to add crypto-asset risk to their portfolio as a standard financial product, while avoiding the complexities associated with direct holding of crypto-assets, such as custody of private keys, blockchain transaction fees or even unclear tax treatment of trading crypto-assets.

The current structure of crypto-assets markets raises questions with regard to liquidity and price efficiency. Unlike traditional financial assets trading on regulated exchanges, crypto-asset markets consist of many non-integrated and independent exchanges without any provisions to ensure that investors receive the best price when executing trades. Low liquidity can have an amplifying effect during market downturns, and might pose a challenge for large non-retail traders. Institutional investors noted liquidity concerns in their top four concerns over investment in crypto-assets (Figure 1.4). Liquidity measures differ between exchanges; (Ma et al., 2022[22]) test intraday liquidity measures across three Bitcoin exchanges - Bitfinex, Bitstamp, and Coinbase – from January 2017 to October 2020 and find large differences in liquidity (Table 2.1).

Table 2.1. Intra-day liquidity measures across exchanges for Bitcoin against USD

	Effective spread	Quoted spread
Bitfinex	0.3455%	0.0130%
Bitstamp	0.2563%	0.0805%
Coinbase	0.1614%	0.0082%

Note: This table presents the means for various liquidity measures for the period 2017:01-2010:10.
Source: (Ma et al., 2022[22])

Results from the analysis of trading and market depth of Bitcoin and Ether highlight low trading volumes relative to market capitalisation and limited free float availability. According to publicly available trading volume data, average daily trading volume for Bitcoin (Ether) during 2021 amounted close to USD 46bn (USD 32bn) (CoinGecko). These figures correspond to 5% and 12% of the market cap respectfully (CoinGecko). However, research estimates that about 90% of trading volume of Bitcoin is associated with non-economic activity (Makarov and Schoar, 2021[23]). As for market depth, the estimated free float for Bitcoin (Ether) is 14% (27%) as of January 2022 (based on data from Chainalysis). The free float of digital assets refers to the assets that are most likely to be available for public trading, and in particular refers to the amount held by entities that send at least 25% of the assets they receive and that have held the assets for less than a year. More than half of the Bitcoin reserves are held by long term investors which do not seem to move their holdings even during price decreases, as was the case in the end of 2021 (Chainalysis data). In Ether, such long-term investors hold close to 40%. Estimation of the free float ratio in equities is commonly performed based on the ownership of equity ownership and not trading characteristics. In accordance, the free float ratio of equity in advanced economies is estimated at 19% for the US, 30% for Asia, 32% for Europe and 47% for other advanced (De La Cruz, Medina and Tang, 2019[24]).

Ownership of crypto assets is highly concentrated, although this is still a nascent market with limited participation. Individual investors collectively controlled 8.5 million bitcoins by the end of 2020, with the top 1000 investors controlling about 3 million Bitcoins and the top 10,000 investors owning around 5 million Bitcoins, corresponding to a third of all Bitcoin in circulation (Makarov and Schoar, 2021[25]).. Ether ownership might be even more concentrated (see Section 1.2) although trading volumes are relatively higher. However, as Ether is used in various on-chain applications, trading volumes might be overestimated due to rollovers. These ownership characteristic correspond to much lower ownership concentration than in listed equity markets - for example, in the US and UK, almost 50% of equity at the company level is held by only 20 investors, while in European and Asian markets these percentages tend to be even higher (De La Cruz, Medina and Tang, 2019[24]) . It is important to note, however, that in global equity markets, many of the large concentrated owners are institutional investors, an ownership segment that still presumably accounts for small ownership stakes in crypto assets.

2.2. Indirect holding of digital assets

2.2.1. Crypto-asset investment vehicles and funds

Global financial institutions have been providing vehicles for indirect exposure to crypto-assets via dedicated investment funds or other types of vehicles. Goldman Sachs offers Bitcoin investment vehicles (CNBC, 2021[26])and Morgan Stanley offers its private wealth management clients access to Bitcoin and crypto funds (Bitcoin.com, 2021[27]). BlackRock added Bitcoin futures as a potential non-principal investment for two of its funds (micro-allocations), while a number of incumbent investment banks are launching digital assets units (CNBC, 2021[28]). State Street launched a new division on digital assets and announced its role as the administrator of a planned Bitcoin-backed exchange traded note (ETN) initiated by Iconic Funds BTC ETN GmbH that will be listed on the Frankfurt Stock Exchange, following the approval by the German securities regulator (BaFin). Separately, State Street was appointed as the fund administrator and transfer agent of the VanEck Bitcoin Strategy ETF, one of the new Bitcoin exchange-traded funds (ETF) investing in CME-trade Bitcoin futures[18] that was launched in the US in late 2021 (State Street, 2021[29]).

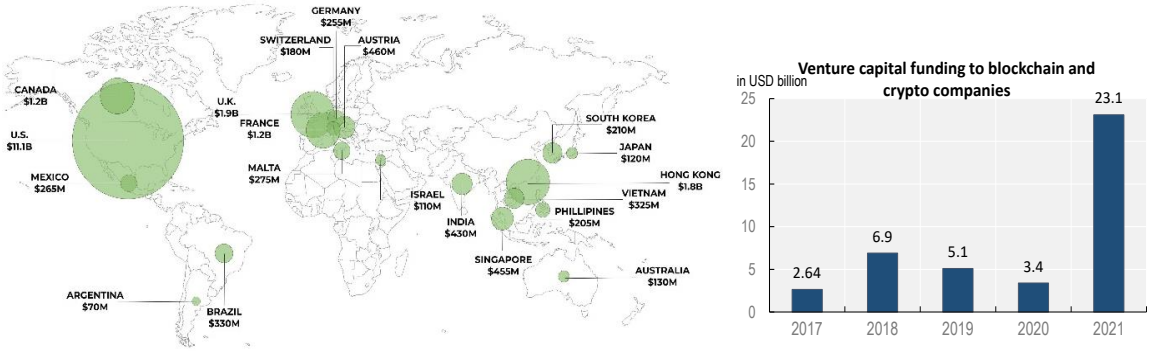
Investment vehicles that passively track the price of main crypto-assets are also attracting significant investments. The Grayscale Bitcoin Trust (GBTC), with USD 32bn AUM[19] which passively tracks the price of Bitcoin, was the first publicly-quoted Bitcoin investment vehicle open to accredited investors and the first digital currency investment vehicle to attain the status of an SEC reporting company (Grayscale, 2021[30]). In Europe, numerous cryptocurrency exchange-traded products (ETPs) have been launched in

Switzerland, Germany, France and the Netherlands.[20] Changes in the regulatory/supervisory framework of some jurisdictions are allowing institutional investors (Spezialfonds) to hold up to a maximum percentage of overall assets in the form of digital assets. For example, in Germany, BaFin introduced new rules for German funds[21] aimed at institutional investors, allowing them to allocate up to a fifth of their assets to crypto-assets (FT, 2021[31]).

2.2.2. Investment in companies holding crypto-assets or involved in crypto-mining and other crypto-asset activity

Indirect holding of digital asset risk can also take the form of participation in venture capital funding of blockchain companies and initiatives. In 2021, venture capital funding for crypto and blockchain companies stood at USD 23.1 billion, more than the aggregate funding in the period 2017-20 (Blockdata, 2022[32]).

Figure 2.3. Venture funding raised by blockchain companies per country (2021) and per year



Note: Includes only equity funding and not any other forms of funding (including ICOs or other token offerings), only the top 20 countries are depicted [LHS].
Source: (Blockdata, 2022[32]).

A more straightforward (although not less risky) way to get exposure to crypto-asset risk is by investing in corporates with large holdings of crypto-assets or with activity related to such assets (e.g. crypto-mining). Nasdaq-listed Microstrategy, for example, is the largest bitcoin-holder out of all listed entities worldwide. In 2021, the company purchased an additional 50,575 Bitcoins, raising its crypto-asset portfolio to more than USD 2.5bn. What is important to note is that such companies and their actions related to their crypto-asset portfolio are driving to a large extent market sentiment. Tesla is a prime example of such influence on investors (particularly on retail ones).

Table 2.2. Publicly listed companies with more than 1,000 Bitcoins on their balance sheet

As of December 2021

Company	Country	Bitcoin Owned	% of Bitcoin supply
MicroStrategy LLC	US	121,043	0.64%
Tesla, Inc.	US	43,200	0.23%
Square Inc.	US	8,027	0.04%
Marathon Digital Holdings	US	7,453	0.04%
Coinbase Global, Inc.	US	4,487	0.02%
Hut 8 Mining Corp	CA	4,450	0.02%
Galaxy Digital Holdings	CA	4,000	0.02%

Company	Country	Bitcoin Owned	% of Bitcoin supply
Bitcoin Group SE	DE	4,000	0.02%
Riot Blockchain, Inc.	US	3,995	0.02%
Bitfarms Limited	CA	2,973	0.02%
NEXON Co. Ltd.	US	1,717	0.01%
Argo Blockchain PLC	US	1,268	0.01%
Hive Blockchain	CA	1,266	0.01%
Seetee AS	NO	1,170	0.01%

Note: The Bitcoin supply in circulation is 18.916 million, as of 31 December 2021 (Blockchain.com)
Source: Bitcointreasuries.net.

3 Growing interconnectedness between decentralised and traditional markets and associated risks

Increased participation of institutional investors in digital asset markets can give rise to investor risks at the micro-level, while it may also create channels of potential contagion between decentralised finance and traditional finance. Growing involvement of institutional investors in crypto-asset markets may in the future lead to increased interconnectivity between traditional finance and decentralised finance through many avenues, and risks of spillovers to the traditional financial system and the real economy may emerge. Stablecoins constitute the key bridge linking the decentralised finance with the traditional financial markets. Other points of possible linkage between decentralised finance and traditional markets include institutional versions of DeFi protocols and the pledging of tokenised assets on DeFi protocols instead of crypto-assets or the potential future use of CBDCs in DeFi protocols. Growing institutionalisation of digital assets could bring a number of potential benefits to financial markets and their participants that should not be underestimated or overlooked.

Crypto-assets are increasingly seen by parts of the traditional investment industry (asset managers, family offices, hedge funds) as a distinct asset class that merits assessment and adoption as part of the alternative investments of investor portfolios. The supply of regulated instruments referencing crypto-assets give the possibility to institutional investors to hold such risk without going through cumbersome and risky direct participation in decentralised markets for such products. Although current levels of adoption are still low and concentrated in specialised crypto-funds and family offices, the increased interest of other types of institutional investors could translate into larger holdings in the near future. From a more systemic viewpoint, crypto-assets and DeFi's use of automated protocols that do not rely on traditional financial intermediaries does not eliminate standard risks to financial stability such as those arising from excessive leverage, liquidity mismatches and interconnectedness, as well as the lack of shock-absorbing capacity.

This section analyses potential benefits and key risks rising from potential increased participation of institutional investors in markets for digital assets and highlights the potential increased interconnectedness between traditional and decentralised finance. It describes some of the key linkage points between traditional finance and decentralised finance (including crypto-assets, DeFi). These include stablecoins as the bridge between the two environments; the emergence of institutional versions of DeFi protocols; the use of tokenised regulated securities on DeFi platforms, and the integration of DeFi protocols in CBDC pilots.

3.1. Risks emerging from increased institutionalisation of crypto-assets

Increased participation of institutional investors in digital asset markets gives rise to investor risks at the micro-level, while it may also create channels of potential risk contagion between traditional finance and all forms of decentralised finance (digital assets, DeFi), depending on the scale of use of digital assets in the future. It has now been established that DeFi can pose significant potential for investor harm (IOSCO, 2022[33]). Investor risks related to positions on digital assets are significant, and are stemming from the fact that many DeFi participants are acting outside of, or in non-compliance with regulatory frameworks that safeguard market integrity, consumer protection and ensure financial stability. Pseudonymity and lack of AML/CFT checks give rise to risk of illicit activity or outright fraud (see Box 3.1 and (FATF, 2021[2])). The extremely high volatility of crypto-assets exposes investors to price spikes and total loss of investment with potential for spillovers to the traditional markets. For example, when investors face large losses or margin calls, they may need to close positions in other parts of their portfolio (potential wealth effects as defined by the FSB (FSB, 2018[34])).

Potential adverse confidence effects can emerge as the result of the absence of any of the traditional safeguards for investor protection and market integrity in such markets. Risks of market manipulation in crypto-assets are elevated given that they are traded to a large extent in unregulated venues with total absence of disclosure and reporting requirements and/or practices. For example, holders of large proportion of Bitcoins in circulation (so-called 'whales') can move the entire market so as to make profitable trades. Numerous cases of wash trading have also been observed in markets for crypto-assets. Governance frameworks of crypto-assets are unclear or untested and the technological and operational risks related to the underlying technology remain significant risks for investors. Escalating ESG concerns related to mining activity for certain major crypto-assets such as the Bitcoin also deserve attention as important considerations by investors with sustainable investment criteria for their portfolios, given the environmental impact of Bitcoin's proof-of-work validation mechanism. Lastly, the lack of credible and solid data around crypto-asset market activity and the difficulty in evaluating such assets with conventional methodologies and valuation techniques obscure and complicate investment decision making with possible total loss of capital as consequence of that.

Although stability risks related to crypto-asset activity and DeFi are currently limited, given their limited size and interconnectedness with the wider financial system, they could present financial stability risks in the

future if their growth pattern persists, and as they become more interconnected with the wider financial system (Bank of England, 2022[35]). Related risks could potentially arise from interlinkages between crypto-assets and traditional finance; new forms of financial and operational risks for financial institutions; growing activity outside of the existing regulatory perimeter; and challenges in regulating new forms of entities and business models (Bank of England, 2022[35]).

Box 3.1. Hacks, operational failures and DeFi exploits

Crypto-asset markets are ripe for market manipulation, fraud, and exploits, while operational errors and bugs are also leading to loss of investor funds. In DeFi alone, it is estimated that c.USD 2.3 billion funds have been lost in over 83 DeFi hacks and exploits that have occurred as of 17 February 2022 (CryptoSec, 2022[36]).

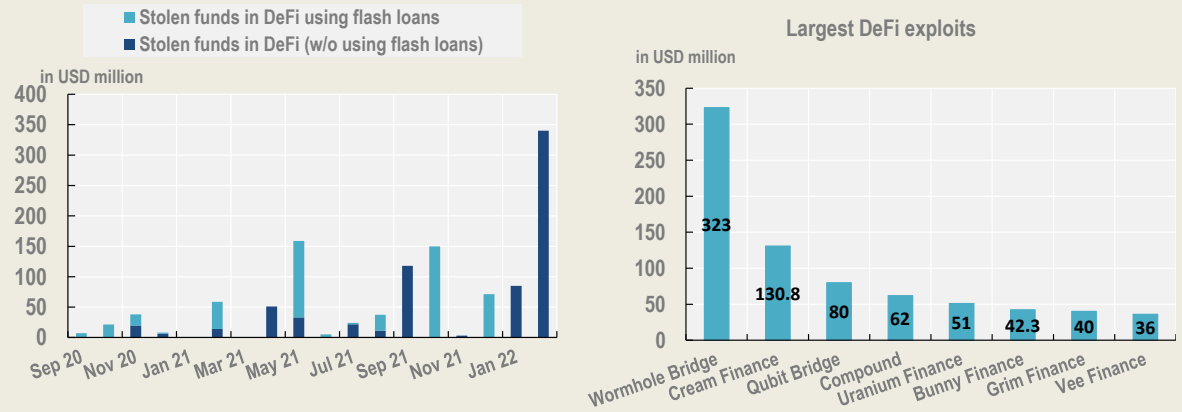
'Exploits' are bad actor attempts to manipulate DeFi protocols by exploiting loopholes and logical errors in the smart contracts on which they're run, resulting in the theft of user assets (rugdoc.io). Validator-based exploitations known as "miner extractable value" (MEV) involve the front running of transacting users or the selective transaction reordering by miners or validators at the expense of users.

Numerous examples of bug exploits leading to theft of crypto-assets also occur from operational failures. The level of automation and dependence on the functioning of smart contracts and their underlying code intensifies the corresponding risks to users.

Flash loans are increasingly being used for such exploits in DeFi. Flash loans are uncollateralised loans which enable users to borrow without collateral, provided that they repay the loan to the pool in the same block on the blockchain (i.e. in one single transaction). Such flash loan attacks allow cyber-criminals to take out uncollateralised loans and use them to manipulate the market in their favour. Such attacks require zero capital, occur in seconds and can involve numerous DeFi protocols for the same attack.

For example, PancakeBunny yield farming aggregator suffered a flash loan attack in May 2021 that caused its token to plummet by more than 95% of its previous value, due to an attacker who initially borrowed a large amount of the protocol's coin and dump it on the market, causing the price to crash and reportedly stealing USD 3 million (Coinmarketcap, 2021[37]).

Figure 3.1. Stolen funds in DeFi and largest DeFi exploits by amount stolen



Note: Largest DeFi exploits as of 9 February 2022, stolen funds in DeFi as of 9 February 2022.
Source: The Block.

The risk of cyber attacks and exploits is more pronounced in DeFi settings given pseudonymity and numerous examples of market manipulation of voting and token prices have been observed. In the absence of any recourse, recovery or resolution mechanisms, investors are exposed to total loss or erosion of value without any protection.

Source: (OECD, 2022[3]).

In terms of emerging risks at the institutional level for financial institutions involved in digital assets, the continued growth in the adoption of crypto-assets could increase risks to the banking system in the future.[22] Jurisdictions should consider how investments in crypto-assets or DeFi products by financial intermediaries and credit institutions should be appropriately regulated. In this context, the Basel Committee on Banking Supervision (BCBS) has published a consultation on the prudential treatment of banks' exposures to crypto-assets (BCBS, 2021[38]). This will eventually lead to a set of minimum standards that national regulators will need to implement for banks in their regulatory frameworks.

Increasing participation of institutional investors in markets for digital assets may give rise to the creation of new channels of transmission of risks from the crypto-asset market to the traditional financial markets. As digital assets become mainstream, the boundaries between the two markets, traditional and decentralised finance are therefore becoming more porous and risks of spillovers to the traditional financial system and the real economy may emerge. Extreme price volatility and movements that directly affect traditional financial products referencing digital assets could have an indirect effect on such traditional financial products. Any rapid shifts in the behaviour of crypto-asset market participants or in the mechanisms underlying crypto-assets or DeFi protocols can affect the valuation of the reference assets in abrupt ways. Changes in supply/demand dynamics of crypto-assets and DeFi applications as a result of changes in the regulatory or supervisory environment related to digital assets and their participants are also likely to be reflected in the price movements of referenced crypto-assets, which in turn will be transmitted to the traditional finance space through derivative products. Cyber risk, operational or other failures of underlying blockchains would also affect prices and operation of crypto-assets involved and the impact could be diffused to traditional finance through the same transmission channels. Equally, in case of generalised distress on digital asset markets, investors exposed to losses may have to close positions on traditional markets, propagating the shock. Adverse confidence effects, particularly emerging from the retail investment on crypto-assets, could also have negative repercussions to financial stability overall (FSB, 2022[39]).

Innovative mechanisms used in DeFi protocols, such as automated liquidation, increase the overall complexity of the crypto-asset market, which could further exacerbate existing risks and could spill over to traditional markets (Nassr, 2022[40]). Corrections in markets for crypto-assets that are used as collateral in DeFi lending protocols affect DeFi markets through the margin call mechanism incorporated in lending protocols. Such mechanism automatically liquidates underlying collateral when their price drops, without notifying the participant. The high volatility of crypto-asset prices intensifies the fragility of the DeFi market, and volatility spikes in the price of main crypto-assets, coupled with increased use of leverage, can induce massive automatic liquidations in DeFi protocols. On top of these automatic collateral liquidations, crypto-asset futures liquidations that are likely to happen simultaneously – particularly on unregulated crypto-exchanges – intensify potential market stress. Such liquidations can have a domino effect on investor holdings across the board, and may even have spill-over effects in traditional markets given increasing interconnectedness between decentralised and traditional finance and growing institutional investor participation in digital asset markets (Nassr, 2022[40]).

In addition to new financial products tracking or providing exposure to digital assets (see Section 2), new avenues for the use of crypto-assets by financial consumers are being opened by traditional payment service providers (e.g. Visa settling payments in USDC stablecoins on the Ethereum blockchain, partnering

up with centralised crypto-exchange providers and other crypto-asset service providers, PayPal allowing users to spend their crypto-currency holdings at online merchants globally (Forbes, 2021[41]), (Paypal, 2021[42])). Centralised exchanges and other FinTech players are offering user-friendly interfaces and products linked to DeFi protocols and/or the native crypto-assets issued in DeFi markets, and DeFi protocols are creating new versions of their markets exclusively for institutional investors (see Section 3.2.2). Financial institutions are also testing the pledging of regulated tokenised instruments in DeFi protocols (see Section 3.2.3). But the most important link of traditional finance to decentralised finance is stablecoins, with important implications for policy makers given the risks they represent at the current stage, and which may call for policy action as a priority.

Box 3.2. The experience of liquidations in the recent crypto-asset market turmoil

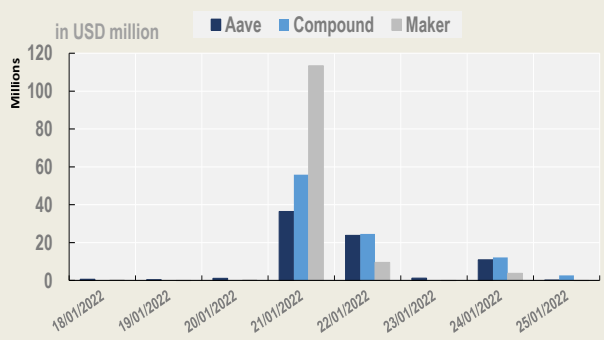
Corrections in markets for crypto-assets are not new and we have already experienced many cycles of exuberance followed by corrections. Although frequent, such corrections are becoming an increasing concern for financial market participants and policy makers

A recent crypto-asset sell-off that started in November 2021 has intensified in the past few weeks amid a broader correction in risk assets, such as growth equities and technology stocks, and perhaps driven by an environment of higher real yields and the foreseen tightening of monetary policy.

The recent crypto-asset market turmoil saw USD 295m of crypto-asset collateral liquidated only over the past 7 days by the top three DeFi lending protocols (Aave, Maker and Compound), according to Dune Analytics (as of 27 January 2022), and could further intensify if the crypto-asset sell-off continues. MakerDAO liquidated USD 119m of collateral on 21 January 2022, stating that over USD 600m worth of Ether was in danger of liquidation at the time, and Aave recorded USD 61m of collateral liquidations the day after. In addition, over the same period, over USD 1.3bn in long liquidations of 500,000 futures contracts occurred in decentralised exchanges.

Figure 3.2. Liquidations of collateral in top DeFi lending protocols and related social media posting of leading lending protocol founder

Protocols based on the Ethereum blockchain



Source: The Block, Twitter.

Mass liquidations during crypto-asset sell-offs test the limits of the DeFi protocols under stress. Until today, the high levels of collateralisation involved in lending protocols have allowed DeFi to withstand such pressures, although at the cost of financial consumers who incurred important capital losses and high transaction costs. For example, similar liquidations were observed during the 'Black Thursday' event (12 March 2020), which constituted the first noteworthy stress-test event in DeFi's short history, when Ether dropped by more than 20% in a day. Such drop caused waves of automated liquidations, while users trying to shift their crypto from one application to another led to a raise in Ether gas fees to 200 Gwei, crowding out small-value transactions that became uneconomical to execute.

Source: (Nassr, 2022[40]), (OECD, 2022[3]).

3.2. Key linkage points between traditional finance and decentralised finance (including crypto-assets, DeFi) that could drive increased interconnectedness

Increased interest and adoption of crypto-assets by institutional investors and other traditional financial service providers can lead to increasing interconnectivity between centralised finance and the parallel system of decentralised finance through many avenues. It has to be stated, however, that at the time of writing of this report, the direct connections between crypto-assets and systemically important financial institutions and core financial markets, and the associated risks to financial stability, remain limited (FSB, 2022[39]). In terms of systemic risk, the channels of transmission of risks emerging in crypto-assets markets identified by the FSB would involve financial sector exposure to crypto-assets; wealth effects; confidence effects and a potential use of crypto-assets in payments and settlements (FSB, 2018[43]). Based on the assessment of the FSB, crypto-assets are currently not used in critical financial services (including payments) on which the real economy depends, although it remains challenging to assess inflection points given the rapid evolution of these markets and the significant data gaps that impede authorities' risk assessments. According to the FSB analysis, if the current trajectory of growth in scale and interconnectedness of crypto-assets to these institutions were to continue, this could have implications for global financial stability (FSB, 2022[39]).

3.2.1. Stablecoins: the bridge that links decentralised to traditional finance

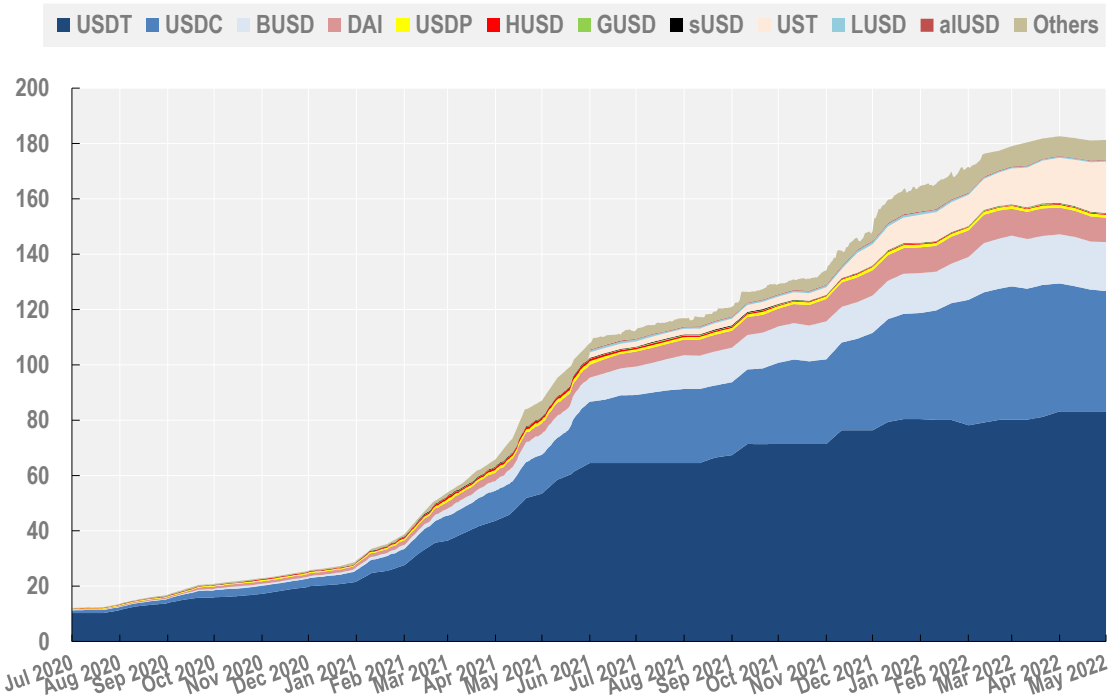
Stablecoins are digital assets created, or 'minted', in exchange for fiat currency[23], and designed to maintain a stable value relative to a national currency or other reference asset (PWG, FDIC and OCC, 2021[4]).[24] Stablecoins issuance and usage has grown to a multiple of its initial size in a very short time span, reaching nearly USD 120 billion as of 10 February 2022 (see Figure 3.3), although the market for such instruments is highly concentrated in a few issuers (see Figure 3.4). The top two stablecoins account for almost 70% of the total stablecoin supply (as of 14 February 2022) raising significant concentration risks, although it has decreased from previous, even higher levels.

Although initially designed by the industry to serve as a means of payment, today stablecoins are mainly used to facilitate trading, lending and borrowing and other transactions involving digital assets. For example, stablecoins are used to move between crypto-assets or crypto-exchanges (e.g. lending, borrowing, collateral pledged on DeFi lending protocols, liquidity mining in DeFi), or to reduce their exposure to crypto-assets without having to convert their holdings to fiat and/or exit the decentralised finance space. As stablecoins are perceived to be more stable than highly volatile crypto-assets, stablecoins are used to convert volatile digital assets or transfer these across platforms without the use of national currencies or traditional financial institutions (PWG, FDIC and OCC, 2021[4]).

Stablecoins are an indispensable ingredient and one of the foundational basis of DeFi markets; indicatively, it is estimated that DeFi lending protocols like MakerDAO, Compound, and Aave hold about 23% of the total USDC supply (Consensys, 2021[43]). Stablecoins are also used by participants in decentralised finance markets as a way to hedge against crypto-asset volatility without having to convert their crypto-assets into fiat currency through a centralised exchange. Indeed, swaps between Ether and other ERC-20[25] tokens and stablecoins are one of the most frequent trading pairs that users access through MetaMask Swaps (Consensys, 2021[43]). In addition to their use as collateral in leveraged lending, and as trading facilitators within DeFi in decentralised exchanges, stablecoins constitute the main bridge between DeFi and traditional finance.

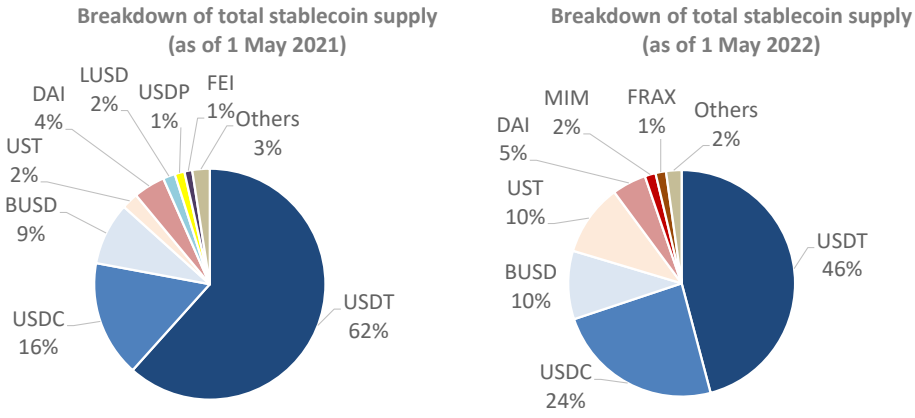
Figure 3.3. Stablecoin supply

As of 1 May 2022



Source: OECD, CoinMetrics.

Figure 3.4. Breakdown and evolution of total stablecoin supply



Source: OECD, Coinmetrics, as of 1 May 2022..

Stablecoins present important risks from an investor protection and market integrity standpoint, while they also raise prudential concerns related to the potential for runs, payment system risks and the possibility to rapidly scale (PWG, FDIC and OCC, 2021[4]) as well as potential concerns under the securities laws. These risks are exacerbated given that such instruments currently do not comply with a consistent set of prudential or investor protection regulatory standards. Stablecoins offer a promise or expectation that the

coin can be redeemed at par upon request. This attributed draws similarity between stablecoins and traditional deposit-taking. A fall in the price of reserve assets, failure to safeguard them appropriately, lack of clarity regarding the redemption rights of holders or operational risks and disruption related to cybersecurity would undermine investor confidence. This could, in turn, lead to self-reinforcing cycles of redemptions and fire sales of underlying assets. A negative sentiment toward crypto-assets or a severe disruption in DeFi platform could spike large demand for stablecoins redemption that would as well turn into a classic run due to insufficient amount of liquid backing assets. Such fire sales could disrupt critical funding markets with potential impact on financial stability overall (FSOC, 2021[44]) especially given that traditional financial institutions may hold assets of stablecoins' reserves (IOSCO, 2022[33]). In addition, concentration in few large issuers could lead to excessive concentration of power to the detriment of market competition and with potential anti-competitive effects, especially in the absence of interoperability (FSOC, 2021[44]). The same applies to key participants in such arrangements, for example custodial wallet providers.

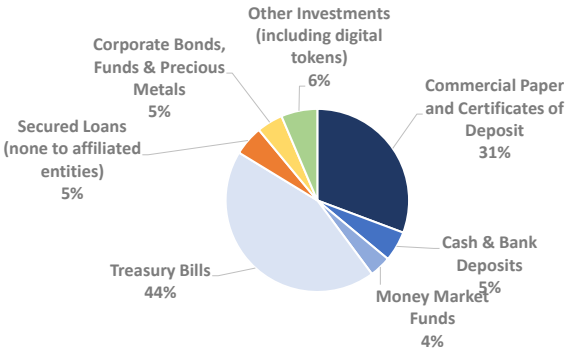
The use of major stablecoin arrangements constitutes one of the greatest points of vulnerability of the DeFi market and the connecting tissue between DeFi and traditional finance (OECD, 2022[3]). In a scenario where a major stablecoin loses its peg due to solvency issues related to the reserves backing the stablecoin or due to its under-collateralisation, decentralised exchanges would go under severe stress and liquidity pools would be further forced to mass liquidations with possible spill-over effects on traditional markets (Nassr, 2022[40]). Failure or disruption of a digital asset trading platform could also threaten a stablecoin and vice-versa (PWG, FDIC and OCC, 2021[4]).

Risks related to stablecoins are exacerbated due to limited trustworthiness associated with the auditability and reporting around their reserves, as well as with the composition of such reserves and stability of third parties acting as custodians. Centralised stablecoins[26] in particular expose users and the system to risks related to their trustworthiness associated with the auditability and reporting around their reserves, as well as with the composition of such reserves and stability of the custodian of such reserves (OECD, 2022[3]). Tether, the issuer of USDT, has been charged for making untrue or misleading statements and omissions of material fact relative to the reserves backing the stablecoin (NY Attorney General, 2021[45]).

Stablecoins are reportedly increasingly investing in commercial paper as part of their reserves backing the crypto-asset issued. Indicatively, Tether holds c.USD30bn in commercial paper, ranking as the 7th largest holder of such instruments globally, according to JPMorgan (Financial Times, 2021[46]). Any sudden risk aversion to such stablecoins with significant holdings of such short-term debt instruments could disrupt CP and other short-term debt markets (Figure 3.5) (OECD, 2022[3]). There is currently no disclosure around what kind of commercial paper is backing Tether and who the issuers of such CPs are, although there is speculation that these may be associated to Chinese issuers (Bloomberg, 2021[47]).

Potential contagion risk resulting from spillovers to money market funds (MMF) could also result from sudden mass redemptions of such stablecoin arrangements, affecting the stability of broader short-term credit markets. It should be noted, however, that there is still lack of clarity as to the redemption rights of some of these stablecoin arrangements.

Figure 3.5. Tether's USDT reserves breakdown



Note: As of December 2021, breakdown of consolidated total assets amounting to USD 78.7 billion.
Source: OECD, (MHA Cayman, 2022[48]).

3.2.2. Institutional versions of DeFi protocols

Another point of crossover between traditional and decentralised finance is through institutional versions of DeFi protocols, tailored to their needs for compliance with KYC and AML/CFT regulations (e.g., Aave Arc, Compound Treasury). Such institutional suites are based on permissioned networks allowing institutional investor participants access to DeFi liquidity pools that consist of known/identifiable participants. Unlike pure DeFi that operates in a pseudonymous manner, participants of such liquidity pools are whitelisted before joining the platform. This means that they undergo customer due diligence (CDD) and completion of other AML/CFT verifications in line with regulatory requirements, including around beneficial ownership of legal entity participants. Such controls are usually performed by third party FinTechs, which also provide off-ramps to move funds out of DeFi to wallets or other applications (e.g., Fireblocks). At this stage of development of the market, whitelisted participants have access to a smaller subset of native-DeFi tokens in such platforms (Fireblocks, 2022[49])

The interoperability of DeFi protocols with traditional financial market infrastructure could potentially further intensify the interconnectedness between traditional financial markets and DeFi. Anecdotal evidence suggests that hedge funds and family offices are already some of the heaviest users of DeFi lending protocols as a tool to engage in unregulated leveraged trading in crypto-assets. The introduction of whitelisting and compliance when it comes to AML/CFT verification could incentivise other financial market participants to join permissioned versions of DeFi driven by the potential to lever up in an uncontrolled manner.

In parallel, FinTech firms create interfaces to allow institutional clients to access DeFi markets in a more user-friendly way. For example, the MetaMask Institutional wallet, launched by Consensys, is built to allow institutional investors to access DeFi while ensuring that they create safeguards by holding the keys to the assets, introducing reporting or promising enhanced protection against nefarious activity by fund managers having access to the digital assets. The absence of KYC remains nonetheless a stumbling block in non-institutional versions of DeFi protocols, as funds cannot commingle their assets with assets from unverified sources in anonymous marketplaces.

3.2.3. Tokenisation 2.0: Bringing tokenised securities into decentralised finance

Tokenised assets, i.e. digital representation of real (physical or financial claim) assets on distributed ledgers, or traditional asset classes issued natively in tokenised form, constitute an important part of the

digital asset space (OECD, 2020[50]). When it comes to tokenised financial assets, regulatory reforms, clarifications of existing applicable frameworks or adaptation of these in recent years provide the conditions necessary for these instruments to develop further (OECD, 2021[51]). Tokenisation issuances by high profile institutions and organisations are showcasing the potential of these instruments. The EUR 100m bond issued by the EIB in April 2021 (EIB, 2021[52])or the tokenisation of green bonds by the BIS Innovation Hub and the Hong Kong Monetary Authority are just some examples of such initiatives (BIS, 2021[53]).

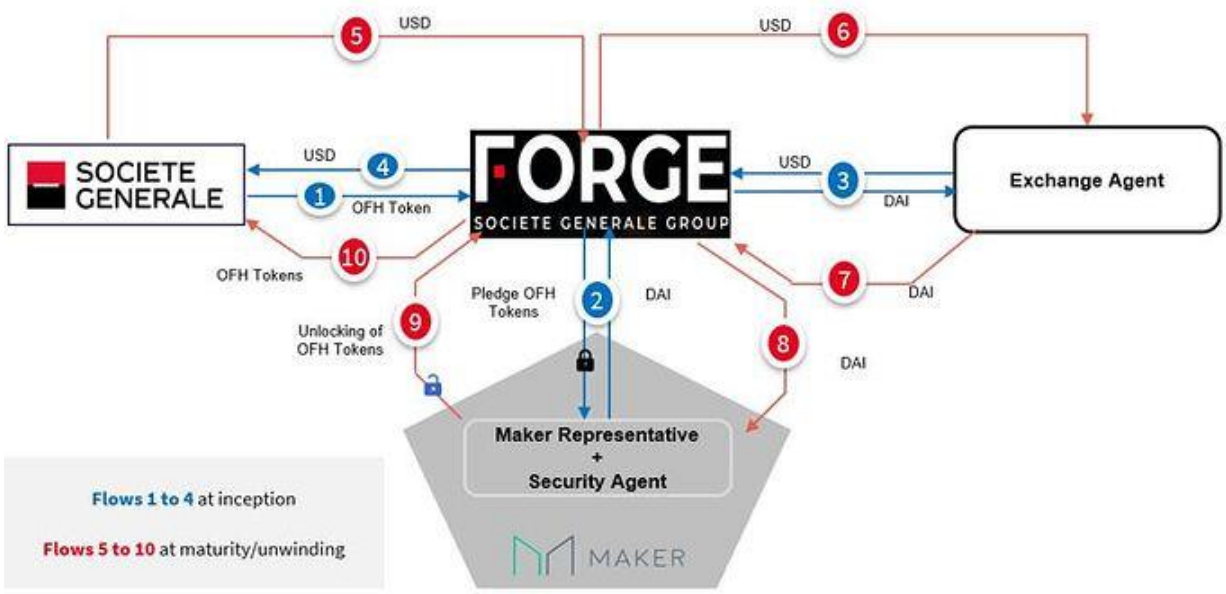
There may be merit in differentiating between digital assets that are regulated financial instruments and those unregulated forms of crypto-currencies that operate on the margins of regulation. For example, native tokenised securities and the tokenisation of existing securities could be described, in some jurisdictions, as a form of cryptography-enabled dematerialised securities that are based and recorded on a decentralised ledgers powered by DLTs, instead of electronic book-entries in securities registries of central securities depositories (OECD, 2020[50]). Tokenisation in these jurisdictions could therefore be seen as merely replacing one digital technology with another where requirements are set without having any specific technology in mind and would not give rise to numerous risks mentioned above associated with unregulated or non-compliant forms of crypto-assets (OECD, 2021[51]).

Tokenised financial assets could be used as collateral in DeFi protocols instead of mainstream crypto-assets or stablecoins in order to unlock liquidity and obtain leverage on pre-existing assets though a DeFi protocol. On 30 September 2021, Societe Generale Forge submitted to the MakerDAO community an application for discussion and approval of tokenised security refinancing through the Maker protocol (Figure 3.6). This first experiment at the crossroads between regulated and open source initiatives intends to refinance a tokenised covered bond, backed by mortgages, that has been issued in 2020 on the Ethereum public blockchain. This transaction pilot proposal combines traditional capital market activities with the emerging and growing ecosystem of decentralised finance through one of the largest DeFi protocols. MakerDao had already previously tested the use of U.S. Treasury securities as the underlying collateral for borrowing DAI (Amico, 2019[54]). The platform also collaborates with third party asset originators who tokenise assets that are used as collateral on the protocol and allow the user to draw stablecoins and finance new loans.

The motivation for such repo operations of regulated tokenised assets in DeFi, like the one described above, lies in the potential for financial institutions, asset managers or other traditional market participants to refinance their existing DLT-based assets and take advantage of the (currently) high yields available at DeFi. Although the search for yield seems to be, once again, the main motivation for the investment in digital assets, the benefits of such innovation should not be underestimated. In the absence of secondary markets for tokenised financial assets (currently mostly OTC), liquidity for such securities is very thin and negatively affects the incentives of participants in those products/markets. Alternative avenues for refinancing activity through DeFi could foster price discovery for such tokenised assets by facilitating and encouraging primary market activity as well as by feeding liquidity in the secondary markets for these assets. At the same time, it can provide an efficient source of short-term funding for institutions participating in the issuance of tokenised financial instruments. All that said, such structures offer additional leverage opportunities to these institutions and depending on the structure of the transaction, these can involve regulatory arbitrage.

Figure 3.6. Societe Generale Forge pledging tokenised covered bonds on MakerDao DeFi protocol

Suggested structure as proposed by Societe Generale to the MakerDAO community



Note: This refinancing transaction experimentation has been approved by the supervision committee of Societe Generale Forge with the relevant validations from Business, Compliance, Legal and Risks departments of Societe Generale. The OFH Tokens that will be used as collateral have been characterized as debt obligations, qualified as covered bonds, issued and governed by French law. They are fungible, negotiable and they provide the same right per securities to the holder and they represent a claim against the issuer.
Source: (Societe Generale Forge, 2021[55]).

Other applications of tokenisation, such as NFTs, and their evolution in what is described as the internet of assets, is also noteworthy. NFTs have emerged as a way to tokenise art or other assets (such as real estate) by guaranteeing the authenticity of the token and have attracted increased investor interest in the past couple of years. An estimated USD 27bn of issuance of NFTs was recorded in 2021. The possibility to supply NFTs as collateral in DeFi platforms and NFT collateralised loans open up new possibilities for transactions on the back of such digital assets. Some NFTs may be offered and sold in non-compliance with existing laws, or may be tokens largely outside the regulatory perimeter at this stage, with the corresponding risk implications for their users and the market.

From the DeFi market perspective, participation of traditional financial institutions can test the limits and improve the credibility of protocols and models involved, given the high bar of pre-conditions for participation by regulated entities in alternative markets. It could be argued that it may be beneficial for the DeFi markets to use tokenised assets as collateral as this would reduce the risk of the market as compared to the use of non-compliant or unregulated crypto-assets as collateral in the DeFi protocols. This remains, however, an untested argument and it is doubtful whether the current high yield offered would remain if crypto-collateral where to be replaced by tokenised assets. It should also be noted that DeFi operation outside of, or in non-compliance with existing regulatory frameworks, including those relating to AML/CFT, tax and sanctions compliance, investor protection and market integrity, raises important risks to markets and their participants.

Box 3.3. The unique challenges of custody of digital assets

Custody and ownership of DLT-based assets are in many ways different to the current construct around custodianship. On the one hand, confirmation of transactions is performed without the need of centralised verification, and asset ownership can be verified efficiently given the transparency of DLTs. At the same time, investors are increasingly relying on centralised crypto-exchanges that offer to custody the assets in addition to providing a trading venue for such assets.

As institutional investor adoption of digital assets grows, so does their need to have safe and secure storage for the safekeeping of their holdings. Custodial services for digital asset products have increasingly emerged, and concern the safekeeping of digital assets and of the private keys of owners of digital assets. Contrary to retail investors, institutional investors generally do not self-custody their digital assets, primarily due to regulations and legal obligations that define their fiduciary responsibilities.

The availability of reliable and credible solutions for custody is a pre-condition for institutional investor participation in the digital assets space. It is perhaps for this reason that large traditional custodians are setting up digital asset divisions to service their clients (e.g. State Street (State Street, 2021[29])). Moreover, there is currently little connectivity between DLT-based markets and legacy financial system which creates downsides for holders of such assets at the day-to-day operational level (e.g. impossible to have an aggregated risk view or cross-collateralise positions, which is not capital efficient from the investor viewpoint)

It should be noted, however, that novel custody and settlement processes lack standardisation and quality control (PWG, FDIC and OCC, 2021[4]). When it comes to stablecoins, digital asset trading platforms hold stablecoins in non-segregated omnibus accounts, co-mingling their own assets with those of clients, while they may also be involved in proprietary trading without any disclosure, oversight or constraint on such activities (PWG, FDIC and OCC, 2021[4]).

Still, a number of challenges remain to be addressed, concerning the application of existing policy frameworks to digital asset custodianship; how such firms will deal with the important volatility of crypto-assets, how secure can the holding of digital assets be from an operational perspective (e.g. hacks) and whether there are insurance solutions available for such transactions. The most fundamental question will nevertheless remain whether custodian services are not against the ethos of DeFi, whose characteristics include its non-custodial nature (OECD, 2022[3]).

Currently, institutional investors generally use crypto-exchanges and digital wallets to trade and hold their crypto-assets instead of traditional custodians, given the inherent self-custody nature of some decentralised assets, but also by the limited supply of regulated financial service providers offering to hold crypto-assets or custody them on behalf of their clients.

3.2.4. Integration of DeFi in CBDC pilots and potential future use of CBDCs in DeFi

Interconnectivity between DeFi and traditional finance can also involve the integration of DeFi protocols in CBDC pilots and the possible future use of CBDCs in DeFi protocols in the place of stablecoins. In concept, and depending on their design, CBDCs could be used instead of stablecoins, both as collateral pledged in DeFi protocols and for exchange purposes. For example, CBDCs could in concept be used to move between crypto-assets or crypto-exchanges, to move between DeFi protocols or to reduce crypto-asset exposure without having to exit the decentralised finance space.

The use of CBDCs in the place of stablecoins in DeFi protocols could provide numerous benefits to users compared to private stablecoin arrangements. First, the use of CBDCs could limit the risks associated with stablecoins, such as run risk (see Section 4.2.1.). This could in turn reduce stability risks by avoiding

systemic stress that could result from a potential failure of entities issuing dominant stablecoins, with potential spill-over risks to the real economy. As such, the use of CBDCs instead of stablecoins could enhance the safety and stability of the DeFi market overall, promoting user confidence and trust in the system. CBDCs have also advantages when compared to private stablecoin arrangements when it comes to ensuring safer settlement of transactions (OECD, 2020[50]).

The use of CBDCs could allow for the maintreaming of CBDCs, although this would also involve the paradox of 'centralising' DeFi and introducing characteristics that are contrary to the concept of decentralised finance markets. For example, depending on the design of the CBDC and the specific arrangements underpinning the integration of CBDCs in DeFi, enhanced transparency could eliminate the pseudonymous nature of DeFi protocols which attracts some part of the user base at the moment. A possible co-existence of CBDCs and stablecoins in DeFi may offer optionality to users, while also possibly reducing the overall risk associated with this market.

On the 3rd of March, the Central Bank of Brazil has selected DeFi protocol Aave as part of its LIFT Challenge, and with the objective to evaluate use cases of CBDCs and their feasibility (Banco Central do Brasil, 2022[56]).

3.3. Potential benefits of an increased integration of decentralised finance with the traditional financial system

From the overall market perspective, increasing integration of decentralised finance with the conventional financial system, conceivable as a further stage of development, could have a beneficial impact on the traditional financial markets (Deutsche Bundesbank, 2021[57]). Such integration could result in stronger competition accompanied by lower transaction costs to the benefit of end users. The disintermediation involved in pure or truly decentralised DeFi markets could translate into lower costs and lower counterparty risks, especially given atomic settlement at the post-trade part of transactions.

Increased institutional participation in markets for digital assets could allow for the materialisation of network effects (Metcalfe's law[27]). The value of DLTs underlying those assets grows proportionately with the number of participating connections or nodes, so greater participation allows for the achievement of critical mass in order to make the network valuable. The emerging ecosystem that are being built around decentralised finance (e.g. interface providers, custodians, wallet providers) are also important given such network effects realised in blockchain-based systems (OECD, 2019[58]). More to that, institutional investors add sophistication and 'rationality' compared to retail investors.

Growing participation of sophisticated investors could potentially add liquidity to those markets. Such participation could potentially allow for volatility to decrease, as more supply becomes available to meet increased demand, if such supply is concentrated in key offerings of large digital assets. However, this is likely not going to apply in the case for the Bitcoin given the finite supply of this crypto-asset.

The important transformation that digital assets bring at the infrastructure level of the financial markets should be highlighted as perhaps the most important benefit that can be derived from the evolution of the digital assets space. Lessons can be drawn from digital assets for the use of DLTs in traditional finance in order to allow for potential efficiency gains in speed and costs associated with financial market transactions. DLT-based finance is fuelling innovation (conventional and disruptive) and leading established market infrastructures and players to review existing processes to make them more efficient. Rethinking of post-trade processes and financial intermediation are the most prominent examples of learnings from the decentralised finance space to the traditional environment. To that end, it may also be beneficial to make a clear differentiation between regulated digital assets that are simply DLT-based forms of regulated financial instruments (e.g. tokenised securities); and those unregulated or non-compliant forms of digital assets (e.g., unbacked crypto-assets).

4 Policy considerations

Given the multitude of potential risks involved in these growing markets for crypto-assets and DeFi, there is a role for policymakers to evaluate such risks and consider policy action to address them. If crypto-assets' adoption continues to increase, the linkages between the traditional and decentralised finance markets may become stronger, possibly increasing the risk of spillovers to traditional financial markets and the real economy. Given the high level of innovation in decentralised finance, policymakers may consider ways to allow for the safe and responsible innovation in a compliant manner, anticipating and addressing emerging risks for participants and the markets.

The interaction between the traditional finance and the decentralised finance markets is likely to grow further, despite the primary motivation being currently a search for yield in what has been a prolonged period of low interest rates. At present, the DeFi ecosystem is geared predominantly towards speculation, investing and arbitrage in crypto-assets, rather than real-economy use cases (BIS, 2021[59]). Given the multitude of potential risks involved in markets for crypto-assets and DeFi, both at the micro (investor) and macro (market) levels, there is a role of policymakers to evaluate such risks and consider policy actions to address them.

In the future, if crypto-assets' adoption continues to increase, the linkages between the traditional and decentralised finance markets may become stronger, possibly increasing the risk of spillovers to traditional financial markets and the real economy. To that end, it is important to monitor the evolution of the market for digital assets and document points of linkage to traditional finance and channels of risk transmission. The evolution of the ecosystem built around decentralised finance (including custodians, wallet providers, DeFi protocols, other FinTech providers) would also need to be mapped and monitored in order to better understand possible contagion channels. Gathering solid data evidence in a structured way around the adoption of digital assets by institutional investors, as well as documenting the scale of interconnectedness

between the two environments would be the first step in better understanding the evolution of this market and anticipating potential risks. This will likely involve the analysis of the plethora of data available on the blockchain but which are difficult to read and interpret in a structured manner.

Regulators could consider providing increased guidance and/or clarification of the applicable regulatory and supervisory framework around crypto-assets and decentralised finance, and consider new rules where policy gaps are identified. A large part of crypto-asset activity currently exists outside the regulatory perimeter and/or in many cases in a non-compliant manner where the frameworks are in place (e.g., parts of DeFi activity or DeFi with centralised characteristics). A review of existing regulatory and supervisory tools could at the same time allow policy makers to consider further action as appropriate in order to address emerging risks where gaps are identified in the current frameworks.

Regulatory standards that can mitigate the risks emerging from unregulated and unsupervised crypto-asset activity should be considered the priority when it comes to stablecoins, as these are identified as the key bridge between traditional and decentralised finance. Stablecoins constitute one of the foundational bases of DeFi markets, but at the same time are one of the greatest points of vulnerability of decentralised finance markets, with clear links to traditional markets (e.g. short-term debt markets) (OECD, 2022[3]). Stablecoins have also a central role in trading, lending, and borrowing activities on centralised crypto-asset trading platforms, with the latter playing a key role in the distribution, trading, and redemption of stablecoins (IOSCO, 2022[33]). Potential failure of a stablecoin issuer or a crypto-asset trading platform primarily involved in a particular stablecoin would give rise to significant volatility, impairing the collateral and liquidity of DeFi (IOSCO, 2022[33]). The ensuing risks of the wider use of stablecoins within and outside the crypto-asset space and their role as linkages between the DeFi and the traditional financial system warrant an appropriate application of a regulatory and supervisory framework and standards that will ensure appropriate protection levels for investors and financial consumers while supporting financial stability overall. To address the run-risk in stablecoins and the associated possibility of wider contagion, policymakers can draw on precepts in bank regulation and supervision, or securities regulation about fund oversight, and on international risk management standards for payment infrastructures (BIS, 2021[59]). For example, in the US, recent recommendations suggest that issuers of stablecoins with the potential to be used as a means of payment be required to be insured depository institutions, which are subject to appropriate supervision and regulation, at the depository institution and the holding company level (PWG, FDIC and OCC, 2021[4]).[28]

When it comes to truly decentralised financial application (as opposed to currently observed DeFi protocols with centralised characteristics), there may be a need for policy makers to rethink some of the policy tools to allow for compatibility with truly decentralised structures (OECD, 2022[3]). This mainly relates to the absence of single regulatory/supervisory access points in decentralised systems, and the possible resulting incompatibility that tools of the existing oversight architecture designed with financial intermediaries at its core (e.g. enforcement in the absence of identifiable accountable entity). There may be a need to 'recentralise' DeFi in order to get some comfort from a regulatory and supervisory standpoint, without necessarily completely undermining decentralisation, by identifying forms of centralisation that may exist in such networks (OECD, 2022[3]). Examples of such could include organised governance structures (e.g. Decentralised Autonomous Organisation (DAO)); holders of controlling shares of governance tokens; identified parties benefiting from the operation of DeFi services through profit sharing mechanisms or fees; or holders of admin keys, all of which could be considered as potential regulatory access points. Another possible access point is through regulatory controls in the on- and off-ramps used to access or exit decentralised systems and particularly when exchanging fiat into crypto-assets and vice versa. Other tools, such as regulatory compliance embedded in machine readable format (code) or the audit of smart contracts, could also be examined in the future (OECD, 2022[3]).

Promotion and encouragement of investor protection disclosures is another possible area of action for policy makers in order to mitigate risks related to the holding of crypto-assets and participation in DeFi. Many investors driven into this market by speculative motives may not be sufficiently aware of the risks

related to such investments, and a better understanding of the mechanisms involved, and in particular of the limitations and related risks involved, should be fostered. Better transparency and reporting around activities and risks could be beneficial for participants in those markets, while encouraging financial education could further protect non-professional investors in these markets. Given the fact that many DeFi protocols have centralised elements which raise the risk of fraud, theft, and other risks, the identification of such centralised elements and characteristics in DeFi protocols would be beneficial in order to mitigate risks for consumers and investors participating in such markets.

Policy dialogue and coordination should be fostered at the national and international levels. At the national level, this involves cooperation of authorities who may have jurisdiction over part of the activity in decentralised finance markets to avoid fragmentation. Cooperation is also required when it comes to providing frameworks and standards for activities that may currently fall outside the regulatory perimeter. Importantly, given the speed and ease at which crypto-asset and decentralised finance participants move geographic location, it is important to ensure cooperation at the international level so as to prevent regulatory arbitrage. Given the inherently global nature of such assets and markets, some level of coordination needs to be encouraged at the cross-border level.

Given the level of innovation in decentralised finance, there is a role for policy makers to promote an environment that can allow for the safe and responsible innovation in a compliant manner so as to avoid emerging risks for participants and the markets. Potential beneficial aspects of the decentralised finance mechanisms and practices could be transposed to traditional markets in order to promote efficiencies in financial market infrastructure and encourage possible productivity gains (e.g. clearing and settlement of tokenised securities)[29]. Nevertheless, it should be highlighted that there are significant risks if DeFi continues to operate outside of, or in non-compliance with existing regulatory frameworks, including those relating to AML/CFT, tax and sanctions compliance, investor protection and market integrity.

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Notes

[1] It could be argued that the use of regulated on/off ramps, such as centralised crypto-exchanges, allows for easier oversight of market activity and ensuing risks in relative terms, as compared to decentralised exchanges and DeFi markets.

[2] According to data provider EPFR (FT, 2021[5]).

[3] Based on Preqin forecasts about the size of the industry.

[4] Respondents included high-net-worth individuals and institutional investor segments: financial advisors, family offices, crypto hedge and venture funds, traditional hedge funds, endowments and foundations, pension funds and defined benefit plans.

[5] Proof-of-work are energy intensive consensus mechanisms, such as the ones applicable to the Bitcoin blockchain, which require miners to solve complex mathematical puzzles to validate a new transaction, adding a block to the chain and permanently and irreversibly recording a new transaction (OECD, 2022[3]).

[6] Proof-of-stake are energy efficient alternative validation mechanisms for the verification of transactions/blocks without the need for expensive computations. Miners are replaced by validators and the choice of the validator in such mechanisms is based on the pledging of a stake (tokens) in the network (OECD, 2022[3]).

[7] For Ethereum, users need to stake 32 Ether to become a validator. Validators are chosen at random to create blocks and are responsible for checking and confirming blocks they don't create (Ethereum.org, 2021[68]).

[8] Daily return correlation for Bitcoin (Ether) and S&P500 index has increased from 0.01 (0.06) pre-pandemic to 0.36 (0.37) post pandemic. The post-pandemic figures are similar to the correlation of weekly returns in Figure 1.11.

[9] Additional indicators include NASDAX, MSCI Emerging markets, MSCI Advanced economies, NYSE FANG+ index, VIX, exchange rates of emerging markets, FED funds rate, 5Y breakeven inflation rate.

[10] An augmented Dickey-Fuller test points to both Bitcoin and Gold prices being of order I(1). However, the hypothesis that the residuals of a linear regression of the two are stationary is rejected.

[11] Non Fungible Tokens (NFTs) have emerged as a way to prove ownership to art, collectibles or other digital items by guaranteeing the authenticity of tokens issued on the back of artwork.

[12] Followed by the launch of the Valkyrie Bitcoin Strategy ETF (BTF), VanEck's Bitcoin Strategy ETF (XBTF) and Global X Blockchain & Bitcoin Strategy ETF (BITS)

[13] In Canada, a total of seven managers (Accelerate Financial Technologies, 3iQ, CI First Asset, Evolve ETFs, Horizon ETFs, Ninepoint Partners and Purpose Investments) are offering 23 crypto-ETFs, as of 2 December 2021 (TrackInsight, FT).

[14] In Canada, for example, the Toronto Stock Exchange has allowed 3iQ Coinshares, Purpose Bitcoin and CI Galaxy Bitcoin spot ETFs. Other examples include QR Capital's bitcoin ETF on the São Paulo exchange in Brazil (USD 41 million AUM as of October 2021) and Fidelity's first physical Bitcoin ETP in Europe (FBTC), which is 100% physically backed by Bitcoin held in custody provided by Fidelity Digital Assets (Fidelity, 2022[15]).

[15] The futures-based ETFs in Canada have drawn only USD 7.6 million (CAD 10.48 million) AUM or about 0.3% of Canadian ETFs, while Purpose Bitcoin alone, the largest Bitcoin spot ETF in Canada, reached CAD 1.2 billion AUM (as of 13 October 2021) (based on Coindesk data). The 21Shares bitcoin spot ETP listed on both the Swiss Exchange and several German exchanges has reached USD 0.5 bn in AUM, compared to about USD 215 million in AUM for the largest crypto-index ETF in the same markets (as of 13 October 2021).

[16] Examples include Amplify Transformational Data Sharing ETF (BLOK), First Trust Indxx Innovative Transaction & Process ETF (LEGR), Siren Nasdaq NexGen Economy ETF (BLCN) and more.

[17] Bitcoin futures were also made available in 2017 on the Chicago Board Options Exchange (CBOE).

[18] The fund does not hold physical Bitcoins.

[19] As of 5 October 2021.

[20] Examples of such exchange-traded products include WisdomTree, ETC Group and VanEck listed bitcoin and ethereum ETPs, 21Shares listed three crypto ETPs. The ETC Group, VanEck, and 21Shares have issued Bitcoin Exchange-Traded Notes (ETNs) on the Deutsche Börse. The BTCetc Bitcoin Exchange Traded Crypto (BTCE) tracks the price of Bitcoin and is traded on Deutsche Börse´s XETRA and on SIX Swiss Exchange. SIX has over 30 additional ETNs trading on its platform as of January 2021.

[21] Refers to assets held in funds known as Spezialfonds, which are only open to institutional investors and not to the general public.

[22] It should be noted, however, that banks' exposure to crypto-assets is currently limited.

[23] Stablecoins can also be underpinned by crypto assets (decentralised stablecoins such as DAI) and likewise, stablecoins can be purchased using crypto.

[24] To maintain a stable value relative to fiat currency, certain stablecoins are backed by reserve assets held by the issuer. However, stablecoin issuers generally do not adhere to any standards regarding the composition of stablecoin reserve assets, and the information made publicly available regarding the issuer's reserve assets is not consistent across stablecoin arrangements as to either its content or the frequency of its release.

[25] Coins that comply with the ERC-20 scripting standard used within the Ethereum blockchain.

[26] As opposed to crypto-collateralised stablecoins, such as Dai, which are backed by cryptoassets and are therefore less linked to the traditional financial system, although still aims to maintain a (soft) peg to the USD, trading at or around 1 USD on average.

[27] Metcalfe, the inventor of Ethernet, proposed that a network's value is proportional to the square of the number of nodes in the network. Metcalfe's law has been validated empirically in the case of social network activity (Zhang, Liu and Xu, 2015[71]).

[28] It should be noted that the PWG recommendations apply to stablecoins with the potential to be used as a means of payment and did not reflect recommendations regarding market regulation and investor protection arising due to the central use of stablecoins in trading, lending and borrowing activities through centralised trading platforms and DeFi.

[29] At the EU level, the DLT Pilot Regime in which there is already political agreement between co-legislators in the EU tries to exploit precisely those beneficial applications.