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Banking in the Shadow of Bitcoin? The Institutional Adoption of Cryptocurrencies

Abstract

The phenomenal growth of cryptocurrencies raises important questions about their footprint on the financial system. What role are traditional financial intermediaries playing in cryptocurrency markets and what drives their engagement? Are new nodes emerging? We help answer these questions by leveraging a novel global supervisory database of banks' cryptocurrency exposures and by synthesising a range of complementary data sources for other types of institutions. We find that major banks' exposures currently remain at very modest levels. Across countries, higher innovation capacity, more advanced economic development, and greater financial inclusion are associated with a higher likelihood of banks taking on cryptocurrency exposures. We show that substantial activity is concentrated in lightly regulated crypto exchanges. This "shadow crypto financial system" serves both retail and institutional clients, such as dedicated investment funds. An uneven regulatory treatment across banks and crypto exchanges and significant data gaps suggest that a proactive, holistic and forward-looking approach to regulating and overseeing cryptocurrency markets is needed. It should focus on ensuring a more level playing field with regard to financial services provided by established financial institutions and intermediaries in the emerging crypto shadow financial system by introducing more stringent regulatory and supervisory oversight for the latter.

JEL-Codes: E420, G120, G210, G230, G280, O330.

Keywords: cryptocurrencies, decentralised finance, digital currencies, financial regulation, financial supervision, exchange stablecoin, Bitcoin, Ethereum.

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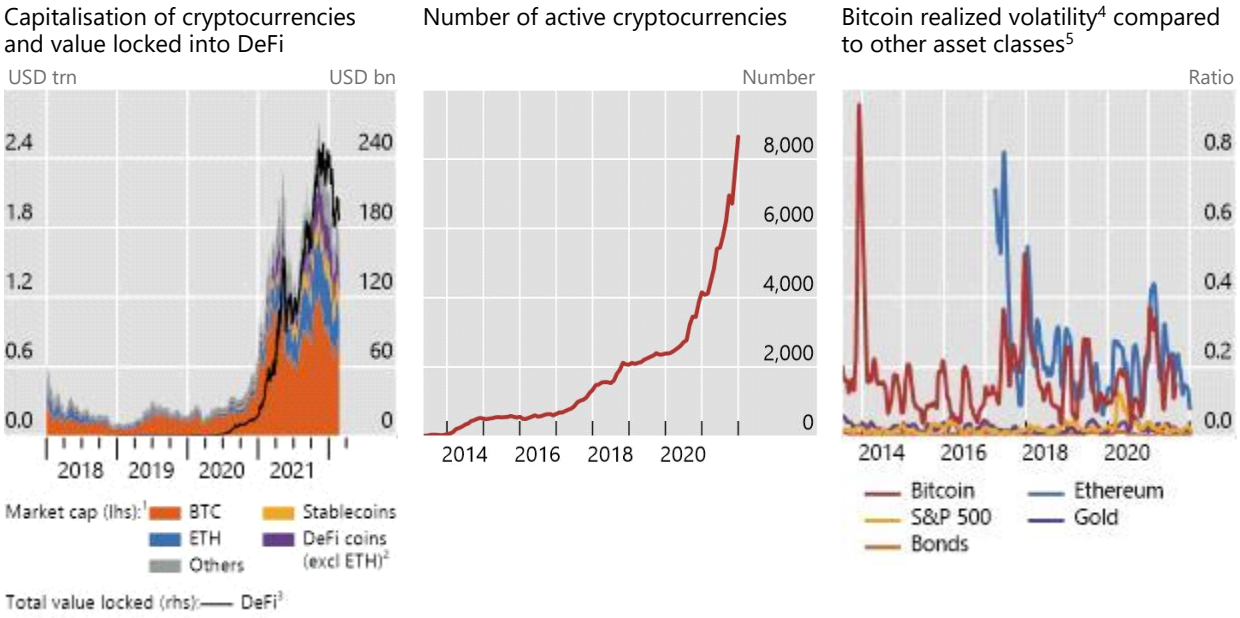
1. Introduction

The past decade has been characterised by phenomenal interest in cryptocurrencies and decentralised finance (DeFi) by the general public, businesses and financial market participants.[1] From their inception as a relatively niche and arcane financial and technological innovation, cryptocurrencies and novel DeFi products have started to play a growing role in the financial ecosystem. Investors in search for alternative investment opportunities in a low-yield environment have helped fuel record-high market valuation, notwithstanding the high market volatility (Graph 1), and have spurred the emergence of various crypto-related initiatives in recent years. Ample anecdotal evidence points to rising investment in cryptocurrencies and supporting technologies by non-financial corporations and new financial start-ups. Moreover, the emergence of exchange-traded funds (ETFs) for Bitcoin and related derivatives could pave the way for further investor engagement. Most recently, the war in Ukraine has further sparked interest in cryptocurrencies and raised questions about their regulatory oversight.[2]

Record capitalisations and growth in cryptocurrencies amid market volatility — Graph 1



[1] As of 22 February 2022. Categories comprise the largest eight stablecoins, 59 DeFi coins and 58 other cryptocurrencies. [2] See Auer (2022) for a list of included coins under this definition. [3] Total value locked refers to the size of capital pools underpinning DeFi protocols. The sample includes 679 protocols. [4] Ninety-day moving averages coefficient of variation, i.e. ratio between the ninety-day standard deviation and the corresponding ninety-day mean. [5] Bitcoin and Ethereum compared with gold, the S&P 500 index and the Bloomberg Barclays US Aggregate Bond Index (bonds).

Sources: R Auer (2022); Bloomberg; CoinDesk; CoinGecko; Coinmarketcap; authors' calculations.

[1] Auer (2022) defines a cryptocurrency as "a digital asset that can be traded on a blockchain or other distributed ledger that seeks to protect from sybil attacks using a permissionless economic mechanism such as proof-of-work or proof-of-stake." and DeFi as "decentralised financial engineering based on computer programs that are either self-executing or triggered by external transactions ("smart contracts") and deployed on top of distributed ledgers."

[2] For example, a Bitcoin ETF was launched in Canada in March 2021, while the US saw the first ETF for Bitcoin futures launched in October 2021 (eg Todorov (2021)). On the need for regulation of cryptocurrencies in the context of the war in Ukraine, see eg Chavez-dreyfuss (2022) and Singer (2022).

Against this backdrop, the public sector has started to consider possible implications for financial stability (eg Financial Stability Board (FSB) (2018, 2019)) and to evaluate the effectiveness of (Auer and Claessens (2018, 2020)) and need for regulatory adjustments, including with regards to prudential frameworks (eg Basel Committee on Banking Supervision (BCBS) (2019a, 2019b, 2021)).[3]

Increasing investor demand for cryptocurrencies also raises the question of how the resulting rise in demand for intermediary services will be met by financial institutions. Has the growth in cryptocurrency activity over the past years occurred primarily within traditional nodes of the financial system, such as banks? Or has the emergence of new nodes, most notably new exchanges, facilitated the boom in cryptocurrencies? We address these questions by looking into the evolution of cryptocurrency exposures at both types of nodes.

Considering these developments, this paper examines the footprint of cryptocurrencies in the financial system. It documents the institutional adoption of cryptocurrencies drawing on a wide range of data sources. Our stocktake reveals that the adoption of cryptocurrencies varies across market participants and differs notably from that of other major asset classes.

We find that banks' direct exposures to cryptocurrencies have remained limited thus far, notwithstanding that some banks are considering a more active role in providing cryptocurrency-related services in the future (Bloomberg (2021)). Based on the most recently available (ie end-2020) global supervisory data, only a handful of internationally active banks reported having any cryptocurrency exposures, with the average exposure amounting to less than 0.02% of their risk-weighted assets (RWAs) and no bank reporting exposures greater than 0.05% of RWAs. We also find that such exposures are primarily in response to growing client interest: the bulk of banks' exposures relate to trading on client accounts, followed by those due to the clearing of futures.

We show that the flipside of limited adoption by banks is a dominant role for novel "crypto exchanges".[4] They provide platforms on which participants can trade and store cryptocurrencies and remain largely unregulated to date, essentially forming a "shadow crypto financial system".[5] Compared to existing regulated exchanges for "traditional" financial assets, the regulatory and supervisory oversight of crypto exchanges – encompassing consumer protection, market integrity, trading, disclosure, prudential and addressing anti-money laundering (AML), combatting the financing of terrorism (CFT) – remains patchy at best.[6] Moreover, these new crypto exchanges offer very different products from existing regulated exchanges and have mushroomed over the past years, supported by strong customer demand. Indeed, Bitcoins held in custody have risen threefold over the past five years. While trading activity remains concentrated in a few exchanges, both in terms of Bitcoin holdings and trading volume – for example, Coinbase accounts for around one third of Bitcoin holdings – new competitors continue to gain market share. The business of crypto exchanges has been shifting towards institutional customers, as asset managers have also started to embrace cryptocurrencies. A rising number of crypto investment funds has begun to provide institutional investors and retail investors a gateway to obtain exposure to cryptocurrencies. Assets under management have thus grown significantly since 2020, albeit starting from low levels.

[3] See Borio et al (2020) for a primer on Basel III prudential framework.

[4] FATF (2014) defines crypto exchanges as "*an exchanger (also sometimes called a virtual currency exchange) is a person or entity engaged as a business in the exchange of virtual currency for real currency, funds, or other forms of virtual currency and also precious metals, and vice versa, for a fee (commission). Exchanges generally accept a wide range of payments, including cash, wires, credit cards, and other virtual currencies, and can be administrator-affiliated, non-affiliated, or a third party provider.*"

[5] For example, Cong et al (2021) find that, on average, 70% of the reported volumes on unregulated crypto exchanges is due to "wash trading", with investors simultaneously selling and buying the same financial cryptocurrencies to inflate volumes.

[6] Mosioma and Walker (2021) find that, of the 16 leading cryptocurrency platforms, just four are subject to a "significant" level of trading regulation.

We next investigate the cross-country drivers of bank's cryptocurrency adoption. We evaluate a broad range of potential drivers based on a formal regression setup. We find that banks domiciled in economies characterised by higher innovation capacity and more advanced financial development have been more likely to engage in cryptocurrency-related customer business than their peers. Unsurprisingly, these factors have also contributed to supporting the activity of crypto exchanges, indicative of a self-reinforcing adoption of cryptocurrencies across different types of institutional investors.

These findings can shed light on the evolving role of cryptocurrencies and their interactions with the mainstream financial system. The creation of Bitcoin, and related cryptocurrencies, was initially motivated by the desire to establish a substitute for fiat money and commercial banking, with the vision to create a new form of decentral exchange that is resistant to debasement and censorship by established institutions.[7] Consequently, a number of central bank officials have argued that the rise of cryptocurrencies and decentralised finance raises fundamental questions about the nature of trust and money in the digital area.[8]

Our findings, however, suggest that the footprint of the current generation of cryptocurrencies does not mark a sharp departure from the existing financial ecosystem. Instead of relying on a trust-free – ie on-chain – environment, a new set of agents has come to the fore that is offering convenience, market access, transaction scale and liquidity to these markets in much the same manner as in commercial banking and securities trading, albeit without the same degree of regulatory and supervisory oversight. This underscores the "decentralisation illusion" argument of Aramonte et al (2021) – the basic economic forces underlying blockchain-based financial applications make some centralisation of power inevitable. It also tallies with the survey results of Auer and Tercero-Lucas (2021), who document that cryptocurrency retail investors do not distrust fiat money or commercial banks. Instead, investors increasingly add cryptocurrencies to their portfolio to diversify risks and boost performance.[9]

Our analysis has three policy implications. First, a new set of market participants, consisting of crypto exchanges and ancillary entities (eg wallet providers), has arisen that deserves closer regulatory and supervisory scrutiny. These new intermediaries not only serve retail clients, but also other institutions, such as hedge funds and investment funds. The exponential growth of this industry requires a proactive, cross-sectoral and forward-looking approach to regulating and overseeing an emerging crypto financial system. Cryptocurrency intermediaries, including crypto exchanges, should be subject to the same types of regulation and oversight as intermediaries in economically equivalent asset classes, including with regards to financial stability, consumer and investor protection, and standards to AML, including know-your-customer requirements, and CFT. The purportedly decentralised nature of cryptocurrencies does not negate the need for these critical public policy functions. A related question is how regulation could leverage on cryptocurrency technology, including novel approaches to enforce AML/CFT and consumer protection standards without imposing large overhead costs. One option for such a framework is "embedded supervision", developed in Auer (2022), which harnesses information in distributed ledgers and decentralised finance to increase the quality of data available to supervisors and to reduce administrative costs for firms.

Second, and most pressing, is the need to address growing data gaps in the industry. While market activity has started from a relatively low base, the growth and trends over the past years underline the potential for cryptocurrencies and other forms of digital money (eg global stablecoins) to scale up

[7] Nakamoto (2008) argued for a system that allows "*two willing parties to transact directly with each other without the need for a trusted third party*", while Buterin (2013) considers "non-discrimination and non-censorship" a key principle behind Ethereum's design. Auer (2019) examines the economics of these systems, documenting their limits.

[8] See for example, Brainard (2018), Carstens (2018a, 2018b, 2019, 2021a and 2021b), Borio (2019), Frost et al (2020) and BIS (2021). The rise of cryptocurrencies has also sparked research on central bank digital currencies (eg Auer et al (2020) and Bank of Canada et al (2020)).

[9] See, for example, Liu and Tsyvinski (2021), Corbet et al (2018) and Bouri et al (2017).

quickly and become widely used. Yet data gaps risk undermining the ability of authorities to oversee and regulate cryptocurrencies holistically. While some of these blind spots reflect the global nature of cryptocurrencies, there is scope to enhance the systematic collection and publication of cryptocurrency data in a more rigorous and robust manner.

Third, the potential for many interlinkages between novel cryptocurrency intermediaries and the mainstream financial system requires a comprehensive approach to assessing and mitigating risks. Growing demand for cryptocurrencies could increasingly see traditional nodes of the financial system – such as banks and institutional investors – relying directly and indirectly on new nodes of the cryptocurrency ecosystem, such as crypto exchanges. A recurring lesson from the history of financial crisis is that risks in the "shadow" corners of the financial system can quickly find their way to established and regulated institutions.[10]

Left unaddressed, this evolving landscape would see conventional and regulated intermediaries relying on a crypto "shadow" financial system. While cryptocurrencies have originated from outside the traditional financial system, risks from cryptocurrencies could easily transfer to banks and other established financial institutions. Indeed, banks and asset managers could potentially be exposed to cryptocurrencies through a number of direct and indirect channels over the coming years.

As such, the fundamental policy choice is to either focus on a framework that allows such interlinkages but adamantly enforces a more level playing field with regard to the regulation and supervision of financial services. Alternatively, policy could treat cryptocurrencies as a self-contained system that can develop in parallel with the mainstream financial system but does not interlink with it. Developments to date, including the gradual, but increasing, prevalence of established financial institutions in cryptocurrency activity, suggests that separating both systems could prove challenging at a global level, making the former solution inevitable. Initiatives to promote regulatory clarity on the treatment of these potential exposures, such as ongoing efforts by the BCBS (BCBS (2021)), could help to ensure a more level playing field and ensure the prudent management of risks from a microprudential and macroprudential perspective. In practice, this would mean applying more stringent regulatory and supervisory oversight of crypto exchanges with regard to the provision of financial services (eg intraday credit, margin financing, provision of custody services), while applying a conservative bank prudential regulatory treatment for cryptocurrency exposures.

These considerations closely relate to a growing number of studies on the regulation of cryptocurrencies and stablecoins. On the regulation of this industry, FSB (2018) investigate the financial stability implications of cryptocurrencies. Several studies show how news pertaining to imminent regulation and adoption by enterprises strongly affect the valuations of cryptocurrencies.[11] Dniprov et al (2021) examine the legal status of cryptocurrencies, while Stolbov et al (2020) present an empirical analysis of the associated drivers. Borri and Shakhnov (2020) examine cross-country spillovers of regulation, while Jagtiani et al (2021) discuss potential avenues for the regulation of this industry and consider the implications for investors. FSB (2020) and Arner et al (2020) examine market developments and regulation of stablecoins.

We structure the rest of this paper as follows. Section 2 provides an overview of trends in cryptocurrency markets and then zooms in on banks and crypto exchanges. In Section 3, we assess potential drivers of institutional adoption. We conclude with a discussion of policy implications in Section 4.

[10] See, for example, Calomiris (2010).

[11] See, for example, Auer and Claessens (2018, 2020), Bhambhwani et al (2019), Biais et al (2021), Chokor and Alfieri (2020), Feinstein and Werbach (2021), Lyócsa et al (2020) and Shanaev (2020).

2. Taking stock of institutional adoption

Cryptocurrency markets are evolving rapidly. While the first decentralised cryptocurrency – Bitcoin – was created in 2009, investor interest in cryptocurrencies did not pick up significantly before early 2017. Since then, the market capitalisation of the more than 8,000 cryptocurrencies has grown to almost US$ 3 trillion in November 2021 before retracting again (Graph 1, left-hand panel).

The journey has been bumpy. The end of 2017 saw the first surge in the market capitalisation of Bitcoin, before valuations declined again over the course of the following year. Bitcoin staged its most notable surge to date starting in late-2020 when its dollar price increased sixfold within five months. Indeed, high volatility relative to other asset classes has been a salient feature of cryptocurrency markets (Graph 1, right-hand panel). Furthermore, valuations remain sensitive to news – and noise – such as social media statements of high-profile investors.[12]

The 2017 surge in the price of Bitcoin has been a catalyst for the broader cryptocurrency market. Since then, several thousand new cryptocurrencies have been created (Graph 1, centre panel). Even so, the market remains highly concentrated and exit rates are high. At the beginning of 2022, Bitcoin accounted for 41% of total market capitalisation, roughly 2.1 times the share of Ethereum, the next largest cryptocurrency. About 2,000 cryptocurrencies are deemed to be "dead coins".[13]

Several motives could be supporting institutional investors' interest in cryptocurrencies. One is the search for yield in an environment of low(er) returns on traditional assets. Another one is portfolio diversification strategies. Yet another could be the search for an alternative store of value or "digital gold", potentially including inflation hedging considerations.[14] Strategic investments in an asset that could serve as a reserve currency for the broader crypto ecosystem and exploration of the technological capabilities that new applications promise could also play a role. By contrast, distrust in sovereign currency or regulated financial institutions, a theme carrying the early era of Bitcoin, has not been found to be a driver of cryptocurrency investment (Auer and Tercero-Lucas (2021)).

Growing interest in cryptocurrencies over the past years has only recently led to a notable increase in institutional investors' demand as several obstacles have (reportedly) been overcome. Indeed, contrary to other asset classes where institutional investors have paved the way for speculators, trading in cryptocurrencies has long been dominated by speculation and individual investors.

Several criteria need to be met for institutional investors, such as hedge funds and other fiduciaries, to be able to invest (eg Laby (2018). This includes certainty about the valuation of the asset, which relies on accounting firms' ability and willingness to audit and approve valuations.[15] In addition, investors require custody service providers that ensure safe storage and settlement. Furthermore, institutional investors rely on the ability to transact in size and provide evidence of "best execution", which calls for sufficient liquidity of the assets as well as robust market infrastructures and comprehensive trade documentation. Finally, investors need to take account of reputational and legal risks that may be associated with investing in particular assets. Investment thus requires sufficient disclosures by counterparties as well as legal and regulatory certainty. The recent wave of entry into cryptocurrency

[12] Tweets by individuals still have a marked impact on the valuation of cryptocurrencies. BBC (2021b) and CNBC (2021) discuss the specific impact of Tweets by Elon Musk on the valuation of individual cryptocurrencies.

[13] As estimated by Coinopsy, which defines *dead coins* as "*cryptocurrencies that have been abandoned, are used as scam, whose website is down, have no nodes, have wallet issues, do not have social updates, have low volume or whose developers have walked away from the project*."

[14] Empirically, however, this relation is not well established, see eg Choi and Shin (2021) and Blau et al (2021).

[15] These conditions must be met so that the investment falls within the scope of the hedge funds' or fiduciary's investment mandate, as otherwise a purchase of cryptocurrencies may result in substantial litigation risk (see Sandler (2010) for a general discussion of litigation risks in the financial service industry).

markets suggests that an increasing number of institutional investors see these criteria as being met by at least some cryptocurrencies and their underlying infrastructures.

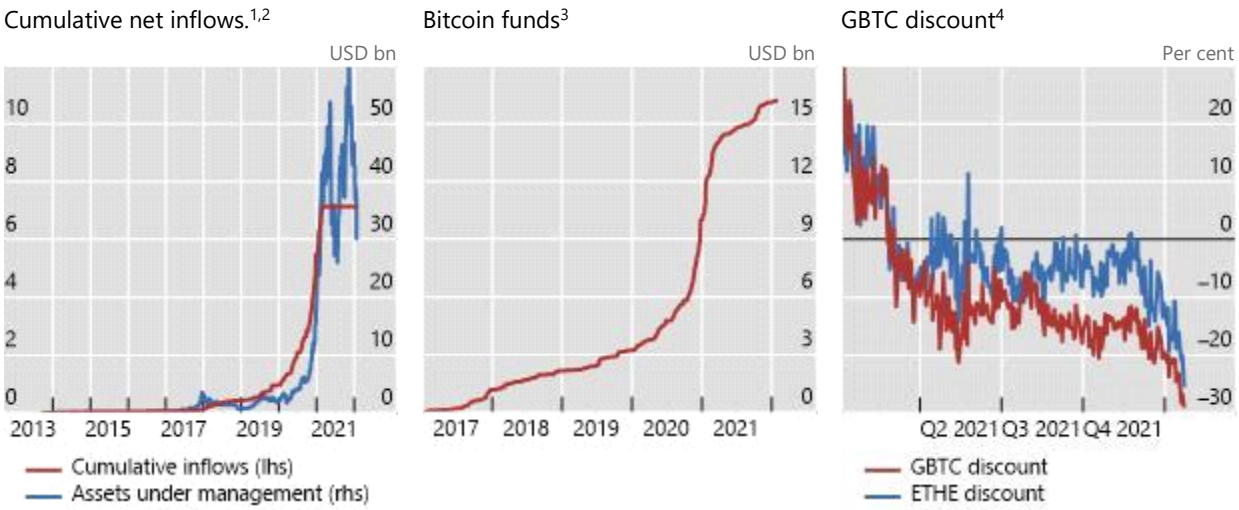
Several considerations suggest that institutional investors are likely to invest via financial intermediaries rather than opting to hold cryptocurrencies directly. One factor is operational complexity and safety. Just like gold, which is generally not stored in a company's own vault, direct holdings of cryptocurrencies (eg in electronic wallets) require that investors build up the appropriate infrastructure and expertise. For investors that seek to invest only a limited fraction of their funds in cryptocurrencies, outsourcing these activities to custodians is likely to be far more cost efficient.

Accounting rules can be another factor. Under US GAAP, for example, Bitcoin is categorised as an intangible asset (ie similar to intellectual property). As a result, unrealised gains due to an increase in the price of Bitcoin cannot be accounted for on the investor's balance sheet. This contrasts with unrealised gains on shares of investment funds that invest in cryptocurrencies. Relative to direct holdings, investment via funds also allows investors to rely on their established infrastructures that are subject to broader regulatory and supervisory oversight.

Investment funds have thus evolved into a gateway for investors to obtain cryptocurrency exposure. Flows into closed-end funds focussing on cryptocurrencies have grown quickly since 2020, closely mimicking the rise in market valuations (Graph 2). However, at around $30 billion and $16.2 billion, assets under management of investment funds dedicated to cryptocurrencies or Bitcoin, respectively, continue to represent only a small fraction of the roughly $69 trillion managed by regulated funds globally at mid-2021 (Investment Company Institute (2021)).

Investment funds providing a gateway to institutional adoption

Graph 2



[1] Based on the following cryptocurrency funds managed by Grayscale: Basic Attention Token Trust; Bitcoin Trust; Bitcoin Cash Trust; Chainlink Trust; Decentraland Trust; Ethereum Trust; Ethereum Classic Trust; Filecoin Trust; Horizen Trust; Litecoin Trust; Livepeer Trust; Stellar Lumens Trust; Zcash Trust; and Digital Large Cap Fund. [2] Sum of net inflows across all funds in the sample. Flows are estimated based on the following approximation using daily (t) assets under management (AUM) and fund returns (R): $AUM_t - (AUM_{t-1} * R_t)$. [3] Based on the following funds: GBTC US Equity, Grayscale Bitcoin trust BTC; QBTC CN Equity, Bitcoin fund/the; BTCG/U CN Equity, CI galaxy Bitcoin fund; COINXBE SS Equity, Bitcoin tracker one EUR; COINXBT SS Equity, Bitcoin tracker one – SEK; BTCE GR Equity, BTCETC Bitcoin ETP; BTCW SW Equity, Wisdomtree Bitcoin; ABTC SW Equity, 21shares Bitcoin single; BTCC/B CN Equity, Purpose Bitcoin ETF; VBTC GR Equity, Vaneck vectors Bitcoin ETN; ABBA SW Equity, 21shares Bitcoin Suisse ETP. [4] The Grayscale Bitcoin Trust (GBTC) discount (or premium) is equal to the difference between the market valuation of GBTC and the spot market valuation of its Bitcoins under management, expressed as a percentage share of the latter. The Grayscale Ethereum Trust (ETHE) discount premium is calculated accordingly.

Sources: Bloomberg; YCharts; authors' calculations.

Looking ahead, ETFs of cryptocurrencies or related derivatives could attract an increasing share of the market. Flows into closed-end funds that invest in cryptocurrencies receded in 2021, while funds

exhibited a move from premiums to steep discounts on their net asset value (Graph 2, right-hand panel). This about-turn has been associated with institutional investors redirecting their funds to newly introduced ETFs with lower expense ratios and more active secondary markets.

Limited cryptocurrency exposure of banks

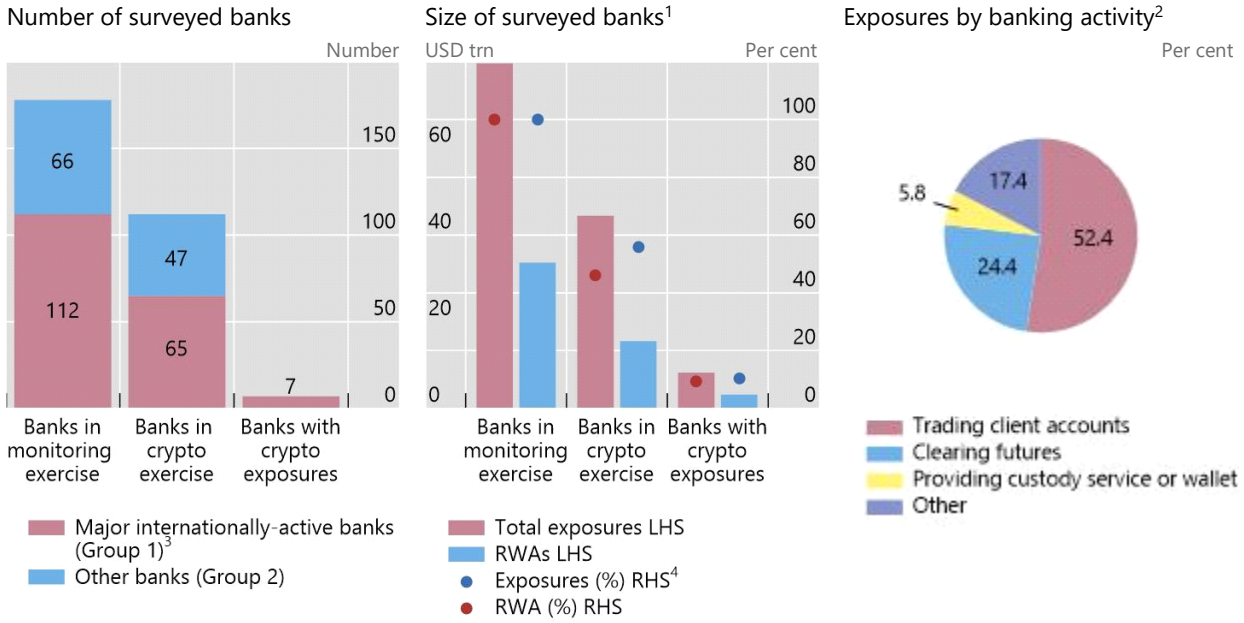
Banks reside at the core of the financial system and thus provide a natural starting point for the assessment of the institutional adoption of cryptocurrencies. Exposure to the cryptocurrency ecosystem could arise from a multitude of direct and indirect interlinkages. These include activities such as direct issuance and ownership of cryptocurrencies, intermediation services for customers who seek exposure to this asset class, clearing of contracts that reference cryptocurrencies, or services for cryptocurrency issuers such as underwriting initial coin offerings (BCBS (2019b)).

We shed light on the materiality of major banks' exposures to cryptocurrencies by leveraging on a novel supervisory dataset by the BCBS. The BCBS collects half-yearly granular balance sheet and regulatory data for roughly 200 internationally active banks as part of its framework to monitor the impact of the Basel III framework. From 2018, the BCBS has included data on banks' cryptocurrency exposures as part of this monitoring framework. This paper is the first to use this dataset. Given the confidentiality arrangements related to the dataset, all results are presented in an aggregated and anonymised manner in this paper.

The BCBS dataset has a broad geographic and institutional coverage. Banks from 26 BCBS member jurisdictions participate in the data collection exercises, resulting in a sample of 178 banks as of Q4 2020 (see Graph 3, left-hand panel). The sample consists of two different categories. The first one

Bank holdings of cryptocurrency

As of Q4 2020 Graph 3



[1] The total amount of reported cryptocurrency exposures was $188 million at end-2020. [2] The residual category ("other") comprises a broad range of banking activities that could result in cryptocurrency exposures, including eg proprietary trading, securities financing transactions, the underwriting of initial coin offerings, or use of cryptocurrency for intra- or inter-bank operational purposes. [3] Group 1 banks have Tier 1-capital of more than €3 billion and are internationally active. [4] The blue and red dots depict the exposure and RWA amounts, respectively, of the group of banks as a percentage of the total of banks participating in the monitoring exercise.

Source: Basel Committee on Banking Supervision; authors' calculations.

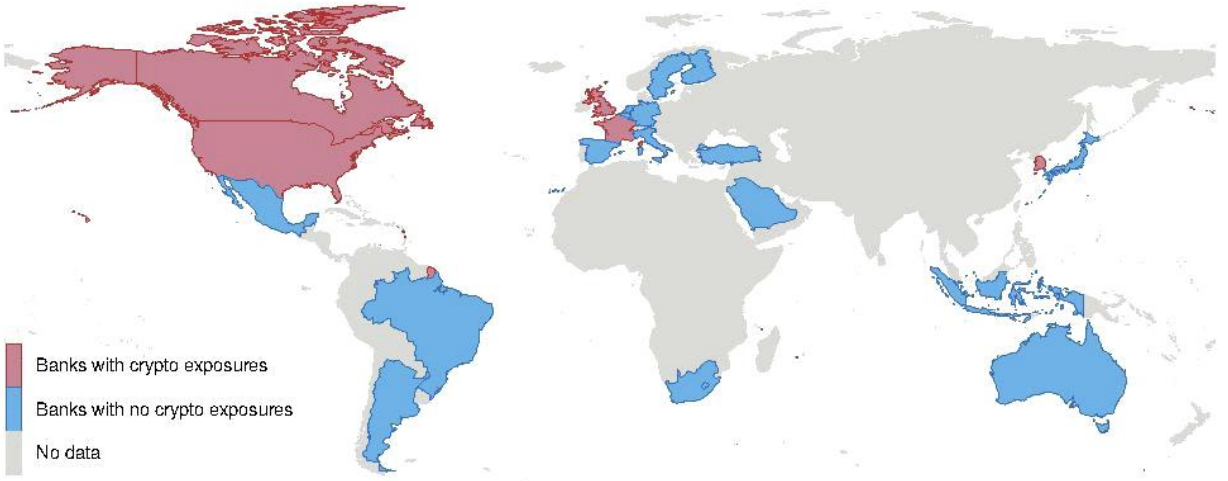
comprises 112 "Group 1" banks, of which 27 are global systemically important banks. These banks are defined by having Tier 1 capital of more than €3 billion. The second sample comprises 66 other "Group 2" banks. Not all of these banks participate in the crypto-specific data collection exercise. The left-hand and centre panels of Graph 3 document the respective sample sizes and compare selected balance sheet characteristics of the respective bank samples.

The data suggests that cryptocurrency exposures of large internationally active banks were immaterial as of end-2020. The amount of reported cryptocurrency exposures totalled merely $188 million.[16] Only 7 out of 178 banks participating in the BCBS data collection reported having any cryptocurrency exposures.

Zooming in closer, we observe that banks' exposures result from a broad range of activities that are primarily client-led (Graph 3, right-hand panel). This includes exposures related to trading on clients account (52.4%), followed by the clearing of futures referencing cryptocurrencies (24.4%). Interestingly, and notwithstanding potential data quality caveats, at the end of 2020 banks did not report having outright cryptocurrency holdings (whether as long-term investments or as proprietary trading), or cryptocurrencies for the purpose of intra- or inter-bank operational purposes (despite public announcements that would suggest otherwise).[17]

A notable omission in the data submitted by banks is any exposures related to custody services. In principle, banks would appear well positioned to leverage on existing infrastructure and governance structures in order to establish a robust custodial network to facilitate trading in cryptocurrencies.[18]

Banks with cryptocurrencies appear to be limited to a few jurisdictions[1] Graph 4



The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

[1] Countries where banks reported having cryptocurrency exposures (red) or having no or only minimal exposures (blue) for the combined end-2018, end-2019 and end-2020 collection periods. Banks in BCBS jurisdictions that did not participate in the data-collection exercise on cryptocurrencies and non-BCBS jurisdictions are highlighted in grey.

Source: Basel Committee on Banking Supervision; authors' calculations.

[16] The reported exposures do not include banks' equity investments in crypto-related companies. Wouters (2021), for example, estimates that these investments totalled about $2.5 billion at August 2020 for the ten banks with the largest investments in these companies.

[17] For example, see Ledger Insights (2019, 2020).

[18] Indeed, some jurisdictions have explicitly permitted banks to provide cryptocurrency custody services (eg OCC (2020)).

Across regions, the banks reporting crypto exposures were headquartered in Canada, France, South Korea, the United Kingdom, and the United States (Graph 4). Their exposure to cryptocurrencies amounted, on average, to less than 0.02% of the banks' total risk-weighted assets, with the maximum exposure at about 0.05%.

Crypto exchanges as key nodes in the ecosystem

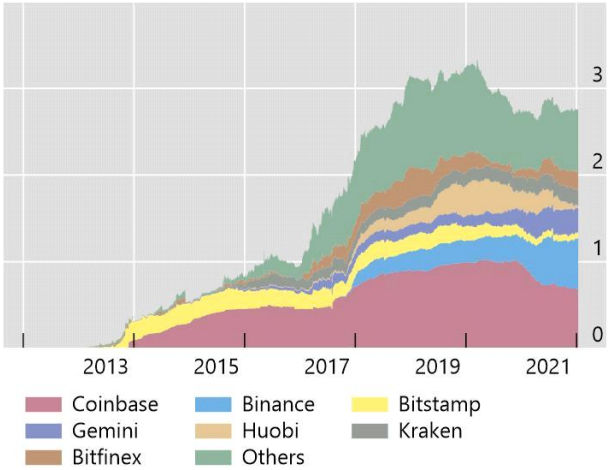
In contrast to the limited involvement of banks to date, exchanges play a dominant role in cryptocurrency markets. They have emerged as the key nodes of the cryptocurrency ecosystem, typically benefitting from light regulation and providing an increasing number of services to customers. Many exchanges are headquartered in offshore financial centres.

Exchanges' holdings of cryptocurrency provide a gauge of their expanding market footprint. Since 2017, for example, the total number of Bitcoins held in custody by exchanges has tripled, accounting for 2.74 million Bitcoin, some 14.5% of total issuance (Graph 5, left-hand side).

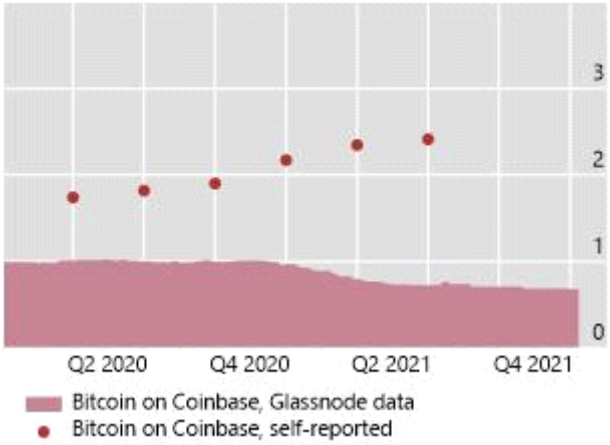
Volume of Bitcoins held at exchanges

In millions of Bitcoins — Graph 5

Total number of coins held in custody by main exchanges[1]



Reported total number of Bitcoin held by Coinbase



[1] Others consist of: Gemini, Bitmex, Bittrex, Poloniex, Hitbtc, Bithumb, Coincheck, Gate.io, Luno and Kucoin. [2] Self-reported Coinbase data is from Coinbase's first and second quarter 2021 shareholder letters.

Source: Glassnode.com; investor.coinbase.com; authors' calculations.

A caveat arises from limited disclosure requirements, which lead to considerable data gaps. In difference to other financial institutions, which are required to submit detailed data to supervisors, crypto exchanges do not report their holdings in a consistent manner. And while open ledger blockchains provide a complete history of all transactions and the amount of cryptocurrencies held by each individual wallet address, the ownership of these wallets is typically not disclosed. Data providers, such as *glassnode*, need to infer the holdings based on monitoring on-ledger flows of cryptocurrencies and by linking these flows to the wallet addresses that are likely to be owned by crypto exchanges. In addition to addresses for which ownership has been verified by the crypto exchanges, data providers apply clustering algorithms to back out potential ownership by exchanges. The inferred holdings can thus deviate – sometimes considerably

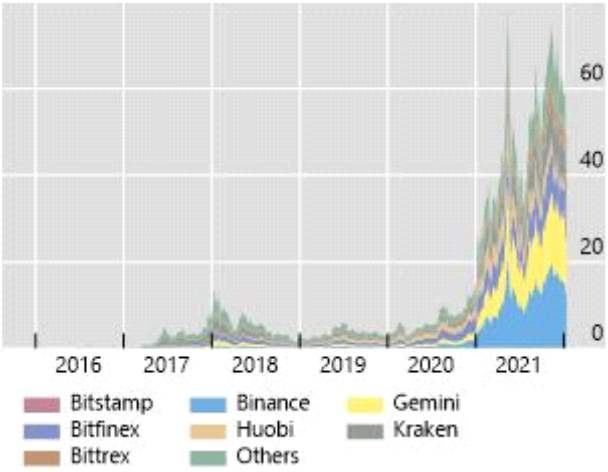
– from those disclosed by some of the crypto exchanges (Graph 5, right-hand panel).[19] Moreover, we note that country turnover data paints a different picture than what would be expected from the regulatory stance on cryptocurrencies in some jurisdictions as we discuss in the next section.

Holdings of other cryptocurrencies by exchanges, including Ethereum and so-called stablecoins, have also increased significantly over the past few years (Graph 6, left and right-hand panel), although at much lower level to Bitcoin.[20] Moreover, the proliferation of cryptocurrencies has gone hand in hand with the establishment of new crypto exchanges, challenging the position of incumbents. While new competitors continue to gain market share, trading activity remains concentrated in a few exchanges. Coinbase – the largest Bitcoin exchange by market share – accounts for roughly one third of Bitcoin holdings. Concentration is also visible in the geographic footprint of crypto exchanges. Exchange activity, as gauged from aggregate turnover, occurs primarily in China, North America, the UK and Russia (Graph 7).

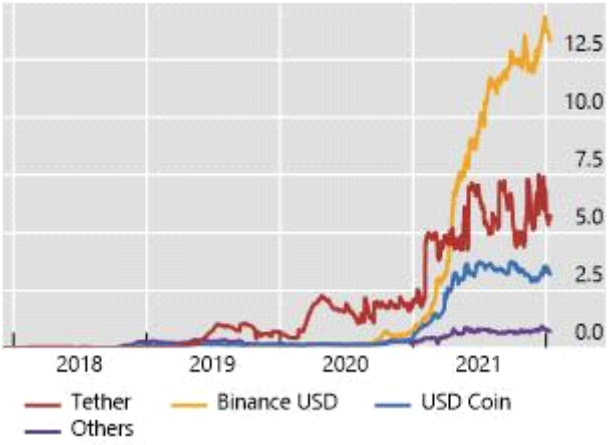
Volume of other cryptocurrencies held at exchanges

In billions of US dollars — Graph 6

Total amount of Ethereum held in custody by major exchanges[1]



Stablecoin holdings[2]



[1] Others consist of: Bitmex, Poloniex, Hitbtc, Bithumb, Coincheck, Gate.io, Luno and Kucoin. [2] Other stablecoins are: Gemini dollar, HUSD, Multi collateral (DAI), Paxos standard, Stasis EURS token, Single collateral DAI (SAI), Synth USD.

Source: Glassnode.com; authors' calculations.

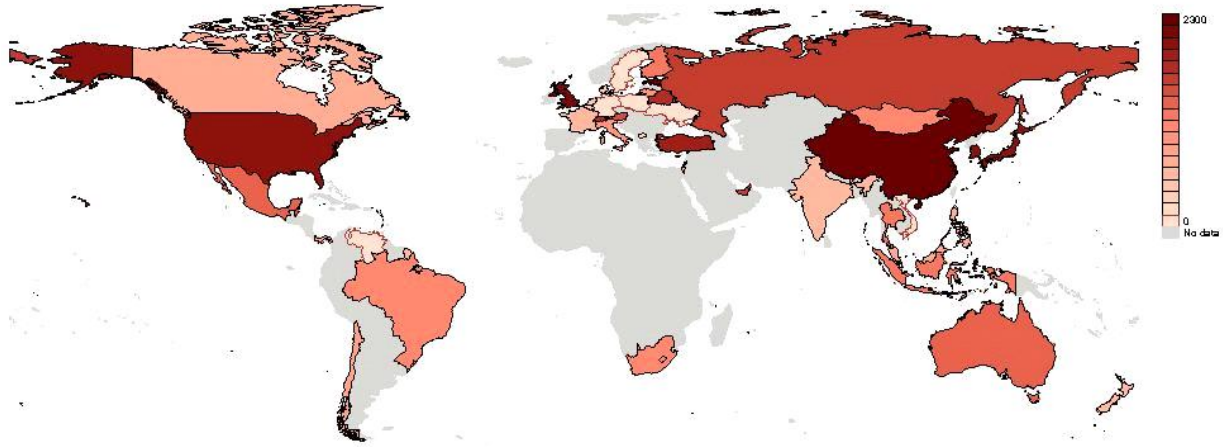
Institutional investors, such as hedge funds and other asset managers, are becoming an increasingly important source of revenue for crypto exchanges. These investors account for a rising share of trading volume and assets under management (Graph 8). One implication of this trend are adjustments to the services provided by crypto exchanges. Margin financing, which some crypto exchanges offer to fund the execution of investors trades, is likely to gain in importance. Another implication is rising expectations regarding the creditworthiness of crypto exchanges, given their growing importance as counterparties. This could require crypto exchanges to strengthen their liquidity positions and loss-absorbing capacity, thereby spurring consolidation among the industry – a trend observed among exchanges of more traditional assets as well.

[19] This process is noisy as the Bitcoin addresses and exchange owners are not universally known. This is why, for example, data on some of the major crypto exchanges such as FTX and Crypto.com are not included in Graphs 5 and 6, respectively. See https://insights.glassnode.com/exchange-metrics/ for a detailed description on the methodology and its drawbacks.

[20] Nevertheless, turnover of stablecoins dwarfs that of all other cryptocurrencies (see Aramonte et al (2021)).

Activity of crypto exchanges

Aggregate country turnover, in billions of US dollars — Graph 7



The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

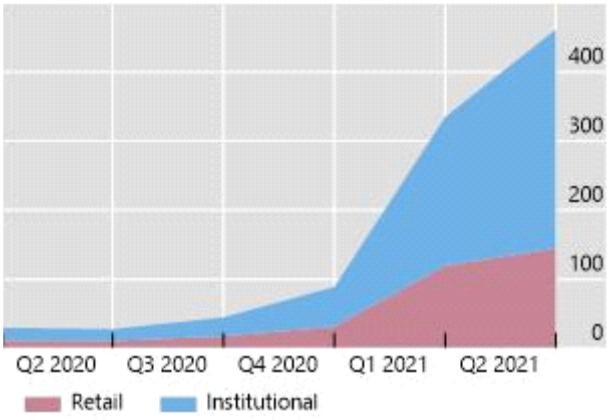
Based on the data from 1 January 2020–31 December 2020. For all non-decentralized exchanges available on cryptocompare.com the volume data is aggregated per country over the relevant 1-year time interval, divided by the IMF's country GDP data, and adjusting the relevant FX using the data from Datastream.

Sources: CryptoCompare.com; Datastream; IMF; authors' calculations.

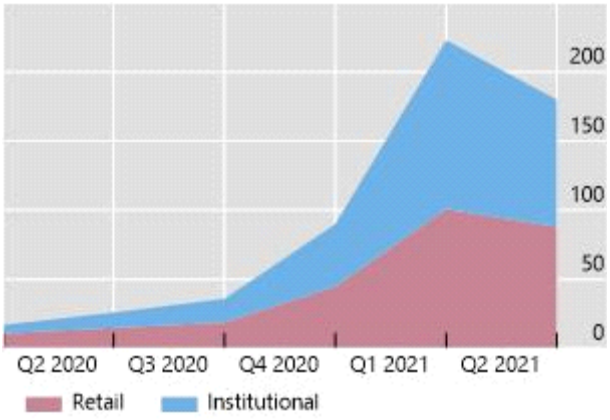
Crypto exchanges are also serving institutional clients

In billions of US dollars — Graph 8

Trading volume



Value of assets under management



Source: Coinbase 2021 quarterly reports for Q1 and Q2; authors' calculations.

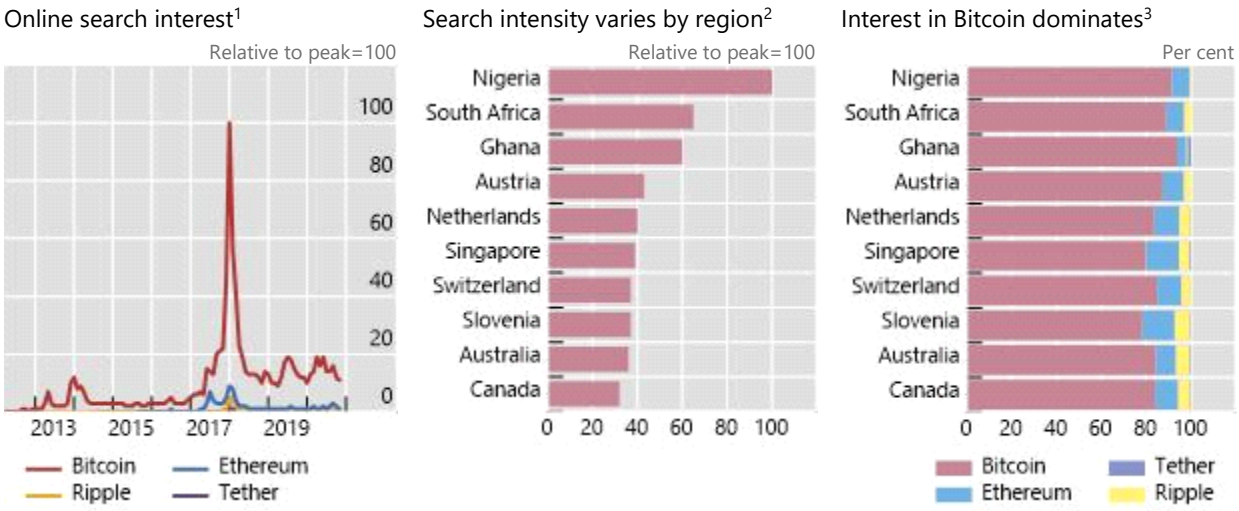
3. The cross-country drivers of institutional adoption

Cross-country differences in cryptocurrency interest and trading

Investor interest mirrors Bitcoin's present market dominance. Interest in cryptocurrencies by retail investors – as gauged from online search activity – closely parallels the market trends outlined above. For instance, search activity related to Bitcoin peaked towards the end of 2017 (Graph 9, left-hand panel). Moreover, Bitcoin-related searches continue to dominate those related to other major cryptocurrencies (centre panel) and continue to span a broad range of regions, with high intensity observed in several sub-Saharan African countries as well as in a number of advanced economies (right-hand panel).

The geography of cryptocurrency trading has been subject to significant change, also due to evolving legislation. The cross-currency composition of cryptocurrencies – ie the currencies used to buy and sell cryptocurrencies – reveals a major structural break (Graph 10). Specifically, the Renminbi accounted for the vast majority of Bitcoin transactions during the first half of the past decade. However, following a series of regulatory restrictions implemented by Chinese authorities in early 2017 (see Auer and Claessens (2018, 2020)), the share of Renminbi-based transactions fell dramatically.[21] As a result, the US dollar, followed by the Japanese yen, has taken over the majority of cross-currency Bitcoin transactions since 2018.

Online search interest across time, regions, and cryptocurrencies — Graph 9



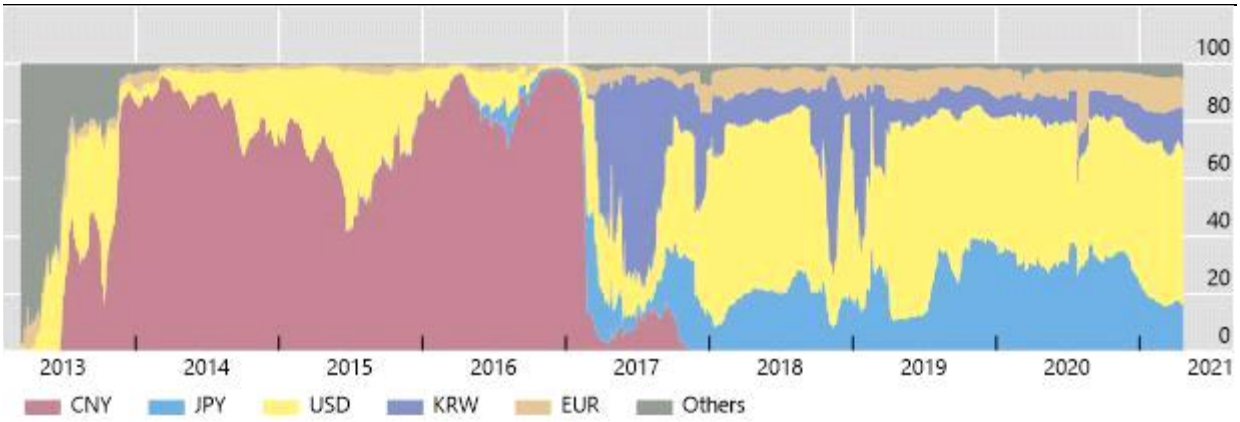
[1] Online search interest for Bitcoin, Ethereum, Ripple and Tether in relative terms and normalised to maximum value of 100. [2] Top ten countries ranked according to online search interest, in relative terms and normalised to 100. [3] Percentage shares for each of the top ten countries by search interest.

Source: Trends.google.com; authors' calculations.

[21] In addition to compositional effects, regulatory measures can also have a strong impact on prices. In early 2021, for instance, cryptocurrency prices fell sharply after Chinese authorities largely banned cryptocurrency "mining" activity, shutting down a substantial share of the crypto ecosystem's mining capacity (eg BBC (2021a)).

Cross-currency composition

In per cent Graph 10



The graph shows 10-day moving average percentage shares of Bitcoin trading volume for each of the largest trading currencies, ranked by their trading volume. The trading volume for each currency is the sum of the Bitcoin-to-currency volume and the currency-to-Bitcoin volume. Others includes AUD, CHF, CAD, GBP, HKD, ILS, INR, PHP, SGD.

Source: CryptoCompare.com; authors' calculations.

Regression analysis

We next conduct a more formal regression analysis to assess potential cross-sectional drivers of cryptocurrency adoption. We start by looking into the factors that determine reporting banks' propensity to take on cryptocurrency exposures. Specifically, we estimate an ordered probit regression of the share of reporting banks from a given country. Given the limited number of reporting banks, we consider a parsimonious specification, where we test sequentially the impact of potential drivers in a univariate setup.

We consider a broad range of potential drivers of banks' adoption of cryptocurrencies as presented in Table 1. These cover regulatory factors, such as the jurisdiction's stance on cryptocurrency trading. We also test the impact of Bitcoin search intensity, recalling the trends presented in Graph 9, as a gauge of general investor interest in cryptocurrencies. Furthermore, we look into proxies of the digital infrastructure (mobile and broadband subscriptions) and of a jurisdiction's innovation capacity. Industrial characteristics, the degree of financial developments and measures of cross-border transactions complete our selection of potential drivers.

Several drivers facilitate the involvement in cryptocurrencies by reporting banks (Table 2, upper part). We find that active public sector engagement in central bank digital currency projects, indicators of higher innovation capacity and more advanced economic development and greater financial inclusion are strongly associated with a higher likelihood of banks taking on cryptocurrency exposures. This is consistent with banks' exposures being strongly related to institutional client business, including clearing activities, as suggested by the survey responses (see Section 2).

A more restrictive approach to crypto regulation lowers banks' involvement, although the limited number of observations constrains our ability to establish statistical significance. Furthermore, indicators associated with a greater share of the informal economy and higher remittances reduce the likelihood of banks' having exposure to cryptocurrencies, suggesting limited bank involvement in crypto-related cross-border retail payments in developing countries thus far.[22]

[22] Other regression specifications, such as binary logit and OLS regressions, lead to qualitatively similar results.

Summary statistics

Table 1

Dependent variables	Obs	Mean	Std dev	Min	Max
Share of respondent banks with crypto exposures	51	0.09	0.23	0	1
Total crypto exchanges turnover per country GDP (×10^9)	630	15.43	354.63	0	8896.20
Independent variables					
Cryptocurrency legal status (index)[1]	627	1.51	0.69	0	2
Central bank digital currency project (index)[2]	497	0.32	0.65	0	2
Bitcoin search intensity (normalised)	581	18.08	14.02	1	100
Mobile cellular subscriptions (per 100 people)	490	112.06	36.29	17.46	345.32
Broadband subscriptions (fixed line, per 100 people)	480	16.69	15.04	0	57.85
Innovation output score (WIPO)	395	26.87	12.90	6.44	67.13
Fast payment system (binary variable)	533	0.37	0.48	0	1
Government effectiveness (index)	600	–0.02	1.00	–2.45	2.34
Informal economy (% of GDP)	368	25.74	11.57	5.43	55.78
GDP per capita (log USD)	512	8.90	1.42	5.71	12.08
Account ownership (% age 15+)	437	58.13	29.17	8.57	99.92
Financial development (index)	470	0.36	0.22	0.06	0.93
Remittances (% of GDP)	444	5.76	7.08	0	44.63
Trade openness (% of GDP)[2]	470	73.91	47.12	0	345.69

[1] Based on Shirakawa and Korwatanasakul (2019). The index is equal to 0 for jurisdictions that have banned cryptocurrencies; 1 if cryptocurrencies are regulated; and 2 if they are fully liberalised or no explicit regulations apply. Data available only for 2018. [2] Based on Auer et al (2020). The score is equal to 0 when there is no announced central bank digital currency (CBDC) project; 1 in the case of public research studies on CBDC; and 2 in the case of an ongoing or completed pilot. [3] Sum of imports and exports divided by country GDP.

Sources: Basel Committee on Banking Supervision; Bech at al (2020); Medina and Schneider (2019); Shirakawa and Korwatanasakul (2019); Svirydzenka (2016); IMF, World Economic Outlook; World Bank, Remittance Prices Worldwide, remittanceprices.worldbank.org; World Bank; World Intellectual Property Indicators (WIPO) 2018; Datastream; Google Trends; authors' calculations.

Next, we consider drivers of cryptocurrency exchange turnover. As in the above approach, our specification is based on an ordered probit regression, and we run univariate regressions on the total crypto exchanges turnover per country GDP for the same set of candidate drivers.

The drivers that we have found to contribute to banks' cryptocurrency adoption are also positively related to the turnover of crypto exchanges (Table 2, lower part). This finding is indicative of a self-reinforcing adoption of cryptocurrencies across different types of institutional investors. Put differently, the factors that have paved the way for the expansion of crypto exchanges appear to have established the market environment that also supports the increase in banks' involvement in the crypto ecosystem.

Drivers of cryptocurrency adoption (univariate ordered probit regressions)

Table 2

Dependent variable: Share of respondent banks with cryptocurrency exposures				
	Estimate	z-value	Observations	Pseudo R2
Regulation and public sector engagement				
Cryptocurrency legal status	–0.541	(–1.512)	51	0.019
Central bank digital currency (CBDC) project	0.613***	(2.915)	51	0.055
Public interest				
Bitcoin search intensity	0.001	(0.102)	51	0.000
Digital infrastructure				
Mobile cellular subscriptions	0.003	(0.285)	50	0.001
Broadband subscriptions	0.042***	(2.875)	51	0.044
Innovation capacity				
Innovation output score	0.069***	(3.228)	51	0.100
Fast payment system	4.221***	(14.714)	51	0.005
Industrial characteristics				
Government effectiveness	0.558***	(3.117)	51	0.037
Informal economy	–0.117**	(–2.217)	51	0.110
Development and financial inclusion				
GDP per capita	1.393***	(2.407)	51	0.089
Account ownership	0.030***	(4.066)	51	0.039
Financial development	9.834***	(3.334)	51	0.170
Cross-border transactions				
Remittances	–0.555**	(–2.034)	49	0.039
Trade openness	–0.002	(–0.446)	51	0.004
Dependent variable: log total crypto exchanges turnover per country GDP				
	Estimate	z-value	Observations	Pseudo R2
Regulation and public sector engagement				
Cryptocurrency legal status	–0.017	(–0.223)	627	0.000
Central bank digital currency (CBDC) project	0.738***	(8.398)	497	0.048
Public interest				
Bitcoin search intensity	0.010**	(2.356)	581	0.003
Digital infrastructure				
Mobile cellular subscriptions	0.013***	(5.677)	490	0.036
Broadband subscriptions	0.035***	(7.675)	480	0.044
Innovation capacity				
Innovation output score	0.057***	(10.819)	395	0.077
Fast payment system	1.305***	(9.601)	533	0.065
Industrial characteristics				
Government effectiveness	0.639***	(9.369)	600	0.061
Informal economy	–0.047***	(–6.646)	368	0.039
Development and financial inclusion				
GDP per capita	0.366***	(8.510)	512	0.038
Account ownership	0.031***	(10.425)	437	0.094
Financial development	3.262***	(10.929)	470	0.084
Cross-border transactions				
Remittances	–0.063***	(–3.431)	444	0.018
Trade openness	0.005***	(4.506)	470	0.011

Notes: ***/**/* denotes results that are significant at the 1/5/10% level. z-values based on robust standard errors, double clustered by country and year. Data on legal status, CBDC project, account ownership, informal economy and financial development are time-invariant due to a lack of data.

4. Policy implications and conclusion

Developments in cryptocurrency markets continue to evolve at a fast-moving pace, amid continuous efforts to develop the crypto ecosystem and expand the range of its business applications. As a result, cryptocurrencies have attracted significant interest among various financial market participants in the recent past. Financial innovations linked to cryptocurrencies and their infrastructure are also argued to hold the promise of significant advances in payments, trading, and other areas of financial intermediation. Institutional investors have thus started to consider their role in the crypto ecosystem.

Notwithstanding rising institutional investor interest, we find that major banks' exposure to cryptocurrencies appears limited thus far. A novel supervisory survey suggests that banks' exposures amounted to less than US$ 200 million in 2020 and are largely related to trading on behalf of clients and clearing of futures. However, exposures could grow rapidly in the future, raising questions about policy implications. Three areas appear to warrant particular attention:

First, the ongoing digitalisation of finance and interest in DeFi could spur the growth in, and systemic risk of, the crypto shadow financial system. While market activity has started from a relatively low base, the growth and trends over the past years underline the potential for cryptocurrencies and other forms of digital money (eg stablecoins and central bank digital currencies) to scale up quickly and become widely used. This, in turn, requires a proactive and forward-looking approach to regulating and overseeing such markets. As such, cryptocurrencies and their intermediaries, including crypto exchanges, should be subject to the same types of regulation and oversight as economically equivalent asset classes and institutions, including with regards to financial stability, consumer protection, and AML/CFT standards.[23] The purportedly decentralised nature of cryptocurrencies does not render these safeguards dispensable.[24]

Second, while most cryptocurrencies have originated from outside the traditional financial system, risks from cryptocurrencies could easily transfer to banks and other established financial institutions. Indeed, banks and asset managers could potentially be exposed to cryptocurrencies through a number of direct and indirect channels over the coming years. Initiatives to promote regulatory clarity on the treatment of these potential exposures, such as ongoing efforts by the BCBS (BCBS (2021)), could help to ensure a more level playing field and the prudent management of risks. This calls for both comprehensive regulation and supervisory oversight of crypto exchanges with regard to the provision of financial services and a conservative prudential approach to the treatment of banks' cryptocurrency exposures.

Third, data gaps risk undermining the ability of authorities to oversee and regulate cryptocurrencies holistically. While some of these blind spots reflect the decentralised setup of cryptocurrencies, there is scope to enhance the systematic collection and publication of cryptocurrency data in a more rigorous and robust manner. One option for such a framework is "embedded supervision", developed in Auer (2022), which harnesses information in distributed ledger based-finance. The aim is to increase the quality of data available to supervisors and to reduce administrative costs for firms.[25]

[23] Fanusie and Robinson (2018) and Foley et al (2019) document the use of cryptocurrencies in illegal activity. FATF (2020) lays out standards for cryptocurrency service providers, while Coelho et al (2021) provide a survey of AML/CFT standards for cryptocurrencies.

[24] Cryptocurrencies could become more centralised as miner income and with it the decentral security model is set to be phased out as the "block subsidy" decreases (see Auer (2019a, 2020)).

[25] In this context, open questions on the nature of decentralisation (eg Walch et al (2019)) and the immutability of smart contracts (eg Fröwis and Böhme (2017)) will need to be addressed.

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