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# Assessing Macrofinancial Risks from Crypto Assets

Burcu Hacibedel and Hector Perez-Saiz

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**Assessing Macrofinancial Risks from Crypto Assets**

**Prepared by Burcu Hacibedel and Hector Perez-Saiz \***

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**ABSTRACT:** Failures in the crypto space—including the fall of Terra USD and the FTX debacle—have sparked calls for strengthening countries’ policy frameworks for crypto assets, including by enhanced regulation and supervision. How have these heightened concerns about crypto assets been picked up in systemic risk assessment, and what can be done going forward? In this paper, we introduce a conceptual macrofinancial framework to understand and track systemic risks stemming from crypto assets. Specifically, we propose a country-level Crypto-Risk Assessment Matrix (C-RAM) to summarize the main vulnerabilities, useful indicators, potential triggers and potential policy responses related to the crypto sector. We also discuss how experts and officials can weave in specific vulnerabilities stemming from crypto asset activity into their assessment of systemic risk, and how they can provide policy advice and take action to help contain systemic risks when needed.

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WORKING PAPERS

# Assessing Macrofinancial Risks from Crypto Assets

Prepared by Burcu Hacibedel and Hector Perez-Saiz<sup>1</sup>

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<sup>1</sup> The authors would like to thank Martin Čihák, Fabián Valencia, IMF departmental reviewers, participants in IMF seminars, and the IMF country teams covering Central African Republic, El Salvador, and Vietnam for very helpful comments. All remaining errors are solely ours.

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# 1 Introduction

**Notwithstanding its benefits, financial innovation has traditionally been a key force of financial instability.** During the recent crises, we witnessed it leading to undetected pockets of risk and propagating the scale of financial distress within the financial system, across the economy and across borders. These events also highlighted the importance of systemic risk assessment, or regulatory and policy frameworks for financial regulators and supervisors. Understanding the macro risks posed by innovative instruments and markets enables timely mitigation of systemic risk and containment of shocks. In this paper, we aim to identify these risks for the case of crypto assets, analyze their macrofinancial implications and provide a dynamic framework to systematically assess them across time and countries.

**Recent advances in digitalization and cryptography have led to the development of new forms of digital assets that are transforming the way we invest, save or settle payments.** Crypto assets could de facto constitute a new “shadow financial system” increasingly important in the economy. With an estimated market capitalization of about \$US 1.2 trillion as of end April 2023, they represent an important component of the financial sector. Key potential benefits include more efficient payment systems, faster cross-border transfers including remittances, lower transaction costs and greater financial inclusion. However, there are high risks of spillovers to the rest of the financial sector and the economy, including also losses from large asset price corrections, and lack of transparency about the underlying value and the transactions. All of these could potentially have dire consequences if not anchored by thorough regulatory and policy frameworks capturing the macrofinancial linkages. In many ways, crypto assets resemble other risky asset classes from a mispricing and shock transmission perspective.

**In this paper, we propose a conceptual framework and a tool to integrate macrofinancial risks from crypto assets into regulatory and systemic risk assessment frameworks.** First, we introduce a macrofinancial framework to gauge, understand and track risks stemming from crypto assets comprising the so-called “stablecoins”, unbacked tokens, utility tokens, and security tokens. Secondly, we identify areas of risk from a micro-prudential perspective. Both the macro and micro risks and vulnerabilities are then reflected in the proposed crypto risk assessment matrix (C-RAM, henceforth). The C-RAM consists of three steps starting with a decision tree followed by a country-level risk mapping and a global crypto risk assessment matrix. The country-level analysis highlights vulnerabilities and risks, analyzes potential triggers leading to systemic risk and proposes potential policy tools. The global C-RAM identifies global risks that would be exogenous to countries and have implications for macrofinancial stability.

**Linkages of crypto assets with the rest of the economy are still limited but are being established rapidly as crypto assets become more widely used.** While crypto asset technologies could create de facto a new and alternative financial system, linkages with the traditional financial sector can be substantial. Considering how crypto assets interact with the real, fiscal, or external and financial sectors, they may pose significant risks to macroeconomic and financial stability. As crypto currencies like Bitcoin become more broadly accepted, their usage and risk implications increase in significance. In this paper, our aim is to highlight the channels through which crypto assets could amplify any turmoil in the crypto world into systemic risk. This would enable policy makers contain these risks utilizing timely and effective policy measures.

**Our work complements and elaborates on recent efforts to identify key elements of appropriate policy responses to crypto assets.** The IMF policy paper “Elements of Effective Policies for Crypto Assets” (IMF, 2023a) proposes a framework of nine elements that can help members develop a comprehensive, consistent, and coordinated policy response to crypto assets in the areas of financial stability, financial integrity, legal risks, or consumer protection. The elements are fully aligned with the relevant standards of the Financial Stability Board and other standard setting bodies. A recent G20 note prepared by the IMF summarizes implications of crypto assets for domestic and external stability and the structure of financial systems (IMF 2023b). Crypto assets have also been widely covered in recent IMF *Global Financial Stability Reports* (IMF, 2021a; IMF, 2022a), Article IV staff reports (e.g., El Salvador 2021, Marshall Islands 2022, or Central African Republic 2023), and Financial System Stability Assessments (e.g. Sweden 2023, Ireland 2022, or Hong Kong 2021), among others.

**There are still high-priority gaps, especially in the multilateral sphere.** In particular, data and transparency issues are key for monitoring and policy implementation. At the moment, while there is a concerted effort in developing a regulatory framework, its effectiveness relies on availability of data on transactions, market size, transparency about counterparties, intermediaries and how crypto assets affect their overall risk. Our paper aims to contribute to the policy and monitoring gap and complement the data and transparency efforts.

**This paper is divided into six sections.** Section 2 describes the main actors in the crypto eco system, main macro/micro risks of cryptos, and sectoral linkages. Section 3 characterizes the C-RAM framework that operationalizes systemic risk assessment of crypto risks. Section 4 applies the framework to several country cases. Section 5 discusses the policy challenges and implications. Finally, Section 6 concludes.

## 2 Analyzing Macroeconomic Risks and Sectoral Linkages of Cryptos

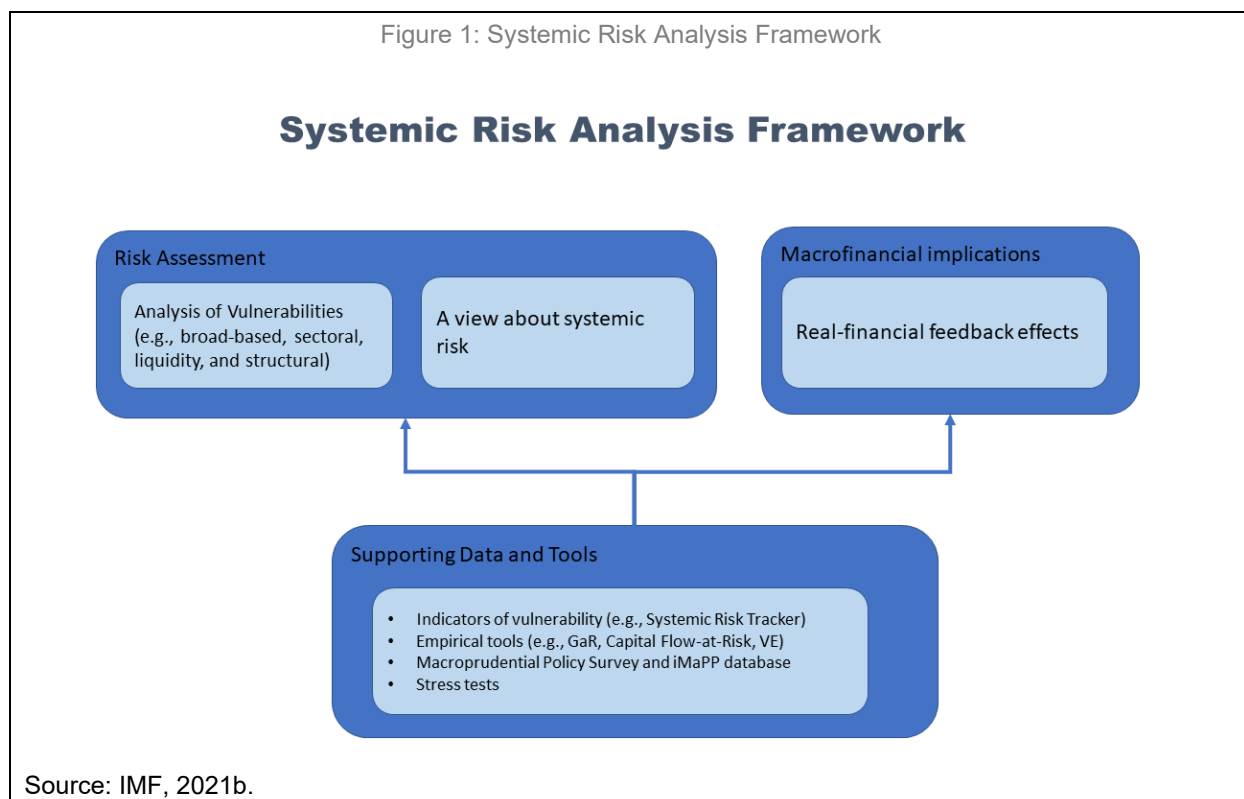
### 1.1 A GENERAL FRAMEWORK

**Conceptually, a framework to study systemic risk and macro financial linkages associated with the presence of crypto assets would be similar to the framework that has emerged over the last decades (Figure 1).** It would include appropriate granular data across sectors and tools, in addition to information on the legal and regulatory status of crypto assets (e.g., legal tender status, outright bans). This would support the analysis of vulnerabilities and assessment of systemic risk and the macro critical importance of crypto assets.<sup>2</sup> After the realization of a shock, contagion, amplification effects and

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<sup>2</sup> Following the Fund’s updated Guidance Note for Surveillance Under Article IV Consultations (IMF, 2022b), an economic issue is assessed as macro critical if it significantly influences present or prospective balance of payments or domestic stability.

feedback/in loops between the crypto asset sector, the traditional financial sector and the rest of the economic sectors could exacerbate the negative financial stress, initially limited to the financial sector. Policy recommendations would encompass both micro and macro prudential policies, in addition to more traditional macro policies.



**For the specific case of cryptos, this framework would deviate from the standard analysis of traditional financial markets by including new elements and omitting some others.** First, some of the traditional indicators used as early warning indicators of increasing vulnerabilities, such as bank credit growth or household prices, may not be appropriate in the crypto world. Available data sources are also currently quite limited to allow for sufficiently granular analysis of the cryptos. Second, many of the empirical tools used for systemic risk analysis, such as growth-at-risk (GaR), capital-flows-at-risk (CaR), or the Fund's vulnerability exercise (VE) do not incorporate crypto-related indicators or are not well-suited for crypto-related risks. Third, it is not well understood yet the nature of vulnerabilities, the contagion and amplification channels, and the linkages with the real sectors related to crypto assets.

**Thus, policymakers would require a redesigned framework to safeguard the economy.** It would include new analysis tools, novel transmission channels between the financial sector and the rest of economic sectors and policy recommendations well-tailored to address the vulnerabilities posed by crypto assets.

**In this section we focus on the analysis of micro prudential risks of cryptos and the linkages with the rest of economic sectors.** After describing the main actors in the crypto eco system, we analyze the main risk channels and the linkages with the traditional financial sector and the rest of economic sectors. Our analysis assumes a state of the world where comprehensive regulations and supervisory practices for crypto assets as described in IMF (2023a) or other similar frameworks have not been properly implemented.

## 2.1 MICRO-PRUDENTIAL RISKS AND LINKAGES

**Crypto asset technologies, if not well regulated and supervised, could create de facto a new and alternative financial system.** It includes new financial instruments, some of them money-like, and a decentralized structure of system participants. These technologies, centered around the Distributed Ledger Technology (DLT), also enable alternative financial market infrastructures that support many of the key functions of traditional financial markets such as the secured record, clearing or settlement of financial transactions between participants. We consider the following six categories in the crypto asset eco system, which is consistent with classification used in the literature (e.g. Bains et al., 2022):

- i) Issuers: Design or issue crypto assets
- ii) Miners/validators: Verify and validate transactions, sometimes by solving complex cryptographic problems, and getting a reward for it
- iii) Crypto exchanges/platforms: Provide custodian services and facilitate transactions between players
- iv) Wallet providers: Promise the secure storage of crypto assets in exchange of a fee
- v) Investors, including individuals and institutions
- vi) Payment providers, that enable clients to use crypto assets to pay merchants or transfer funds abroad using crypto assets, in addition to other payment services

**While the decentralized structure of the crypto eco system theoretically reduces the systemic importance of many of its main actors, it also introduces new risks and regulatory challenges.** In theory, systemic risks posed by the failure of crypto issuers, financial intermediaries or operational/infrastructure providers might be limited within the highly fragmented and decentralized governance and market structure in the crypto ecosystem. At the same time, decentralized structures are harder to control and monitor by regulators and they might also facilitate the rapid propagation of risks because of the impossibility of creating financial firewalls.

**These crypto categories and main actors are prone to credit, market, liquidity, concentration, cyber/operational, and legal/regulatory risks.** We utilize the crypto asset taxonomy proposed in IMF (2023a) and focus on four types including unbacked tokens, stablecoins, utility tokens and security tokens (see appendix).



**Theoretically, credit risk may not be substantial in many cases as some crypto assets do not have a claim on the issuer and are considered nonfinancial assets.** This is the case for instance of Bitcoin, classified as a nonfinancial asset, with no counterpart liability and issued in a decentralized manner via the so-called “mining” (IMF, 2019). As a result, the concept of credit risk, i.e., the inability to fulfill a financial claim by the counterparty in a financial exchange, is in theory non-existent for some forms of crypto assets. The absence of claims on the issuer theoretically reduces the interdependencies and the risk of default propagation in highly interconnected financial networks.<sup>3</sup> Stablecoins are more likely to be prone to credit risk as they have a claim on the issuer and there are concerns on the quality of the assets or the effectiveness of the algorithms used to back their value. While many types of crypto assets do not contain an inherent credit risk, in practice they may indirectly pose credit risks. For instance, a substantial fraction of trade and transactions use cryptos as the settlement asset, or as collateral, and sudden price drops reduce their value. Moreover, crypto firms may default on “traditional” financial products following the realization of large losses in their core crypto activities.

**Market and liquidity risks are more likely to be relevant for crypto assets.** Price volatility, and therefore market risk, is typically high in unbacked tokens.<sup>4</sup> For stablecoins, maintaining the stable value via complex algorithms or financial arbitrage requires high prudential and technological standards that are not always met, such as solid technologies or high-quality assets. Investors are often sensitive to adverse information about the quality of the issuer’s assets or potential exposures to operational risks. Much like banks and money market funds, stablecoin issuers often face the risk of runs (Lyons and Viswanath-Natraj, 2020; Bertsch, 2022). Additionally, runs on stablecoins could induce price pressures and fluctuations in the “stable” asset. This might lead to further spillovers into the financial sector propagating a microfinancial risk into a macrofinancial one.<sup>5</sup>

**Despite the decentralized design of crypto assets, concentration and propagation risks in the crypto industry are relatively high.** In theory, the decentralized nature of crypto assets makes them less prone to a single point of failure risk, as multiple nodes and validators potentially spread around the world (Bains et al., 2022). Decentralization could improve security as well as reduce the need for trust in a single entity. In practice, concentration has also increased over the years due to high network effects, scale economies or the need to diversify risks. There has been a remarkable trend towards concentration in the industry through the formation of large mining pools, the dominance of Bitcoin and Ethereum—

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<sup>3</sup> Internationally agreed statistical standards currently classify cryptos as nonfinancial assets, given their lack of counterpart liability (IMF, 2021c)

<sup>4</sup> A distinction can also be made between crypto assets that are transacted “on-chain” (in the blockchain), as opposed to “off-chain” transactions (processed outside the blockchain). While risk channels discussed in this section are relatively similar for both types of transactions, there could be differences in their relative importance. Off-chain transactions tend to be a) more opaque and faster, as they are processed outside the blockchain; b) cheaper, as they do not involve transaction fees needed to record them in the blockchain; and c) less secure and reliable.

<sup>5</sup> For instance, stablecoins are backed by reserves held usually at commercial banks. A run on a stablecoin can trigger a run on the bank holding these reserves and quickly propagate to the rest of the financial system.

currently representing more than half of the total market capitalization of crypto assets—or the emergence of large exchange platforms and wallets (see Cong et al., 2021; Makarov and Schoar, 2021). Network effects or scale economies are also relatively important in this industry (see Halaburda et al., 2022), which tends to raise concentration over time and increase the systemic importance of some key actors in the industry.<sup>6</sup>

**Decentralization of crypto assets and a high reliance on complex technologies and automatization elevates the importance of operational vulnerabilities and cyber risk in the crypto eco system.**

Crypto technologies a) often rely on automated processes with little or no human intervention; b) are constantly evolving and transmuting, a source of rapid innovation; and c) they are decentralized by design which makes governance more difficult. The automation of the issuance, financial intermediation, or transfer processes reduces substantially the transactional processing times. While this reduces transaction costs and processing times, it can also dramatically increase asset-price volatility or cause abrupt changes in capital flows within or across borders. As a result, crypto technologies are not failure-proof and are not well understood by the general public and regulators, which makes them more difficult to monitor or regulate and be prone to operational risks or cyber-attacks.

**Cyber risks are estimated to be elevated in most types of crypto assets as complex technologies, actors, and weak governance are involved.**

Indeed, emerging financial technologies are particularly exposed to cyber-attacks given their high reliance on technology. Crypto technological innovations may increase vulnerabilities to cyber-attacks, as specialized crypto firms might have poor governance and fewer controls and risk management procedures than large, vertically integrated regulated financial intermediaries (Bouveret, 2018; IMF, 2021a). In such a complex environment, operational failures or vulnerabilities can quickly translate into cyber risks, financial integrity or others. At the same time, highly concentrated players like crypto asset exchanges and wallet providers are also susceptible to cyber and operational risks. While data on cyber incidents losses is scarce in the financial sector, recent data from 2021 suggests that crypto related losses are relatively high compared to the financial system.<sup>7</sup>

**In this uncertain and complex environment, the legal classification and regulation or supervision of crypto assets pose significant challenges, leading to uncertainty and potential legal/regulatory risks.** Some countries such as El Salvador and Central African Republic (CAR) have granted official currency or legal tender status to Bitcoin, but these legal changes could quickly increase the adoption and exposures of highly volatile crypto assets, amplifying the many abovementioned risks (IMF, 2022c; IMF, 2023c). There are also several ongoing ambitious legislative initiatives in various countries to foster the

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<sup>6</sup> The recent collapse of FTX, a large crypto conglomerate, highlighted the inadequate governance and opaque corporate interlinkages that could arise among large crypto players (see Box 1).

<sup>7</sup> In 2021, the two largest crypto-related losses were estimated at about \$2 billion each, compared to an estimated operational risk losses of about \$15 billion for the financial sector (Risk.net “Top 10 op risk losses for 2021 hog \$15bn total”, 14 January 2022).

adoption of crypto assets and the tokenization<sup>8</sup> of economic sectors—also in El Salvador or Central African Republic—but it is not clear these initiatives are in line with prudent regulatory practices being recommended by standard setting bodies and other relevant multilateral institutions. In El Salvador, it has been recommended to narrow the scope of the Bitcoin law to contain some of the macroeconomic risks, in addition to enforcing strict regulation and supervisory oversight to mitigate fiscal, financial integrity and financial stability risks (IMF, 2022c). In CAR, project Sango poses multifaceted challenges, including to financial integrity, governance, and consumer protection among others. It would be crucial to create the adequate prerequisites in terms of infrastructure, institutions, the legal and regulatory framework, capacity development, and others, which demands time and resources (IMF, 2023c).

**While many of the transmission channels brought about by crypto assets are conceptually not new, there are some specific ones that are novel.** The risk of currency substitution of fiat currencies by crypto assets is an important channel that is relatively new compared for instance to previous episodes of financial innovation, such as the emergence of shadow banking in the 2000s. This can potentially reduce the effectiveness of monetary policy, or increase the volatility of cross border capital flows, important sources of macro instability. Another novel and important channel of propagation of risks is linked to the elevated operational/cyber vulnerabilities of crypto assets. In the appendix, we discuss with more detail the taxonomy of crypto assets and related risks.

## 2.2 MACRO-PRUDENTIAL RISKS AND LINKAGES

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**Risks to the real sector from crypto markets principally come from households and corporates (Figure 2).** With the recent boom in crypto assets, household exposures significantly increased. Thus, any market ambiguities and price fluctuations would necessarily have a wealth effect on households. Considering that this was accompanied by excessive risk taking and, in some cases, leveraged exposure, this channel might introduce additional vulnerabilities spilling over to the rest of the economy. While corporate exposure to crypto assets for their business activities and trade has been more limited so far, the integration of crypto assets into payment systems and supply chains in the future would strengthen this channel. This would make corporates more vulnerable in terms of profitability, asset/liability mismatches and cash flows.

**Crypto markets have implications for the fiscal sector through the revenue, expenditure and financing channels (Figure 3).** Any fluctuations in crypto assets affecting economic growth and the real sector would be reflected in fiscal revenues. In case of downturns, this puts pressure on the fiscal deficit. Fiscal revenues and financing could be severely affected in countries where cryptos are legal tender or where the government is highly dependent on unconventional financing from crypto platforms. Even if not deemed legal tender, cryptos could substantially affect tax revenues if used fraudulently or for tax evasion purposes. While not a current concern, the taxation of crypto assets, market makers and participants could be a potential component of the revenue channel. On the expenditure side, a major part of the risk

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<sup>8</sup> Tokenization is defined here as the process of fractionalizing real assets, such as land, into digital tokens stored on a decentralized database.

comes from the financial sector or more broadly any financial intermediary that holds crypto assets on its balance sheet especially if the government has established a trust fund or an SOE to participate in the crypto assets ecosystem. Price fluctuations could lead to losses on bank balance sheets, first through their own holding of these assets and secondly through their credit exposure to crypto issuers. In both cases, the fiscal cost could emerge as a result of bail outs or recapitalization of systemically important financial institutions and state-owned enterprises.

**Currently the main sources of risk to the external sector come from remittances and the volatility of cross-border capital flows.** Leading to potentially lower transaction costs,<sup>9</sup> cryptos are likely to become increasingly important as a transmission channel. Lower transaction costs could also trigger highly volatile capital flows relying increasingly on crypto currencies. Moreover, transmission through trade could also be amplified and have implications for overall macroeconomic stability if the crypto market destabilizes. Reserve adequacy, external buffers and capital flow management (CFM) measures might need to be revisited for countries with high usage of crypto assets (IMF 2020; He et al., 2022).

**Considering the decentralized nature of crypto markets and assets, their increased use could have implications for the monetary transmission mechanism.** Cryptos could accelerate bank disintermediation, reduce the effectiveness of capital controls, and undermine traditional credit transmission channels, thus limiting the effectiveness of monetary policy. There is also the risk of creating a parallel market for exchange rates and domestic currencies. Additionally, the lack of data on the issuance size, holdings and transactions of crypto assets could lead to the mismeasurement of the money supply.

## 2.3 FINANCIAL SECTOR LINKAGES

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**Despite being an industry in its infancy and constantly evolving, the crypto eco system involves key actors that may be substantially intertwined within the traditional financial industry (Figure 2).** Savers/investors and borrowers may have access to both traditional financial intermediaries and crypto platforms, which usually offer competing products and services. Crypto players are dependent on traditional financial institutions for custodial services, storage of funds, liquidity provision and funding. For instance, crypto platforms do not have direct access to central bank liquidity and are thus dependent on commercial banks for liquidity needs.

**Direct exposures between commercial banks and cryptos are still relatively small, but likely unevenly distributed.** A recent Basel III Monitoring Report (BCBS, 2023) shows a relatively small exposure to cryptos among the group of large banks included in the sample, but highly concentrated in

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<sup>9</sup> While crypto technologies have the potential to substantially reduce transaction costs, the median value of some crypto transactions, such as Bitcoin, can be higher than most conventional financial technologies used for domestic transactions. Internationally, the comparative advantage of cryptos depends crucially on the corridor considered (IMF, 2023a).

few banks and in the Americas region.<sup>10</sup> The high level of specialization and concentration of cryptos in high-tech geographic areas suggests exposures may be much higher for smaller commercial banks specialized in technological companies. For instance, Signature and Silvergate Capital were two financial institutions that quickly failed at the aftermath of the financial panic triggered by the failure of Silicon Valley Bank (SVB), a bank specialized in lending to start ups in the Silicon Valley area (see Box 1). This degree of specialization explains that a relatively large fraction of SVB deposits were also owned by crypto firms, which were exposed to the failure of SVB.

**Centralized crypto issuers that supply crypto assets with a claim, such as stablecoins, are particularly vulnerable and pose substantial contagion risks in the financial system.** Stablecoins need to have sufficient high-quality liquid assets to guarantee redemption and are thus vulnerable to price changes of the backing assets. They do not have access to central bank emergency liquidity or central bank reserve accounts, so they are also vulnerable to liquidity freezes or solvency concerns of the traditional commercial banks they work with.

**Crypto platforms such as exchanges, DeFi platforms or crypto payment platforms are at the center of the crypto eco system and are also prone to high risks.** They intermediate or enable exchanges of crypto assets, including for payment purposes, and create innovative credit products through DeFi platforms. Crypto platforms may also perform maturity transformation, thus taking maturity and liquidity risk of their own. Without direct access to central bank money, crypto platforms obtain liquidity from traditional financial intermediaries, which are exposed to changes in crypto prices or the risk of default of crypto platforms.

**Contagion through expectations may be particularly relevant due to the high level of opacity and uncertainty in the crypto industry.** Recent episodes of high volatility after the failures of Terra, FTX and SVB quickly propagated within the crypto industry and across traditional financial institutions, particularly those with relevant linkages to high tech sectors. There is empirical evidence that volatility spillovers among crypto and financial assets increases during periods of heightened turbulence due to negative news, crypto events, or exogenous shocks (Iyer and Popescu, 2023). While contagion through counterparty risk is not directly linked to Bitcoin and other crypto assets without claim on the issuer, liquidity shortages could quickly propagate and amplify as crypto platforms and crypto issuers with claim are highly dependent on liquidity provision by commercial banks. Failures of systemic players such as miners/validators could also quickly spread to other crypto platforms and the rest of the financial system as these are crucial agents that perform vital operations that guarantee the financial integrity of crypto assets.

**In the longer term, tokenization and the widespread adoption of crypto assets could lead to a disintermediation of bank deposits.** While greater competition with crypto agents could be beneficial for consumers, this could also undermine credit provision and quickly weaken bank solvency ratios, causing potential negative feedback effects with the real sector. A financial sector dominated by crypto firms could

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<sup>10</sup> Total prudential crypto asset exposures and crypto assets under custody reported by banks amounted to approximately €2.9 billion and €1.0 billion. In relative terms, this represents only 0.013% and 0.005% of total exposures across the sample of banks (BCBS, February 2023).

also potentially be more vulnerable in the beginning as regulation and supervision adapts to this novel environment. Tokenization could potentially lead to stronger competition by banks in certain crypto activities and reduce regulatory arbitrage benefits of crypto firms.

**Optimal policy responses both at the micro and macro prudential levels must be also adapted to the crypto eco system.** At the micro prudential level, lender-based measures including minimum capital regulatory, or liquidity ratios may need to be redefined or imposed on crypto assets to ensure proper management of risks. At the macro prudential level, borrower-based measures, such as debt service to income limits or loan to value ratios, or access rules to emergency liquidity, may need to be extended. Implementing some of these measures could be prone to important significant challenges as automatization and decentralization may complicate governance and impede effective regulation and supervision. Despite its decentralized nature, some key actors in the crypto ecosystem could grow in importance. As a result, additional capital surcharges could be imposed to systemically important DeFi lenders, or certain agents playing a key operational role in the validation, exchange or custody of crypto assets could be declared as systemically important and impose special regulations and oversight on them.

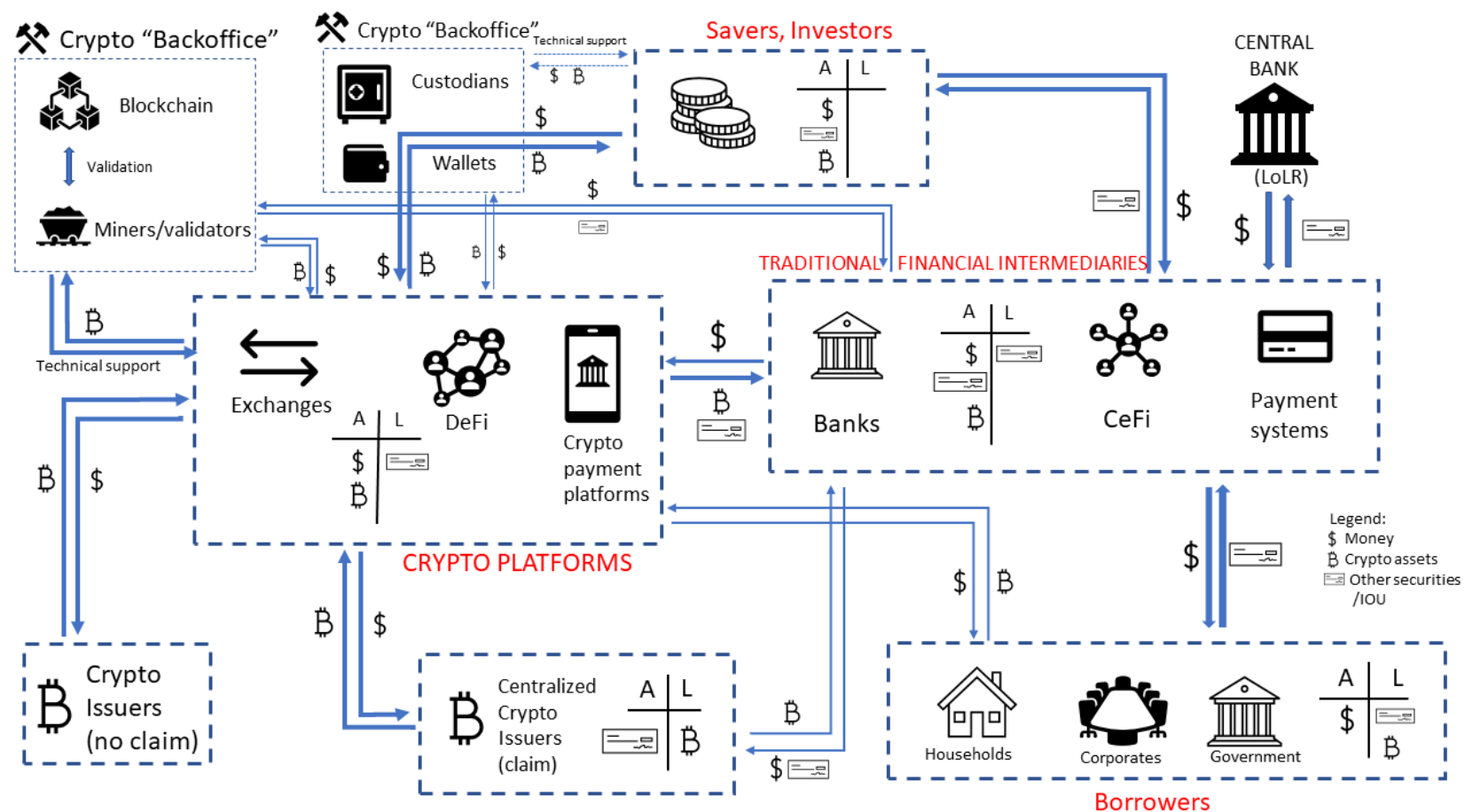
## 2.4 DISTINCTIVE FEATURES BROUGHT BY CRYPTO ASSETS TO THE FRAMEWORK

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**To summarize, the key distinctive features brought on by crypto assets to this framework are the following:**

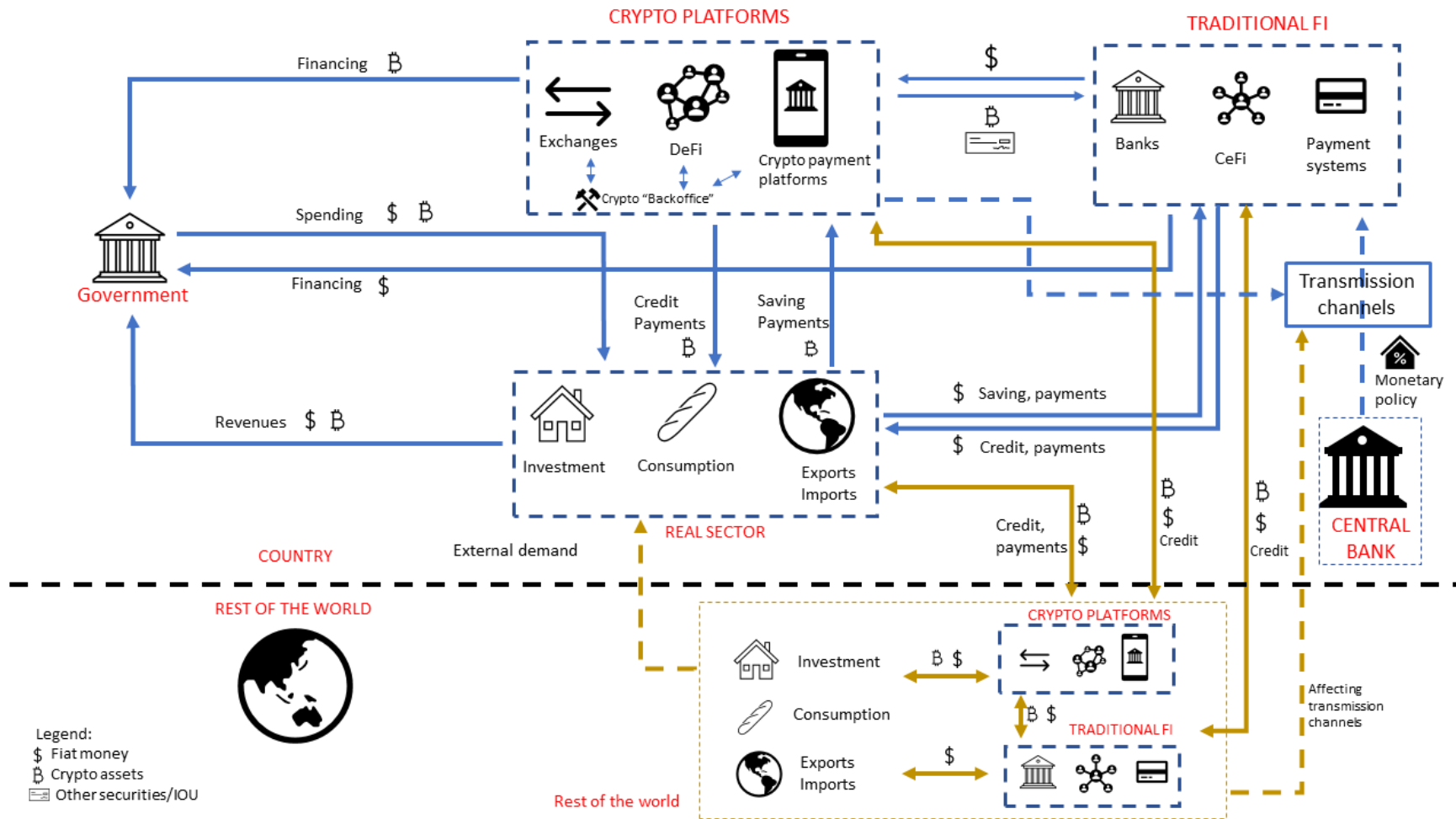
- New business models and forms of financial intermediation, financial instruments, markets and infrastructures, creating de facto a parallel alternative financial system
- Decentralized market and governance structure of main crypto actors
- Crypto assets constitute a new parallel financial system that includes many of its key elements (financial intermediaries and markets, financial market infrastructures, and instruments, including money-like)
- Very fast market response due to automated execution of transactions leading to high price volatility and financial instability, which could also generate unexpected fiscal risks
- Some of the largest crypto assets have no claim on the issuer
- High operational/cyber risks due to high technical complexity and weak governance
- Novel transmission channels to real sector, including much lower barriers to cross-border propagation
- Lack of appropriate data for supervision and regulation
- Rapidly evolving legal and regulatory framework, including the recognition of crypto assets as legal tender in certain countries, impacting fiscal and monetary policy
- Highly dynamic and innovative market environment that obstructs effective monitoring and supervision, and easily circumvents regulatory measures

Figure 2. Linkages of the Crypto Eco system and the Traditional Financial Sector



Note: For the sake of brevity and clarity, only the most relevant links between agents are included. Source: Authors' own work.

Figure 3. Main Macro Financial Transmission Channels of the Crypto Ecosystem



Note: For the sake of brevity and clarity, only the most relevant links between agents are included. Source: Authors' own work.



### Box 1. Triggers and transmission channels in the failure of FTX and SVB

FTX, a major crypto exchange and hedge fund headquartered in The Bahamas, failed in November 2022, highlighting the inadequate governance and opaque corporate interlinkages that might arise among large crypto players. FTX provided custodian, brokerage, exchange, clearing and settlement, and trading services. FTT, an unbacked crypto-asset token issued by FTX, was predominantly present in the cross exposures between FTX and another of its affiliates, Alameda Research. A run on FTX spilled over into the crypto asset markets, including stablecoins and DeFi. Although contagion to wider financial markets was limited, the losses suffered by investors exposed to FTX and spillovers across the broader crypto ecosystem were very significant.

Silicon Valley Bank (SVB) was a state-chartered bank mainly operating in the San Francisco Bay area and closely tied to the high-tech industry and its depositor base included startups, fintech companies and crypto firms. As venture capital and high-tech startups—including some crypto firms—run into financial stress during the post pandemic, SVB started facing large deposit drains. The high vulnerabilities of SVB, inadequate supervision and heavy losses after increased interest rates led to its collapse in March 2023. While all its deposits were fully guaranteed, SVB's failure impacted two other banks with strong crypto focus, Silvergate Capital and Signature, in addition to causing financial turmoil and price drops in the crypto industry.

Additional sources: "What to know about Sam Bankman-Fried and the FTX crypto exchange collapse", Washington Post, December 13, 2022. "SVB, Silvergate and Why Crypto Still Needs Banks", Bloomberg, March 14, 2023.

## 3 The Crypto-Risk Assessment Matrix (C-RAM)

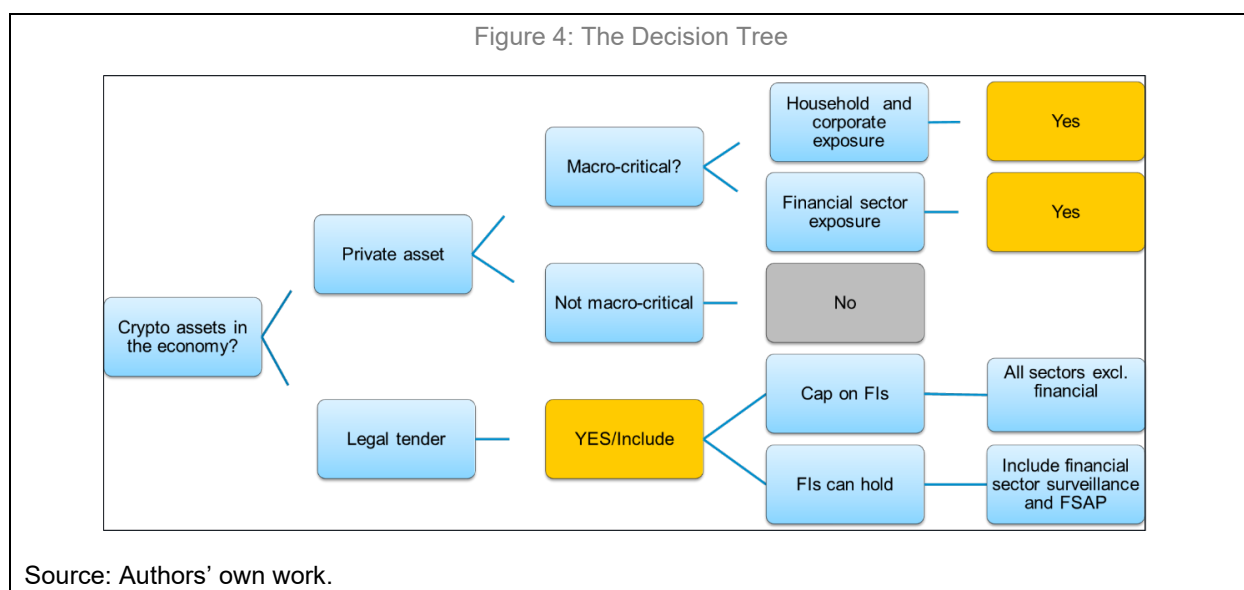
**We propose a three-step approach to incorporate macrofinancial crypto risks described in the previous section in country monitoring.** The first step involves a decision tree to assess crypto sector's macro-criticality in an economy. The second step involves looking at a number of indicators comparable to those used in the macrofinancial monitoring of the traditional financial sector. The third step covers the global macrofinancial risks from crypto assets that would have implications for a country's systemic risk assessment.

**Data availability and sufficient granularity remains an issue, but some proxies could temporarily help gauge the level of macrofinancial linkages and risks.** We propose this to be a dynamic data initiative, where country experts and officials could also contribute to existing databases, as more data becomes available through monitoring missions and reviews. Some of the macrofinancial linkages proposed in this paper are expected to be better quantified with data availability.

### i. First Step: The Decision Tree

The first step of the Crypto-RAM is centered around assessing the macrocriticality of crypto assets in an economy. Macrocriticality refers to an economic issue that significantly influences present or prospective balance of payments or domestic stability (IMF, 2022b). If in the first step, crypto assets or the crypto sector are deemed to be macro-critical, this would automatically implicate its inclusion in country monitoring.

The decision tree approach (Fig. 4) starts with the question on whether crypto assets are being used in a country in an economically meaningful way. While this would imply assessing its importance using relevant indicators (e.g. as percent of GDP), this is aimed to be a qualitative assessment. If the answer is yes, there are two routes forward: as legal tender and as private assets. If crypto assets are being used as legal tender (e.g., El Salvador, Central African Republic), then crypto assets should be covered in country monitoring as legal tender may further incentivize adoption, undermine monetary policy effectiveness or create fiscal risks (IMF, 2023b). The coverage and macrofinancial linkages would be determined by any legal restrictions to holding for certain economic sectors and agents. If financial institutions are not allowed to hold any crypto assets, then the risk assessment exercise could exclude the financial sector. If no such restrictions exist, a crypto-risk assessment should cover all sectors including the financial sector.



Besides legal tender, the existence of crypto assets could also take the form of private assets with economy-wide implications. The coverage in country monitoring will depend on its macro-criticality as defined above. If deemed not macro-critical, its coverage would be optional.<sup>11</sup> If macro-critical, the risk

<sup>11</sup> While monitoring of macrofinancial crypto risks may be optional if deemed not macro-critical, this does not preclude the monitoring, regulation or supervision of crypto assets at the micro-prudential level if risks and vulnerabilities are significant.

assessment should cover household and corporate exposure to identify the vulnerabilities and risks in the real sector as well as the significance of macro-linkages stemming from these. Financial sector exposure should also be assessed in light of vulnerabilities and risks coming from private crypto assets in a similar manner. If the coverage of crypto assets is deemed to be necessary in this first “decision tree” step, then country experts and officials can proceed to the second C-RAM step explained in the following subsection.

## ii. Second Step: Country Risk Mapping

**The second step in C-RAM focuses on quantifying the crypto risks in an economy via country risk mapping.** The mapping is based on a risk matrix that identifies vulnerabilities, triggers, risk implications and policy options for crypto risk mitigation (Fig. 5).

**We identify seven groups of vulnerabilities based on the macro and micro financial linkages identified in the second section of the paper.** These include:

1. Systemic importance
2. Credit risk
3. Concentration risk
4. Liquidity risk
5. Market risk
6. Regulatory risk
7. Operational risk

**Systemic importance refers to the significance of a sector/issue in an economy, its potential impact on macroeconomic stability and systemic risk especially in the case of negative spillovers or shocks from the crypto sector.** The concept is also closely linked to macrocriticality as discussed earlier. This could be measured by indicators such as crypto assets market cap as percent of GDP, crypto adoption indicators in an economy, or DeFi adoption in an economy, among others. Similarly, these could be compared to the size of the traditional financial sector assets, including also nonbanks, to measure systemic importance as well. While we expect country data to be more accessible and comparable across countries over the years, given the nascency of crypto sector assets, time-series data may be hard to obtain. These indicators would also help country experts and officials with the decision—the decision tree step. Risk triggers could be more macro-policy focused such as monetary policy tightening, or increasing risk aversion in the economy. These triggers would result in repricing of crypto assets with systemic risk implications

**While some crypto assets do not have a claim on an issuer, counterparty credit risk can be relevant when crypto-denominated trade and assets is substantial.** This risk could be measured by adoption of crypto assets in transactions or trade as percent of GDP and could include a sectoral focus by adding crypto transactions of non-financial corporates, and crypto transactions of non-bank financial institutions if more granular data is available. This also involves the cross-border repayment risk in the case of exports and imports. Stablecoins are also more likely to be prone to credit risk as they have a claim on the issuer and there are concerns on the quality of the backing assets. Risk triggers would include large fluctuations in crypto asset prices or in the backing assets, corporate defaults, defaults of

crypto agents due to extraneous reasons, or fire sales due to liquidity squeeze. These could spill over to the rest of the economy through both the financial sector and DeFi, increasing fiscal risk for public finances. Defaults could also spiral through counterparty credit risk and default cascades.

**Concentration risk encompasses concentrated or common exposure to crypto assets or crypto assets in general.** Therefore, this covers the exposure to crypto issuers and platforms as well as interconnectedness within DeFi, the financial sector and with the rest of the economy. Considering the current challenges about crypto-asset data, this risk could be measured only at the aggregate level. Ideally, as detailed balance sheet data on crypto holdings become available, concentration risks would be assessed more clearly. The BIS published data in 2022 on banks', NBFIs', and corporates' exposure to crypto assets albeit for a limited group of countries (BIS, 2022). Risk triggers for interconnectedness/concentration include sudden asset price fluctuations, increase in cybercrime, geopolitical shocks, and fragmentation. These triggers could lead to fire sales of crypto assets, margin calls, contagion within/between sectors and further price corrections.

**Liquidity risk is mainly directly linked to backed stablecoins and other backed assets.** Currently, there is little information or guidance about the reserves, stabilization mechanisms in place and the adequacy of reserves for stablecoin issuers. As vulnerability indicators, reserve ratios, or detailed information of asset quality and liabilities of the stable coin issuers could be used. Potential triggers could be similar to what we have recently observed in the “crypto winter” when risk aversion increases, balance sheet vulnerabilities become visible through fragile buffers, reserves and exposures. This could rapidly spillover to the rest of the economy both through the financial sector and household exposure, which might aggravate fiscal problems and growth slowdowns.

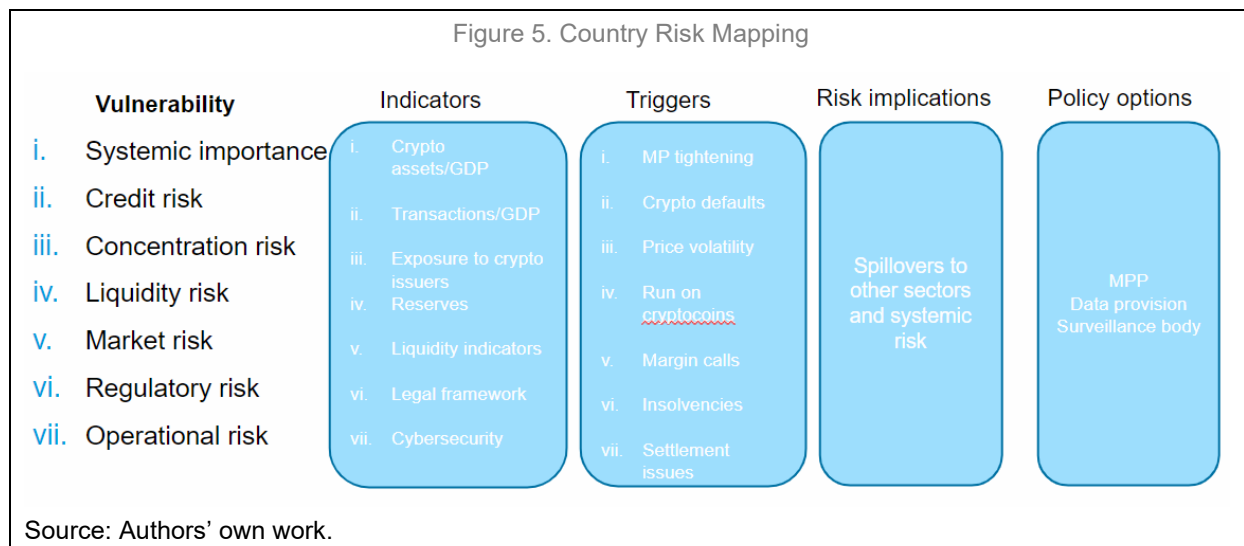
**Market risk involves risks from mispricing of crypto assets such as overvaluation and price bubbles.** Indicators would include those reflecting the market structure, liquidity squeezes, and can be captured by bid-ask spreads, volatility ratios, turnover ratios, and other liquidity measures. These would capture the increase in market risk sensitivity, and triggers like monetary policy changes, margin calls, fire sales, or liquidity shocks could lead to systemic events.

**Regulatory risk applies to economies' legal infrastructure, resolution frameworks and capacity to manage crypto assets.** If these are weak or not existent, the related vulnerabilities would be high. The assessment of this vulnerability would be more qualitative indicating if the necessary infrastructure exists and is effective. Given that the crypto assets are in early stages of development, we recommend country experts and officials to follow the framework provided in the recent IMF Board paper on “Elements of Effective Policies for Crypto Assets” and other related work.

**Operational risk refers to vulnerabilities stemming from the actual IT infrastructure and capacity in a crypto-using country.** Similar to the assessment of regulatory risk, this would also be qualitative in terms of determining the strength of the IT infrastructure, crypto payment systems and custodians, miners, e-wallets, and other crypto infrastructures, and measures for cybersecurity.

**The last pillar of “Country Risk Mapping” presents the policy options to mitigate risks and spillovers from any of the seven risk categories.** These cover existing macroprudential policies, crypto-sector specific micro and macro financial regulation and supervision to improve the sector's resilience. These might come in the form of insurance mechanisms, international monitoring frameworks,

data provision and formal reporting including the assessment and disclosure of crypto assets ecosystem fiscal risks in the government's fiscal risk statement. Additional (risk-weighted) buffers for crypto-exposures of banks, NFCs and NBFIs, reserve requirements for stablecoins, national and international regulatory frameworks, resolution mechanisms could be part of the policy toolkit.



### iii. Third Step: Global Crypto Risk Assessment Matrix (C-RAM)

**Considering the lack of data and regulatory framework for crypto assets, the assessment of global risks could be based and developed further on the recent IMF, FSB and BIS work.** The October 2021 GFSR (IMF, 2021a) identifies some global risks from the crypto sector such as financial stability risks/spillovers of runs on crypto currencies, implications for monetary policy transmission, climate costs of “mining” especially for emerging markets, severe turmoil and disruption in many parts of the crypto market and crypto contagion. More recently, the FSB has published various consultative reports with recommendations for the regulation and supervision of crypto assets (FSB 2022a, 2022b and 2022c). The December 2022 BIS Quarterly Review (BIS, 2022) highlights crypto risks that could have widespread implications including spillovers to traditional financial sector, corporate exposure and payments systems. Finally, the 2023 IMF policy paper on “Elements of Effective Policies for Crypto Assets” (IMF, 2023a) proposes a nine-element framework with a firm foundation to operationalize crypto asset policies. Monitoring the impact of crypto assets on the stability of global financial system is included as one of the nine elements.

**In the third step of the C-RAM, we propose a map of global risks for or from crypto assets with implications for macroeconomic stability and systemic risk (see example in Fig.6).** Together with the decision tree and country risk mapping, country experts and officials could use the Global C-RAM table to assess the global risks in their country context and lay out the policy option for risk mitigation. The third column reflects the likelihood of each risk materializing. For each country, those global risks that would impact them would be selected, adjusting the implications for each country using the potential implications listed in the table and highlight the policy options.

**There is a significant need for aligning policies by standard setting bodies such as FSB, BIS.** Data and reporting gaps should also be addressed by SSBs and IFIs. Global coordination efforts and better data availability would help quantify the impact of global crypto risks at the country level.

Figure 6: Global Crypto Risk Assessment Matrix (example)

Step 3: Global Crypto Risks		
Risks	Implications	Likelihood
1. Prolonged financial conditions tightening: Countries continue to tighten monetary policy to curb the surging inflation	i. Higher discount rates result in lower PV of cryptos. closing of unhedged and speculative positions leading to sudden price shocks.	
2. Increase in risk aversion in financial markets	i. Repricing of risky assets resulting in spillovers across financial sector participants. Portfolio rebalancing ii. <b>Reversal of search-for-yield to flight-to-safety.</b> might lead to unbalanced price changes in crypto assets safe vs risky. <b>Increased correlation of price volatility</b> between different asset markets.	
3. Bankruptcies of major cryptos	i. Price pressure on "stability" assets if globally held. leading to balance sheet effects ii. Cross border contagion from a systemic failure onto other crypto assets	
4. Increased adoption of cryptos as legal tender	Capital flow fluctuations/sudden stops/ outflows Exchange rate pricing out of line with the fundamentals Weakening of AML surveillance Spillovers from trade-partners Fluctuations in remittances	

Source: Authors' own work.

## 4 Application of C-RAM to Country Cases<sup>12</sup>

### 4.1 EL SALVADOR

#### Context

In September 2021, El Salvador became the first country to recognize Bitcoin as legal tender. In January 2023 the new Digital Assets Law was passed with the objective of reinforcing the use of crypto assets in

<sup>12</sup> This section is partly based on the most recently published IMF Article IV (AIV) consultations for El Salvador (IMF, 2022c), Central African Republic (IMF, 2023c and 2023d) and Vietnam (IMF, 2022d). Only three country cases have been selected in an effort to keep the analysis succinct and to illustrate the possible application of this framework in different world regions. This list of three country cases is not meant to be comprehensive or capture all countries where these risks are relevant.

the country. The government also introduced Chivo, an e-wallet operating transactions in Bitcoin and U.S. dollars. The conversion from Bitcoin to U.S. dollars is guaranteed by a trust funded from the budget (1/2 percent of GDP). The new digital assets law includes the legal framework for the issuance of a Bitcoin-backed bond, the Volcano Bond. The adoption of Bitcoin by households and corporates has been limited so far (Alvarez et al., 2023).

### Step 1. Decision Tree

Given the legal tender status of Bitcoin in El Salvador and following the decision trees previously discussed, the coverage of crypto assets would be deemed necessary in the country monitoring. In addition, the use of crypto assets in El Salvador could also be assessed as a macrocritical as recent regulatory and legal changes entail the risk of substantial cryptoization in the country, undermining financial stability and affecting the large remittances and other capital inflows.

### Step 2. Country risk mapping

**We start analyzing the main vulnerabilities and risks in the fiscal, monetary and financial sectors.** Broad coverage of economic sectors is compulsory to clearly map the risks to macroeconomic stability.

**Fiscal sector.** A number of risks of the fiscal sector to crypto assets can be highlighted, namely market risk, liquidity risk, and regulatory risk as discussed in our country risk mapping. *Market risk* was captured through the risk of Bitcoin price fluctuations and its implications for the fiscal buffers, the government's convertibility warranty in Chivo, and the loss of value of the government's Bitcoin portfolio. *Liquidity risk* due to limited access to markets could be amplified as Bitcoin prices continue declining and government revenues or buffers deteriorate. *Regulatory risks* are also elevated in the context of public financial administration constraints including tax collection, and AML/CFT implications have been highlighted in various surveillance reports, calling the country to strengthen its supervisory and regulatory frameworks.

**Monetary and financial sector.** While banks are not currently allowed to hold any crypto assets, the coverage of the financial sector is essential because of the risks of financial disintermediation posed by Bitcoin. *Liquidity risks* are high in Chivo, as it is not subject to central bank standards, and it is not clear how customers' funds are safeguarded. *Concentration* risk may not be substantial since banks and financial institutions are prohibited from holding and trading crypto assets although Chivo could become a systemic infrastructure as crypto adoption rises in the country. *Regulatory risk* is high in the context of lack of robust internal risk and control frameworks in crypto asset exchanges and wallet providers. Sufficient AML/CFT requirements need also to be addressed in Chivo to reduce financial integrity risks. *Operational risk* can also be analyzed in the context of IT infrastructure, internet access and financial inclusion.

### Step 3. Global risks.

Global crypto risks are likely to be relevant for El Salvador given the high level of dollarization and dependence on the U.S. economy and the relatively high correlation of crypto assets and U.S. stocks.

## 4.2 CENTRAL AFRICAN REPUBLIC

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### Context

In April 2022, the Central African Republic became the second country in the world to adopt Bitcoin as legal tender. Soon later, the government announced a plan to launch its first crypto currency, the Sango, as part of an ambitious project that includes the tokenization of natural resources (the Sango Project). Given that the legal tender of crypto assets was eventually abolished in April 2023, the following is for illustration purposes.

### Step 1. Decision Tree.

Given the legal tender status of Sango coin in CAR, the coverage of crypto assets is deemed necessary in country reviews and monitoring.

### Step 2. Country Risk Mapping

Without proper regulatory and supervisory safeguards, the following risks would emerge in case of cryptoization of the economy, which would be aggravated with crypto assets having legal tender status<sup>13</sup>:

- *Legal risk*: The application of CEMAC laws and regulations could render contracts executed under CAR crypto law provisions illegal or unenforceable. This risk also derives from contradictory or inconsistent regulations, such as the regulatory misalignments highlighted in the section on legal risks.
- *Credit risk*: The acceptance of crypto assets as collateral, with improperly designed legal protection and haircuts can increase credit risk. Crypto asset volatility could give rise to adverse wealth effects to the exposed corporate or household balance sheets', which in turn could reduce repayment capacity and deteriorate bank assets quality through raising NPLs.
- *Liquidity risk*. In the case of CAR and CEMAC banks, holding and dealing with crypto assets could deteriorate banks' liquidity, as crypto assets may not qualify as high-quality liquid assets. In addition, the Sango Project involves the deployment of a payment system and other market infrastructures that would act as central security depositories and securities settlement systems, for which liquidity risks may also materialize.
- *Market risk*: potential direct or indirect bank exposures to extremely volatile crypto assets could increase market risk, with important spillovers across the monetary union.
- *Operational risk*: The Sango project involves complex infrastructure, and this translates in high operational risk. Deficiencies in information systems or internal processes, human errors,

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<sup>13</sup> This is based on the recently published Selected Issues Paper in CAR' AIV consultation for 2023 (IMF, 2023d).



management failures, or disruptions from external events could result in the reduction, deterioration, or breakdown of services provided and even result in large losses of customer funds.

- *Cyber risk*: The Sango infrastructure proposes a model with centralized elements, which increases the risk of failure, in contrast to crypto assets issued on a decentralized public network with nodes and validators potentially spread around the world.

### Step 3. Global Crypto Risks.

Global crypto risks are not likely to be highly relevant in CAR, although the spillovers with and from other CEMAC countries could be substantial.

## 4.3 VIETNAM

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### Context

According to some data sources (e.g. Chainalysis or Statista), the use of crypto assets in Vietnam is among the highest in the world (Figure 7). Despite the popularity of Bitcoin and other crypto assets, the Vietnamese law does not make any references to these assets.

### Step 1. Decision Tree

While Vietnam has one of the highest crypto adoption levels in the world, it is unclear crypto should be deemed as macrocritical. By law, virtual currencies are not recognized as a means of payments, and people using crypto as a means of payment could face heavy fines. It is illegal to conduct financial transactions in virtual currencies in Vietnam. There is no strong evidence that the financial sector is exposed to crypto.

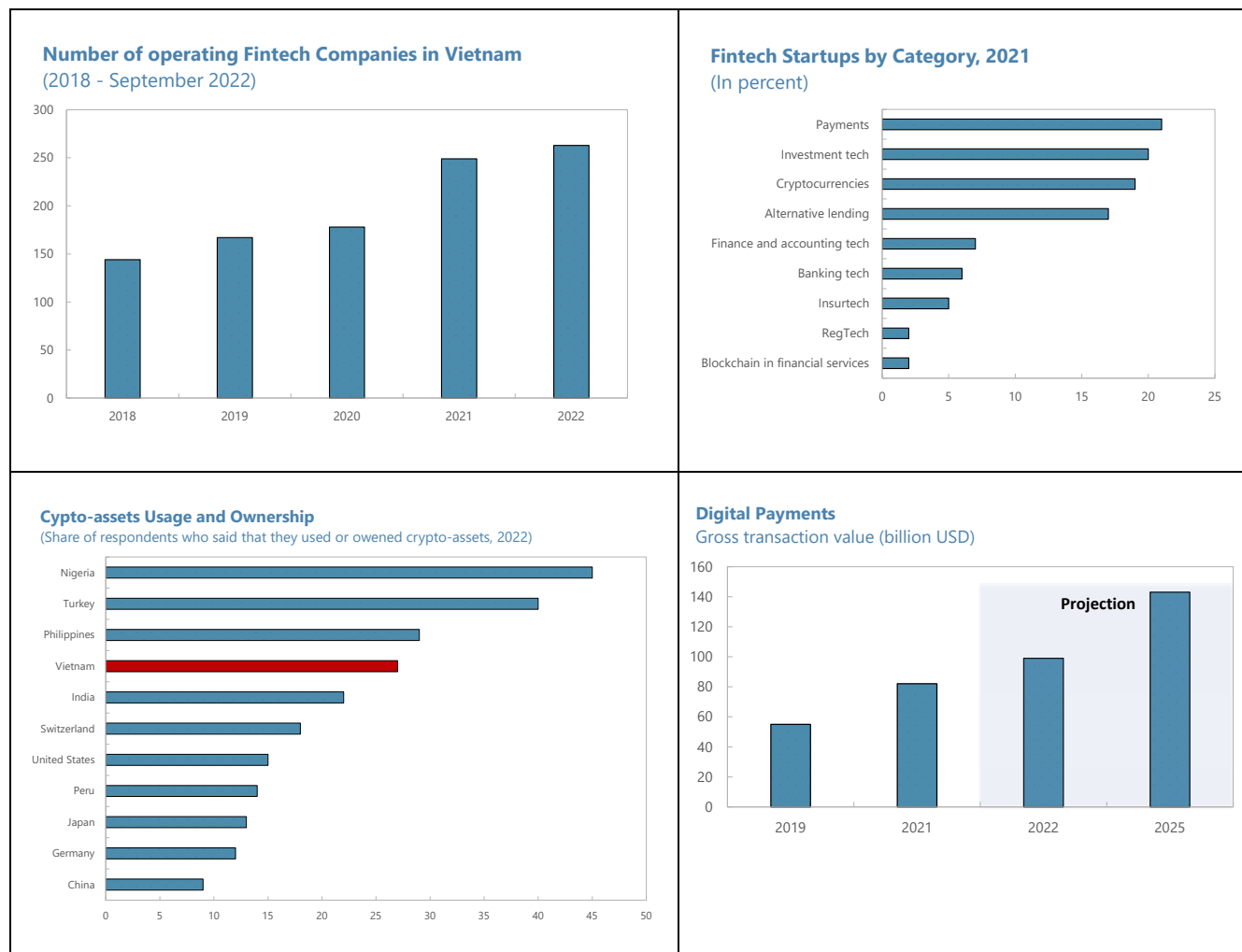
### Step 2. Country Risk Mapping

Credit risk can be discussed in the context of e-commerce, e-wallet and digital payments with cross-country comparisons. There have been efforts by the State Bank of Vietnam to reinforce regulations against operational (cybersecurity) and regulatory (surveillance) risks. Concentration risk may also be relevant in the context of increasing presence of fintech. Rapid development of fintech solutions including crypto assets has also implications in terms of consumer protection, with risks of fraud on decentralized finance platforms, AML/CFT risks, and financial integrity. Lack of clear and complete legislation is clearly identified as a risk in P2P and crypto activities.

### Step 3. Global Crypto Risks

Global crypto risks are likely to be relevant for Vietnam given its relatively high dependence on external markets.

Figure 7: Crypto Firms and Fintech in Vietnam



Source: Statista.

## 5 Policy Challenges and Implications

**The rapid development of the crypto sector presents significant challenges to the existing financial and macroprudential policy frameworks.** We identify a number of areas where coordinated efforts would be needed, but by no means this is an exhaustive list.

### *i. Data collection*

**Sufficiently granular and high frequency data is needed to provide a broad view of credit exposures, including crypto providers and traditional financial intermediaries.** This must also include foreign exposures in addition to payment providers and other service providers, to form a view on their systemic importance in the financial or real sectors. While the decentralized structure of crypto assets and high level of anonymity of the blockchain may pose challenges for data gathering, public access to the blockchain is guaranteed by design, which facilitates monitoring. To facilitate the task, sufficiently granular and high frequency data reporting requirements could be formally set by the regulator for crypto firms and financial institutions. This would also facilitate the coverage of crypto-related data in monetary, external and other official macroeconomic statistics (IMF, 2019; FITT, 2022). International data sharing arrangements between national regulators could be set to facilitate foreign data collection and analysis.

### *ii. Building supervisory bodies and international cooperation given the cross-border risk*

**The decentralized market and governance structure of the crypto eco system impedes its effective monitoring and supervision.** On the other hand, the digital nature and the use of distributed ledgers favors real time and highly granular data gathering as demonstrated by the multiple crypto data and business intelligence providers. Therefore, establishing or reinforcing international supervisory bodies and coordination among them should be prioritized (IMF, 2023e).

### *iii. Expanding the existing macroprudential policy toolkit with crypto and DeFi specific measures*

**The first line of defense against increasing vulnerabilities in the crypto eco system is to reinforce micro and macroprudential supervision.** Cross exposures between crypto actors and financial institutions should be properly monitored and appropriate risk weights and maximum concentration ratios be imposed. Stablecoin issuers are particularly vulnerable and sufficient capital and liquidity minimum requirements should be enforced. Regulations to reduce operational vulnerabilities and cyber risks are also particularly important.

**More generally, a system-wide analysis of cross-interdependencies between cryptos and traditional financial players is needed, and appropriate structural tools should be imposed.** For instance, certain banks may be of systemic importance as they are particularly exposed to large crypto actors. Interaction with other macro policies such as monetary policy, CFMs, should also be taken into account to ensure a desirable overall impact from crypto-specific policies.

## 6 Conclusion

**Over the last few years, the private crypto asset industry has experienced rapid growth and is becoming increasingly more integrated into the global economy.** It represents a new shadow financial system with substantial risk implications for the traditional financial sector and beyond. Existing policy frameworks are yet to catch up with this new financial market amidst potential systemic risk implications. This has been illustrated by the recent crypto winter, failure of large crypto issuers and platforms, and banks calling for better data, monitoring and policies.

**In this paper, we present a conceptual framework to identify the micro and macroprudential risks stemming from the rapidly growing private crypto sector.** We propose a three-step tool, Crypto Risk Assessment Matrix, to assess and surveil these risks and their systemic risk implications in country reviews. The C-RAM comprises a country risk mapping and a global risk assessment using the conceptual framework discussed in the first part of this paper. We aim to present a dynamic tool that can be updated as new analyses and data become available.

**Significant policy challenges remain, calling for international cooperation.** The lack of data and any centralized data collection is a key challenge and should be prioritized. Therefore, establishing or reinforcing supervisory bodies and international cooperation given the cross-border risk is of utmost importance. The current policy toolkit remains inadequate given the speed of progress, innovation and decentralized nature of this market. This challenge calls for expanding current macroprudential policies with more crypto and DeFi-oriented policies. The interaction and complementarity with other macro policies should also be considered in crypto policy design.

**Going forward, the conceptual framework presented in this paper is to be updated as more data and country analysis becomes available.** Coordinated efforts of international organizations will also help refine this framework and tailor effective policies to contain macrofinancial risks from crypto assets.

## Appendix. Crypto Taxonomy, Main Actors and Risks

**Crypto assets are defined as a privately issued digital representation of value, cryptographically secured, and deployed using a distributed ledger technology.** CBDCs are excluded from this definition as they are issued by central banks.

**Crypto assets encompass different subcategories based on underlying features.** The main features are a) centralized or decentralized issuance; b) existence of a claim on the issuer; c) backing assets, and; d) stability of price.

**Based on this definition, recent IMF work (IMF, 2023a) classifies crypto assets in a) unbacked tokens, b) stable coins, c) utility tokens, and d) security tokens.** These are defined as follows:

- Unbacked tokens, such as Bitcoin are digital assets that have no backing assets, are usually issued in a decentralized manner, are transferable, have no redemption pledge, and provide no direct claims on the issuer.
- Stable coins such as Tether are usually issued by a centralized entity and are designed to maintain a stable price.
- Utility tokens are crypto assets that are usually centrally issued and provide the token holder with access to an existing or prospective product or service.
- Security tokens are crypto assets that are usually centrally issued, are transferrable, and that meet the definition of a security within respective jurisdictions.

Table 1. Main Risks for Crypto Holders, by Crypto Asset Type<sup>14</sup>

Crypto asset	Credit risk	Market risk	Liquidity risk	Operational and cyber
Unbacked tokens		X		X
Stable coins				X
With claim on issuer	X	X	X	X
Without claim on issuer		X	X	X
Utility and security tokens				X

**Risks associated with crypto issuers are particularly elevated when there is a claim associated with the crypto asset.** In that case, assets used by issuers to back up the issued cryptos are exposed to swift changes in market prices, counterparty default or lack of access to liquidity.

**Wallet providers or crypto exchanges and platforms are also exposed to various risks.** These include cyber/operational, market and liquidity risks.

**Miners fund their operations by monetizing the rewards they receive to verify transactions and adding them to the ledger.** Sudden price declines or energy cost rises can severely jeopardize the miner's business model using proof-of-work consensus mechanism, affecting also the supply of crypto assets and also crucial operational elements.

<sup>14</sup> Definitions used: Market risk is the risk of losses in positions arising from movements in market prices. Credit risk is the risk of default on a debt that may arise from a borrower failing to make required payments. Liquidity risk is a financial risk that for a certain period of time at a given financial asset, security or commodity cannot be traded quickly enough in the market without impacting the market price. Two subcategories are market liquidity risk (an asset cannot be sold due to lack of liquidity in the market) and funding liquidity risk (the inability of a financial intermediary to service its liabilities as they fall due).

Table 1. Main Risks by Crypto Asset Function/Actor

<b>Functions/Actors</b>	<b>Credit risk</b>	<b>Market risk</b>	<b>Liquidity risk</b>	<b>Operational, cyber and other risks</b>
Issuers	X	X (Assets used to back redemptions may change price)	X (Risk of a run if assets backing cryptos are not enough)	X
Miners/validators		X (Risk of crypto prices falling, reducing revenues)		X
Crypto exchanges/ platforms	X (Risk of default of borrowers)	X (Risk of inventory values falling)	X (Risk of not having enough liquidity to meet selling orders of clients)	X
Wallet providers	X (Risk of default of asset holders)	X (Risk of crypto prices falling, reducing revenues)	X	X
Investors	X (Risk of default for claim based cryptos)	X (Risk of crypto prices falling)		X
Payment providers	X	X (Risk of price change during crypto transfer)	X	X

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