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THE INTERCONNECTEDNESS OF DECENTRALIZED FINANCE WITH THE TRADITIONAL FINANCIAL SYSTEM AND POTENTIAL IMPLICATIONS FOR SYSTEMIC RISK

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Declaro que sou o autor desta obra, que é original e inédita. Os autores e obras consultados são devidamente citados no texto e estão incluídos na lista de referências.

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(Hugo Miguel de Araújo Veloso Gomes)

ABSTRACT

Decentralized Finance (DeFi) was introduced to replicate the traditional financial system in a more open and transparent way by removing intermediaries and enabling peer-to-peer interaction in a way that was not possible until now. However, with innovation, unknown risks and concerns always arise, and the case of DeFi is no different. The main objectives of this research are as follows: to understand how the DeFi ecosystem works; examine if this new technology can bring innovation to the financial system; analyze if it can be a potential threat to the global financial system stability; and understand which aspects of interconnectedness can exist between DeFi and the traditional financial system, how prone can DeFi be to systemic risk, and how this could impact the global financial system. The analysis shows that DeFi has traits that have the potential to bring great innovations to the financial system, although it also has several risks. The study shows that some of the main characteristics of DeFi are already creating a bridge between both markets; the interconnectedness between both markets is growing with the growth of the financial institutions participating in the DeFi markets. Whenever the level of interconnectedness is high, the systems tend to be more prone to systemic risk. The case of DeFi is no different. Systemic risk is present within both markets, and potential spillovers are more likely to happen with the continuous growth of interconnectedness. Regulators and policy makers will need to explore and create new ways to enforce the regulations needed to create a space where users are protected and global financial stability is assured without compromising the innovation happening within this ecosystem.

Keywords: Decentralized Finance, Interconnectedness, Systemic Risk, Traditional Financial System, Financial Stability, Stablecoins.

RESUMO

DeFi é o acrónimo de Finanças Descentralizadas em inglês. Foi criada com o objetivo de replicar o sistema financeiro tradicional, mas de uma forma mais aberta e transparente, removendo os intermediários e permitindo a interação entre pares de uma forma que até agora não era possível. Mas com a inovação, há sempre riscos e preocupações desconhecidos que surgem, e não há diferença neste caso. O principal objetivo desta investigação é compreender como funciona este ecossistema, compreender que tipo de inovação esta nova tecnologia poderá trazer ao sistema financeiro. Após isso o principal foco é analisar se este novo sistema financeiro decentralizado pode ser uma potencial ameaça à estabilidade do sistema financeiro global e que pontos de interligação é que já existem e que outros podem vir a existir entre as finanças descentralizadas e o sistema financeiro tradicional, é também analisado se este novo sistema pode ser propenso ao risco sistémico e de que forma pode impactar o sistema financeiro global e se pode por em causa a sua estabilidade. Os factos analisados mostram que a DeFi tem características que têm o potencial de trazer grandes inovações para o sistema financeiro, no entanto ainda existem uma grande variedade de riscos a ter em conta. A investigação mostra que algumas das principais características de DeFi e que são fundamentais para o seu funcionamento, já se encontram a criar a ponte perfeita entre ambos os mercados, a interligação está a crescer entre ambos os mercados. Com instituições financeiras cada vez mais a participar e a aumentar a sua exposição a este tipo de produtos, que por sua vez aumenta a interconexão entre ambos os mercados. Sempre que existe um elevado nível de interligação, os sistemas tendem sempre a ser mais propensos e expostos ao risco sistémico e a relação entre estes dois mercados não é diferente. O risco sistémico está presente em ambos e as potenciais repercussões são mais prováveis de acontecer com o contínuo crescimento da interligação. É fundamental que os reguladores e os decisores políticos terão de explorar e criar formas de garantir a aplicação dos regulamentos necessários para criar um espaço onde os utilizadores estejam protegidos e que asseguram que a estabilidade financeira global é protegida, mas sem comprometer toda a inovação que está a acontecer dentro deste ecossistema.

Palavras-chave: Finanças Descentralizadas, Interconectividade, Risco Sistémico, Sistema Financeiro Tradicional, Estabilidade Financeira, Moedas Estáveis.

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LIST OF ABBREVIATIONS

DeFi – Decentralized Finance

TradFi – Traditional Finance

FOMO – Fear Of Missing Out

DEX – Decentralized Exchanges

CEX – Centralized Exchanges

AMM – Automated Market Makers

MMF – Money Market Fund

KYC – Know Your Customer

AML – Anti Money Laundering

CFT – Combat Financial Terrorism

CBDC – Central Bank Digital Currency

1. INTRODUCTION

Decentralized Finance (DeFi) was created to revolutionize the way the financial system works, the goal is to be an alternative to the traditional financial system where intermediaries no longer exist, and transactions are made directly between users.

It all started when the financial system was reevaluated at the end of the crisis of the late 1990s, which led to an improvement in the functioning of national and international financial systems. Regulation and financial supervision were enhanced and better coordination among financial policy officials was promoted to guarantee that a similar crisis would not occur again.

However, the eruption of the major financial crisis in 2007 demonstrated that the new architecture failed to fulfill its objective. At the end of the 2008 crisis, regulators and supervisors worldwide developed stricter rules for the financial system to prevent something similar from happening in the future. This crisis showed us how great interconnectedness in the global financial system is and to what extent it can affect the system.

The global financial system is a combination of institutions and formal and informal economic actors that have a wide array of functions essential for the correct functioning of the economy to guarantee economic growth and stability. To do so, the financial system relies on the banking system as an intermediary, which leads to banks possessing great power, not just because of the money entrusted to them but also because of the financial system's total reliance on them.

Along with an opaque system, the above mentioned set of factors allows banks to use their power to maximize their interests and profits. The 2008 financial crisis showed that this opaque system as well as the banks' influence within the financial system made it possible to create a situation that — along with the high level of interconnectedness between all economic agents in the system — led to a financial crisis the effects of which reverberated throughout the world.

As a result of this crisis, Nakamoto (2008) invented Bitcoin to create a decentralized and transparent system that eliminates the need for a financial intermediary, relying on the security of cryptography with the invention of blockchain — a shared, immutable ledger that facilitates the process of recording peer-to-peer (P2P) transactions.

This innovation made possible the creation of new applications that rely on the blockchain system. One leading application that is being rapidly developed and that emerged as a solution for those who do not want to rely on the traditional financial system is DeFi, which aims to replicate the traditional financial system in a more open, decentralized, and transparent manner through the use of smart contracts. These smart contracts were developed and implemented using the Ethereum blockchain, creating the technical foundation for DeFi (Buterin, 2014).

Through these new technologies, DeFi supports products similar to those existing in traditional finance (TradFi), such as asset exchanges, loans, and leveraged trading, among others.

Since the 2008 financial crisis, the interconnectedness of the financial system has gained increased attention from financial supervisors and regulators, which is essential for the supervision of systemic risk. Héam (2014) highlighted the risk of contagion through the interconnectedness of financial institutions using the examples of American International Group (AIG), Lehman Brothers, and Bear Stearns whose defaults led to the 2008 global financial crisis. Hynes (2020) added that systems that are more exposed to systemic risk are highly interconnected and intertwined.

Given the velocity at which they are evolving, these new ecosystems could reach a point at which they become a potential threat to global financial stability due to their increasing interconnectedness with the traditional financial system.

As the Financial Stability Board (FSB) (2018) report highlighted, an increase in the scale and interconnectedness of and in the institutional involvement in crypto-assets markets could jeopardize global financial stability.

Therefore, it is essential for financial regulators and system participants to understand the interconnectedness of both financial systems and the channels through which this

occurs so they can take measures to prevent any negative impact from spreading throughout the financial system so as to mitigate global financial instability and prevent another financial crisis.

This study aims to explore the main characteristics of DeFi and how prone this new system can be to systemic risk, while understanding the interconnectedness between DeFi and TradFi and how that affects global financial stability.

First, we describe DeFi and its characteristics to gain an understanding of the system. Next, building on the work by Schär (2021), we have a closer look at the DeFi architecture to understand its layers and their purpose. According to Schär (2021), DeFi can be divided into five different layers.

Then, is analyzed the current market state of DeFi to understand its evolution since its day of creation until recently. A significant drop in the total value locked (TVL) in DeFi was noticed, which was due to a recent incident where stablecoin TerraUSD lost its peg to the US Dollar when is main objective and utility was to maintain its value stable and in this case was not able to guarantee that.

This case demonstrated that if stablecoins cannot fulfill their purpose of keeping their value stable, it can lead to the loss of investors' trust and, consequently, a total depreciation of the product. The TerraUSD incident had repercussions all over the crypto-assets markets and led to financial losses of individual investors and some companies.

We compare the three most distinctive characteristics of DeFi to that of the traditional financial system. First, we explore the different types of governance in DeFi and how they are different from that of TradFi. Second, we examine how decentralized exchanges (DEX) work differently from centralized exchanges (CEX), which are more familiar to the market participants. The third characteristic we focus on is the role of stablecoins in DeFi.

The study tries to understand stablecoins and how they work. It is concluded that they can be the main point of contact between DeFi and TradFi; this way, they have the potential to affect financial stability in the future.

We also identify the potential advantages of DeFi. These include the opportunity to achieve financial inclusion for those who do not have access to financial services, primarily because they live in remote places. In the DeFi ecosystem, these people can access financial services using a smartphone and internet connection and, thus, improve their lives.

Since DeFi is a new market and has an unregulated environment, potential risks to individual investors and institutions also exist. We highlight that the more users come into this space, the more investment in financial literacy is needed for everyday investors to have a good perception of the risks they are exposed to when using DeFi protocols.

More independent audits of smart contracts are also needed for the users to have more confidence in them instead of blindly trusting the developers. The high leverage available in CEX and in DEX alongside the high volatility present in this market can also amplify market stress as the use of high leverage leads to more significant losses.

The borderless nature of DeFi with no defined jurisdiction and geographical location for oversight and regulatory compliance can lead to an increase of illicit uses from criminals. International policy collaboration is needed to overcome these challenges at the cross-border level.

After exploring the most crucial aspects of DeFi, we then focus on understanding the importance of systemic risk in the global financial system, its importance in the interconnectedness of financial services, the potential contagion channels between DeFi and TradFi, and how this risk can be mitigated.

First, we try to understand and define systemic risk in a financial system. As this is a broad subject that can be present in almost all sectors of the economy, it was understood that systemic risk could emerge from the synchronization of the agents' behavior or through the interconnectedness of agents. For this reason, it is essential to understand the weight of systemic risk in highly interconnected systems.

With that in mind, the financial crisis of 2008 is an example of how systemic risk, together with a highly interconnected system, can have disastrous consequences. It is

pointed out that connections in DeFi are still very limited, but they are increasing and can have implications for global financial stability in the future.

Next, we look at what types of interconnectedness channels exist in the financial markets. Four main contagion channels were identified that can lead to herding behavior or panic among the investors and increase the initial impact.

Analyzing the DeFi and TradFi intersection, it is possible to verify that the previous contagion channels can also be identified in the DeFi market. Further, the number of institutional investors is growing in different sectors and, consequently, the intersection between both markets is also growing. This growth might lead to more use of stablecoins, creating a bridge of interconnectedness between markets, making it one of the most significant points of vulnerability as a potential channel of transmission.

Keeping this in mind, the present study looks deeper into the possible interconnectedness channels between DeFi and TradFi. It first identifies the transmission channels within the crypto-assets markets, where four transmissions channels are identified: (i) financial-sector exposures to crypto-assets, (ii) wealth effects, (iii) confidence effects, (iv) crypto-assets used in payments and settlements.

When looking only at DeFi, the channels identified as potential contagion channels are the stablecoins, as we had referred to before, which constitute the most significant point of vulnerability of DeFi. The other potential channel is the tokenized assets created specifically for institutions. This might lead to more significant participation and a more significant connection to the traditional market.

Finally, we analyzed the way in which systemic risk can be mitigated between both markets. The analysis revealed a regulatory gap exists that needs to be filled. However, filling that gap will be a challenge considering DeFi's decentralized nature and international range.

It is pointed out that governance protocols can be a natural entry point for policymakers to prevent and contain risks related to DeFi. In conjunction with that, another possibility can be the central bank's digital currency, which can bring a safer way to use protocols, thus limiting the risks associated with stablecoins and improving the stability of DeFi

markets. In conclusion, regulators and policymakers will have to be creative and explore more ways to ensure that their regulations will be enforced even if this means the creation of new tools to achieve that goal.

Understanding how the world of finance as we know it today may change in the near future and how crypto-assets are fast evolving is essential to understanding if and how this can be a threat to the stability of the global financial system.

This study aims to contribute to an increase in the knowledge about DeFi and to create awareness about which contagion channels regulators and policymakers should create regulations for to prevent spillovers from affecting global financial stability and to guarantee the best protection possible to the users of this space, regulators should aim to promote innovation without stifling it.

2. METHODOLOGY

As all the literature available on this topic is still very recent and limited, and mostly explored by regulators, policy makers, and financial institutions, we mainly chose qualitative methods to collect available information from scientific articles of institutional research, websites related to the topic, and institutions connected to the crypto-assets market.

The analysis started by exploring the research and scientific papers available on this topic, followed by interpretation of the information gathered to determine the best studies on this topic. These studies were then used to develop our study. It is also important to note that scientific papers published during the execution of this research were also analyzed.

3. WHAT IS DECENTRALIZED FINANCE?

Chohan (2021) refers to the term DeFi as a new sub-field of blockchain with the primary objective to be an alternative to TradFi. Among all the other sub-fields created in the past, DeFi has been one of the fastest growing, justified by its ideological leaning or the search for the highest returns possible (Chohan, 2021).

DeFi's main objective is to replicate the financial services without depending on intermediaries or centralized entities. This makes it a non-custodial system, where the users have complete control over their digital assets and where they also take all the accountability of securing their assets. This makes this a peer-to-peer system built on public and permissionless blockchains where the protocols rely on smart contracts to work, trusting its security and transparency.

The creation of blockchain technology made the existence of DeFi possible with the creation of several projects to become an alternative to the traditional financial system by excluding intermediaries and decentralizing the financial services. Zetzsche (2020) held that this technology can offer governance structures that can be seen as a democratization of finance and thereby promote financial inclusion and create new opportunities for entrepreneurs and innovators. However, Zetzsche (2020) said that "the DeFi vision however is more than this: the objective is to develop systems which use technology to eliminate borders, jurisdiction, and the necessity of centralized control including governments".

Open access and transparency are the main characteristics of this technology, which permitted Vitalik Buterin to create the Ethereum blockchain, where the first idea and execution of smart contracts was made possible (Buterin, 2014). As Buterin (2014) explained, a smart contract is a "system which automatically moves digital assets according to arbitrary pre-specified rules", enabling the replication of products identical to those that exist in the traditional financial system.

The creation of a smart contract allows the users to define the rules of the contract in which, if the conditions can be determined, they will automatically trigger other actions to receive or send funds or even the execution of other smart contracts. This type of automation enables the creation of existing financial services over the blockchain

networks, where the network itself assures the conditions and rules of execution (Keller & Stolzenberg, 2021).

One of the main characteristics of DeFi is its non-custodial nature; no central entity has access to or control of the user's assets. In other words, the users have the responsibility to manage their private keys to access their digital assets, with the risk of completely losing access to their funds if they lose the private key, without any chance of getting it back, as there is no centralized entity.

The DeFi protocols are built on top of public blockchains, and the fact that applications on DeFi are open source allow the community to review and develop the code of the protocols, making this the most important innovation brought by DeFi. A strong community of participants is important for network materialization. The more the participants, the more value is generated as the network grows. The community is also vital in governance since many DeFi applications distribute governance tokens, allowing the users to have an active voice in some decision-making topics.

The open-source applications allow the users to be a part of the creation of innovative products and new types of structures. This freedom to create makes it possible to combine several components in DeFi applications (i.e., smart contracts, protocols, and digital assets). This composability is another important innovation that DeFi brought. This creates an immense opportunity for new products and structures, increasing the value of DeFi applications while contributing to network growth.

The IOSCO (2022) report highlights a new organizational structure to achieve a more decentralized system. A decentralized autonomous organization tries to mirror the operation of a corporate entity by building the concept of a smart contract.

As reported by Keller and Stolzenberg (2021), the current customer base of DeFi is often formed by users or institutions looking for a way to maximize their returns with digital assets using yield farming or liquidity mining, which is a process that enables users to lock their crypto-assets in specific protocols to generate rewards in exchange for the liquidity provided to the system or to speculate on the potential growth market.

This forms the perfect conjunction to justify the exponential growth that has been witnessed. However, exponential growth also brings underlying risks to investors and its applications. Users with malicious intents can take advantage of the open source's transparency and exploit vulnerabilities and lead to users losing their digital assets, sometimes culminating in the loss of millions or even billions.

3.1 DeFi Architecture

DeFi uses a public blockchain as the base where all transactions are recorded and smart contracts are run. Smart contracts are programs that execute automatically when determined events occur. This automation allows the creation of new financial services where the network itself guarantees that rules and conditions are executed. While the main action in DeFi occurs on a determined blockchain (on-chain), the users also trust technologies apart from the blockchain (off-chain) to shape new products, coordinating and informing activities such as those in online forums or social media. It is through these means of communication that communities are created and develop around projects. It is in the interest of the project owners that the community grows so that more users will use their products. Social media is also used to attract new investors, such as IOSCO (2022) highlight that "retail investors are drawn by profit-making opportunities, including rates of return or types of investments that they cannot access in the traditional market. Participants talk about their non-financial gains from participating in protocols. They discuss the value of contributing to projects and being part of communities that reflect their personal values". This way it is possible to understand that social networks also have a great weight in the development of projects.

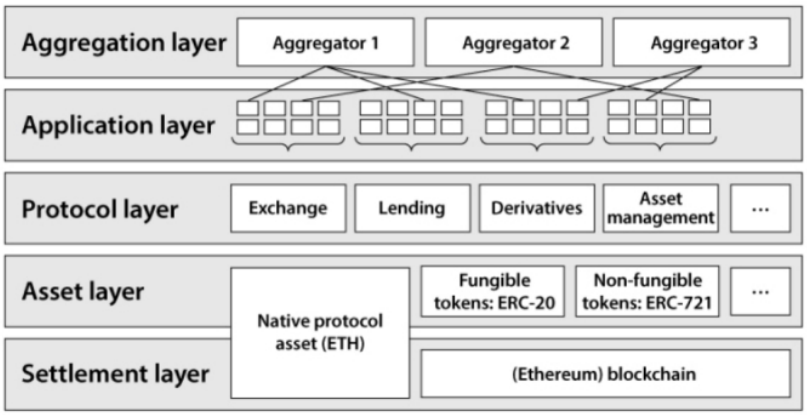
DeFi architecture can be divided into five different layers:

- **The settlement layer:** This is where the transactions are documented on the blockchains, where users have the addresses that hold their crypto-assets and with which they make transactions with other users or make use of smart contracts.
- **The asset layer:** This is where crypto-assets are created, bought, and transferred on a blockchain.
- **The protocol layer:** This is where we find the different protocols for DeFi where the smart contracts are used to grant functionality to DeFi protocols.

- **The application layer:** This is where the decentralized applications store their underlying protocols and create a more user-friendly interface to make it easier for participants to find and use the services.
- **The aggregation layer:** This is the final and most crucial layer in the DeFi ecosystem where the aggregators connect the different types of decentralized applications. They can smoothen the fund transfers between them and traditional financial instruments, allowing better circulation of crypto-assets.

The figure 3.1 shows how the various layers are arranged and how they interact with each other.

Figure 3.1: DeFi stack



Source: Fabian Schär (2021)

3.2 DeFi Market Evolution

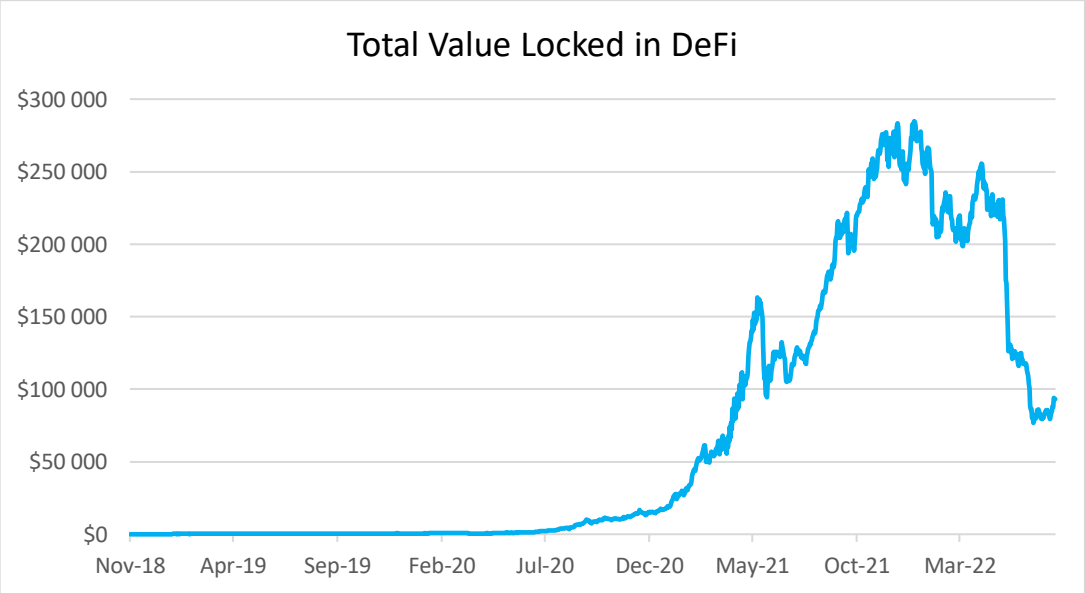
The year of 2020 was the turning point for DeFi. The Total Value Locked (TVL), which shows the global value of crypto-assets that are deposited in DeFi protocols, went from $700 million at the beginning of January to $15 billion in December 2020; this period is the so-called DeFi summer. Several reasons can explain this exponential growth. One is that the market was highly driven by the speculation of early investors about the possibility of very high returns offered by some products. In addition to all speculations, many investors came in with the fear of missed returns (the so-called fear of missing out or FOMO).

From 2020 until now, institutional investors have become increasingly interested in having digital assets in their investment portfolios. However, the reasons for this are not clear yet. An OECD (2022b) points out "that the upside potential for yield in crypto assets has attracted the interest of institutional investors, similar to private investors, as a product of speculation and for fear of missing out". While the hunt for high yield in an environment used to low interest rates is one major driver of institutional investment in DeFi, the crypto space is recognized by its high volatility, which offers an opportunity for higher returns than with the traditional asset classes.

Institutional investors look into digital assets as a potential way to diversify their portfolio and optimize it better. Major crypto assets are often believed to serve as a hedge against inflation or macroeconomic risks, which is another reason for increasing demand for these assets.

Due to this demand for products in the DeFi space, the all-time high for TVL occurred in December 2021, when it reached 287 billion USD. It has now has reached around 90 billion USD, as we can see in the figure 3.2.

Figure 3.2: Total Value Locked in DeFi



Note: The graphic represents the total locked value (TVL) in DeFi protocols (in million USD) between November 2018 and July 2022.
Source: Own elaboration based on data from defillama.com

The chart shows a significant drop in the TVL around March 2022. The stablecoin TerraUSD, which lost its peg to the USD dollar in May 2022, caused this drop. This led investors in the entire DeFi market to lose confidence, and subsequently, the whole crypto market felt the impact which led to a widespread devaluation of the projects and, in the specific case of TerraUSD, led to a 99% devaluation of its value, causing significant losses to investors who were part of the project, but also ultimately affecting all investors in the entire crypto market.

This example shows how volatile this market can be and the risks that institutions are exposed to when participating in these markets.

While this exposure is still too small to have repercussions in the traditional financial system, the system's interconnectedness with the traditional financial system is gaining more relevance as big institutions start adding crypto-assets to their portfolios.

3.3 Governance, DEXs and Stablecoins

In financial services, a significant number of entities, services, and agencies exist for the financial system to work correctly. Each part of it has to work well and if something goes wrong, there is always someone supervising to mitigate any possibility to undermine the overall structure.

Our focus is mainly on the three main services that are used in a completely different way from and revolutionize the way we see financial services. We focus on explaining how these services work, whether they can lead to improvement in the way centralized institutions work, and the risks they can impose on investors and the financial system.

The following points are an analysis on how governance works differently from the traditional institutions, what DEXs are and how they work, and the potential impact of stablecoins on the traditional financial system.

- **Governance**

DeFi aims to replicate the financial instruments that exist in the traditional financial markets in products that private and institutional users coming into the space look for.

From the start, many new products have been developed and several blockchains have been created to develop better options for all kinds of demand.

At the time, more than 200 tokens were related to DeFi only, each representing a different project, which differ in what their product offers and how their governance is conducted. This is one of the most complex parts of the DeFi ecosystem to understand and decide which way is the best.

Keller and Stolzeberg (2021) pointed out that governance is about ensuring that the right decisions are made at the right time, using the correct data to balance the interests of the different stakeholders.

We are used to having an institution that is the intermediary between the market and the investors, where the governance is done internally. In DeFi, the founders of the protocols give the investor tokens that give them a "voice" in crucial decisions, such as in the "monetary" policy of the project. In contrast, in the traditional financial system, is the Eurosystem the monetary authority that manages which monetary policies are applied to the EURO.

This is one example where DeFi works in an entirely different way. While, in theory, it is an excellent way of decentralizing the decision-making to everyone, in practice, the change does not come without risk.

Aramonte (2021) affirmed that "full decentralization in DeFi is illusory". This refer to the fact that all platforms in DeFi have central governance that takes decisions on strategic and operational priorities.

Governance in DeFi works through governance tokens issued by the founders and developers so investors have a say in the voting process when making decisions, similar to corporate shareholders. These governance tokens introduce an element of centralization as the creators and developers usually retain the majority of tokens to maintain their control of the project.

This concentration of power can be risky if a small number of large validators gain enough influence to alter the blockchain for personal financial gain.

After being delivered to some initial investors, these tokens are available on the DEX to be bought by anyone who wants to invest and be a part of the project. As Keller and Stolzenberg's report (2021) highlights, the retention of the majority of governance tokens by some investors or the core developers is another challenge to developing entirely decentralized protocols.

Banco de Portugal (2022) suggested that one way to control governance risk would be to restrict the amount of tokens kept by each individua. Therefore, a strict requirement to know your customer (KYC) would be needed to guarantee that the same person does not have several public keys.

- **DEX**

Gogel (2021) said that exchanges are essential to DeFi in two ways. First, they make it possible for users with different crypto-assets to use DeFi services and provide opportunities to profit from the appreciation of the token's value. In a centralized exchange, the users have to trust an institution regarding the custody of their funds, while providing correct price information, matching the buyers with the sellers to process trades, settling transactions, and monitoring the transactions.

Second, DeFi exchanges aim to decentralize the key functions. Smart contracts automatically process the transactions of DEX on a peer-to-peer basis.

Automated market makers (AMM) are the more prominent form of DeFi exchange as it works differently from the traditional order book CEX. According to Harvey (2021), "an AMM is a smart contract that holds assets on both sides of a trading pair and continuously quotes a price for buying and for selling. Based on executed purchases and sales, the contract updates the asset size behind the bid and the ask and uses this ratio to define its pricing function".

The drawback in AMM is the impermanent loss, Harvey (2021) explains the impermanent loss is "the opportunity cost dynamic between the supply of goods for exchange and holding the underlying assets to potentially profit from the price movement. The loss is impermanent because it can be recovered if the price returns to its original level".

As Gogel (2021) pointed out, “different design choices for DeFi exchanges produce tradeoffs around throughput, latency, security, fees, and slippage”.

Several risks can arise from the use of code. The automation linked to the smart contracts can be a risk to market integrity. Price manipulation and insider trading are a few risks that can be real on a DEX. Once again, regulation and governance are focal factors in the future of DeFi.

- **Stablecoins**

According to the stablecoins white paper by Coinbase (2022), “stablecoins are digitally native payment instruments that are designed to maintain a stable value compared to an external reference asset, usually a fiat currency such as the U.S. dollar”.

The majority of stablecoins are linked to real assets in the traditional financial system, acting as a point of connection between the crypto space and the traditional financial system and allowing a representation of fiat currencies to be used on blockchains more efficiently.

They are necessary for the DeFi to work. They are used as a substitute for fiat currencies as the regular part of the DeFi operations or as collateral for lending or borrowing operations. However, there is no upside without a downside. If a stablecoins loses its peg due to solvency problems that could cause DEXs to go under severe stress and cause mass liquidations. This in turn could lead to investors exposed to losses in DeFi to potentially close positions in TradFi markets. This way, stablecoins can become a liability to financial stability and it is therefore essential to focus on this area in particular.

Different projects use different systems to maintain their stable value. There are three major types of stablecoins that use different types of assets as reserves to back up their value.

- **Crypto-backed:** These are collateralized by digital assets.
- **Fiat-backed:** These are collateralized by reserve assets from TradFi such as cash or securities.

- **Algorithmic:** These are stablecoins that do not have reserve assets as collateral and use algorithms to maintain their value, adjusting the supply corresponding to their digital asset.

The majority of the stablecoins use reserve assets that are linked directly to the traditional financial system as collateral. The rise and wider use of stablecoins across the crypto-asset space in conjunction with the linkages between the DeFi and TradFi systems require a closer look at this ecosystem to ensure the protection of investors and also the wider financial system.

The three biggest stablecoins are Tether, USD Coin, and Binance USD; all these three stablecoins have as collateral either assets that come from TradFi or a type of fiat currency. These three stablecoins control approximately 127 billion USD of the total 153 billion USD stablecoins' market capitalization (data from coinmarketcap.com).

The fact that the top three stablecoins control approximately 83% of the stablecoins' total market cap and that their collateral are assets from the traditional financial system means that these stablecoins are almost the perfect bridge between DeFi and TradFi. This can and will lead to an increase in the interconnectedness between both financial systems.

This interconnectedness is a channel through which the volatility and instability in the crypto markets can directly impact the traditional financial system.

3.4 Opportunities and Risks of DeFi

DeFi brings fast-paced innovation to the financial system which has been slowly evolving since its creation. Automation and immutability, where the processes are automatic and where should be impossible for any entity to manipulate, replace or falsify data that is stored in the network, are two key points to consider when looking at the advantages this new financial ecosystem can bring to a system with several years of evolution.

Democratization of financial services and a much broader financial inclusion are essential points to consider since DeFi makes it possible for anyone from any place with a smartphone and an internet connection to participate, making it accessible and inclusive

for billions of people without access to financial services. These two advantages are hailed by its proponents.

As pointed out by Patrick Schueffel (2021), the data security of the blockchain is exceptionally high since the system does not require any trust in a counterparty. This way, there is no space for anyone—not even the government authorities—to censor or manipulate the data in the system.

DeFi is relatively transparent since all the underlying software, from data to processes, are mostly open-source and permissionless. This enables the possibility for any user to program DeFi applications and contribute to expanding and improving the network, making the system highly flexible. The security of this system derives from its transparency and the replacement of the middleman as a source of error.

Carapella (2022) said that transparency can also be considered a benefit because of the "simplification of audits", since every information in a public blockchain, from all the transactions to balances, are available for anyone who wants to consult. This comes with a price to the traditional institutions, since this increased transparency will expose all the transactions and positions to other competitors, which can lead to the use of that information to perform market moves against them and undermine their business (Carapella et al., 2022).

Vulnerabilities and risks arise with every new evolution, and the case of this new system is no different. The fast growth of DeFi has shown that the system is not flawless. One of the issues is when DeFi's essential tool turns out to be the problem. Smart contracts are the most crucial aspect of DeFi, but if one of these is incorrectly programmed, this can turn out to be a big issue for the whole system.

Schueffel (2021) stated that "if such an integral part of the system is incorrectly programmed and then runs automatically and unstoppably, it can have fatal consequences for the entire system". Thus, the strengths of DeFi can become a massive disadvantage if a malfunction like this happens. These problems can be worse as no counterparty can be held responsible in such cases.

In this space, every user is on their own to understand the technicalities behind the protocols and guarantee their safety. Therefore, it is fundamental to improve the regulations on it and reinforce the financial literacy of the persons for them to be able to understand better the risks they are being exposed to so that they can protect themselves. This lack of knowledge in most of the users makes them exposed to relying only on the software developers; this way, the users risk their funds to possible scams or exploitation.

These essential questions have been pointed out in the Banco de Portugal (2022), which also highlights the need for more frequent independent audits for better scrutiny of the smart contract code to guarantee that the code is safe and secure enough to be used. This way, everyone can ensure that their funds are safe from exploitation and hacking.

The high leverage available in DeFi is another major risk present in this system. Aramonte (2021) shows that despite the loans in this system being normally overcollateralized, it is possible that the funds borrowed before can be re-used as collateral in other transactions. This way, users can increase their exposure for a given amount of collateral.

The leverage available in the regulated exchanges is a lot lower than that in unregulated crypto CEX, which can exacerbate procyclicality. With the high volatility in this market, the high leverage can be an additional pressure on the debt that will eventually need to be reduced. In the case of depreciating collateral, the investors are forced to shed assets. All this, along with the built-in interconnectedness among DeFi applications, can lead to amplified distress in the markets and increase the risk of significant losses with the use of high leverage.

The abovementioned factors are gaining increasing attention because of the rapid evolution of these markets. The FSB (2022) report showed that due to the international nature of DeFi, where the use of these crypto-assets varies beyond different jurisdictions, the risks for financial stability can rapidly increase and reach a point where it can become a threat to global financial stability due to this range and structural susceptibilities, increasing the interconnectedness with the traditional financial system and making it more prone to systemic risk.

4. SYSTEMIC RISK AND THE INTERCONNECTEDNESS IN DEFI

4.1 What is Systemic Risk

Systemic risk started getting well-deserved attention as an outcome of the 2008 financial crisis. The traits that were later understood to be the main factors that contributed to the crisis were the interconnectedness, opacity, size, and complexity of the financial industry (Moontagna et al., 2020).

It was then that the regulators and policymakers understood that financial stability cannot be analyzed just by looking at an institution as if it were isolated. Instead, analyzing its connection to the real economy and other financial institutions was needed (Moontagna et al., 2020).

Systemic risk is a broad concept that can be present in several sectors of the economy. Although it is crucial in the analysis of financial systems, it is still a tricky concept since it has different descriptions.

Hynes (2020) defined systemic risk as "the potential for a threat or hazard to propagate disruptions or losses to multiple nested or otherwise connected parts of a complex system. Systems prone to systemic risks are highly interconnected and intertwined with one another. Such interconnections contribute to complex causal structures and dynamic evolutions".

The Hynes (2020) report also highlights that systemic risks in financial markets generally arise through two structures, the synchronization of agents' behavior or the interconnectedness of agents.

Allen and Carletti (2013) divided systemic risk into four areas:

- Panic
- Banking crises due to asset price falls
- Contagion
- Foreign exchange mismatches in the banking system

These four areas can also fit into the characteristics of DeFi. If these areas can have such a big impact on a sector that is regulated and controlled, the impact can be even bigger in an ecosystem such as DeFi and the cryptocurrencies market. For now, the magnitude of the DeFi market means that there is little to worry about, but close monitoring is needed to mitigate risks.

Therefore, it is vital to focus the study on understanding systemic risk in DeFi and identify the potential contagion channels between DeFi and the traditional financial system to prevent the DeFi negatively impacting the global financial system.

4.2 The importance of interconnectedness in Systemic Risk

One event showed the world how systemic risk could be a severe threat to global financial stability — the financial crisis of 2008. Héam (2014) referred to the crisis that started with the defaults of Lehman Brothers, AIG, and Bear Stearns, all of which showed the risk of contagion in the global financial system. This proved how systemic risk and interconnectedness are significant concerns for regulators and supervisory authorities with regard to global financial stability.

Systems more likely to be prone to systemic risks tend to be highly interconnected in the financial markets. As Hynes (2020) showed, systemic risk can emerge from two mechanisms — through the simultaneity behavior of the investors and through the interconnectedness of agents. Additionally, the difficulty in quantifying and understanding systemic financial risk arising from interconnectedness between the agents in the financial system can lead to financial and economic losses to society. Therefore, understanding how to manage this risk to minimize any impact it can have on financial stability is extremely important.

While the crypto-assets markets are evolving quickly, especially the DeFi, this rapid development can eventually threaten global financial stability because of the markets' susceptibility and the potential scale these markets can reach.

As the FSB (2022) report highlighted, the "direct connections between crypto-assets and systemically important financial institutions and core financial markets are currently limited but proliferating". The willingness to undertake activities and gain exposure to

crypto-assets is increasing around essential banks and other financial institutions. If this tendency continues and the interconnectedness of crypto-assets within these institutions increases, it can have implications for global financial stability in the future.

4.3 The interconnectedness in the Financial Markets and the potential channels between DeFi and TradFi

According to the FSB (2022) report, when there is a shock through the financial system, the shock can spread along some contagion channels.

These contagion channels are the following:

- **Credit risk channel** – The contagion is motivated by insolvencies, leading to more bankruptcies. At extremes, cases can cause a sequence of defaults.
- **Liquidity risk channel** – The decreasing market liquidity drives the contagion. Financial institutions can incur losses due to the inability to meet collateral obligations, which can threaten their financials positions that can lead to financial losses throughout the financial system.
- **Market risk channel** – The contagion occurs by market movements, which leads to trading losses, investments losses, and, in the end, a market crash.

As referred to in the study, these channels can interact with each other and lead to a more widespread contagion that will reflect on the investors and can lead to loss of confidence, panic, and herding behavior, which will magnify the initial impact (OECD, 2022b).

The vulnerabilities in digital assets are also amplified by the lack of a strong regulatory framework. This ecosystem has already proven its fragility several times, but none of those had repercussions on TradFi. However, at present, DeFi is growing and institutions are increasingly participating in it (Azar et al., 2022).

Azar et al. (2022) identified the following risks to financial stability if the interlinkage between both markets continue to grow:

- Risk in stablecoins, as issuers may dispose of reserve assets quickly to meet redemptions, potentially disrupting traditional financial markets.
- Valuation pressures and risk appetite in crypto-assets markets.

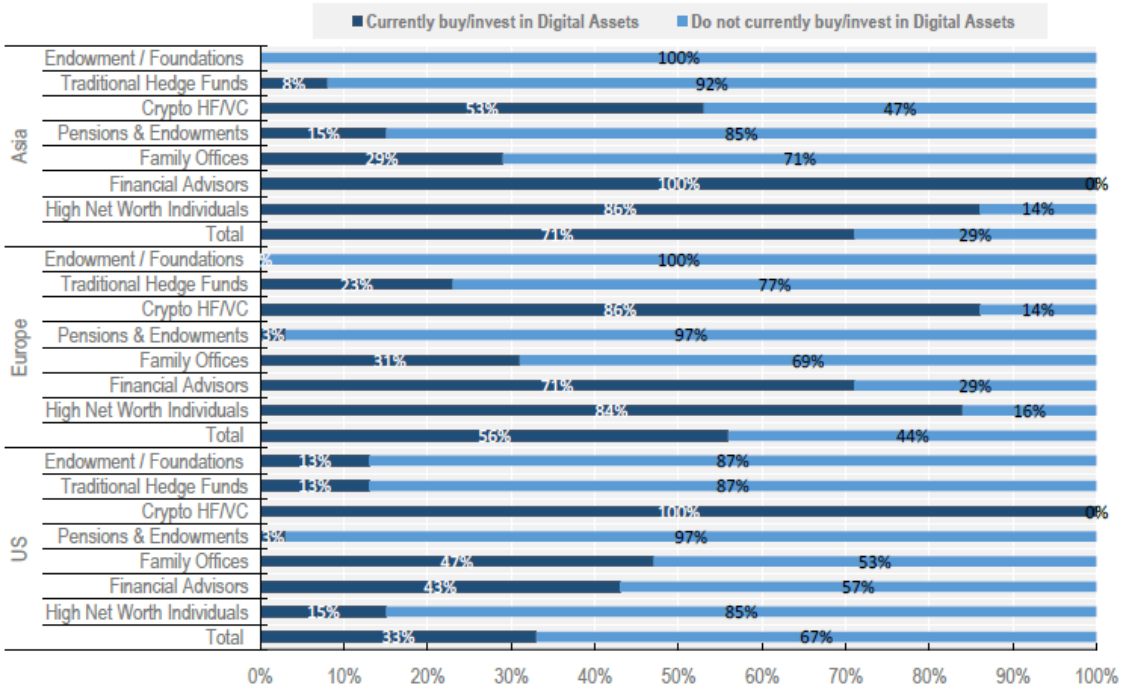
- Fragilities of decentralized and centralized platforms, including leverage and maturity and liquidity transformation and novel risks such as greater automaticity in DeFi.
- Interconnectedness across these vulnerabilities and a general lack of regulation in the ecosystem.

Many potential risks exist that we need to be aware of and pay close attention to in order to keep both markets from affecting each other. With the potential growth in the participation of institutions in the crypto markets, the probability of these risks becoming serious threats to financial stability will increase. To prevent this from happening, regulators are required to create preventive measures.

The contagion channels mentioned before are all associated with risks within the financial system. We can also encounter the same types of risks in DeFi. The difference between DeFi and TradFi is that there are, to date, no regulators in DeFi to ensure that institutions are following the guidelines to minimize any possible risks to prevent impacts, externally or internally.

As we can see in Figure 4.1, the interest in crypto-assets has been growing almost among every type of institutional investor since the so-called DeFi summer in 2020. The interaction between TradFi and DeFi is expected to continue growing, and more institutions are planning to accept payment with crypto-assets. This interest will lead to, as the OECD (2022b) highlighted, an “increased participation of institutional investors in digital asset market at the micro-level while it may also create channels of potential contagion between decentralized finance and traditional finance”.

Figure 4.1: Adoption of digital assets by investor segment



Source: OECD, 2022b

This increase in participation of institutions will lead to more extensive use of stablecoins in DeFi protocols, which will rapidly increase the interconnectedness between traditional and decentralized financial markets.

The heavy use of stablecoins creates a bridge between DeFi and TradFi, and this can accelerate the adoption of DeFi. At the same time, stablecoins constitute one of the most significant points of vulnerability with a potential channel of risk transmission to the traditional financial markets, increasing the probability of spillovers to the financial system. Therefore, they put the market's financial stability at risk.

The potential increase in intersection between both markets can turn out to be beneficial to the traditional markets since it creates strong competition by increasing efficiency and lowering transactions costs.

The FSB (2018) report has set out the following transmission channels between the crypto-space and TradFi that have the potential to threaten financial stability:

- **Financial sector exposures to crypto-assets**: Related financial products, and entities that are financially impacted by crypto-assets.
- **Wealth effects:** One example is the degree to which changes in the value of crypto-assets might impact their investors, with subsequent knock-on effects on the financial system.
- **Confidence effects**: Through these, developments concerning crypto-assets could impact investor confidence in crypto-assets markets (and potentially the broader financial system).
- **Extent of crypto-assets used in payments and settlements:** Most crypto-assets have no stability as a store of value, and have performance shortfalls (speed, cost, and capacity) that limits their practicality for mainstream payments.

These are the identified transmission channels through which crypto-assets can affect financial stability. While crypto-assets can impact a broader range of sectors or groups, DeFi has a direct connection to the financial sector.

As we verify the growing participation in this market of more financial institutions, it is more and more crucial to identify and understand through which contagion channels can DeFi affect global financial stability (FSB, 2018).

One of the critical links to TradFi had already been referred to and explained during this study. Stablecoins, at this moment, are probably the most notorious and recognized bridge between DeFi and TradFi. They are a core aspect of the DeFi ecosystem and, simultaneously, the more vulnerable point.

The fact that stablecoins have their value pegged to a currency like the US Dollar and the possibility that they can lose their peg due to solvency issues associated to their reserves or under-collateralization can cause DEXs to go under severe stress and massive liquidation to liquidity pools. This would disrupt DeFi markets and the potential spillover to the money market fund (MMF) (OECD, 2022b). At this moment, this is the most significant vulnerability of DeFi.

Another point of interconnectedness between both markets, highlighted by OECD (2022b), is the “pledging of tokenized assets on DeFi protocols instead of crypto-assets”. Institutional versions of DeFi are explicitly made for the institutions’ needs, which also

require Know Your Customer (KYC), Anti-Money Laundering (AML) and Combating the Financing of Terrorism (CFT) regulations.

These tokenized assets represent real and regulated assets that were issued in traditional markets and are being used as collateral in DeFi, which means that investors can refinance or leverage borrowing on the back of those tokenized assets. This possibility can lead to more interconnectedness that can grow to significant levels in the future (OECD, 2022b).

As the OECD (2022a) refers, while the bank's exposure to crypto-assets is limited at the moment, the continued growth and innovation, such as in digital assets and DeFi, will continue to bring the interests of institutional investors, make the boundaries between DeFi and TradFi more porous, and increase the risk of spillovers to the real economy.

Given this growth in interconnectedness and the associated risk, policymakers need to evaluate these risks and consider how they should address their policy action, allowing the innovation to unfold in a safe and responsible way for the participants and markets.

4.4 Possible implications for systemic risk that arise from the increasing interconnectedness between DeFi and TradFi

With the growing use and holding of crypto-assets by institutions in the traditional financial system, the increase in interconnectedness is unavoidable. In other words, the use of stablecoins is likely to increase and tokenized assets might be on the path to mainstream adoption. The increasing adoption of DeFi instruments by institutions, along with the lack of traditional safeguards in this ecosystem, will make possible the probability of spillovers happening to the real economy.

The implication of the increased interconnectedness on the financial system is to make the market more porous to DeFi risks, which will turn it to be more prone to systemic risk.

The sizeable growth of DeFi for financial services such as lending could lead to greater procyclicality (FSB, 2019). Further, considering the use of stablecoins and tokenized assets, it was already noted that both have more potential to become bridges of contact between DeFi and TradFi.

The higher the interconnectedness between markets, the more prone they are to systemic risk and the more significant are implications such as spillovers to the real economy or an increase in volatility and the more likely this is to impact financial markets.

As the OECD (2022a) highlighted, as a result, “investors exposed to losses in DeFi have to close positions in traditional markets, too, propagating the shock”.

This propagation will increase the likelihood of systemic risk turning into a problem for the real economy and jeopardizing the global financial system.

4.5 How can the systemic risk between DeFi and TradFi be mitigated?

The continuous and rapid growth of DeFi, along with its unique characteristics, means that the existing regulatory framework does not apply in this space. The OECD (2022a) highlighted a regulatory and supervisory gap, and filling it will be a challenge to the regulators due to the lack of regulation and supervisory access points in DeFi systems and the difficulty in identifying the parties involved that are to be regulated or supervised.

It is affirmed that complete decentralization is an illusion in DeFi. The protocols and platforms have groups of stakeholders that take and implement decisions and exercise ownership and have managerial benefits (Aramonte et al., 2021). The governance protocols on the interactions of these groups are natural entry points for policymakers; Aramonte et al. (2021) highlight “they should allow public authorities to contain and prevent DeFi related issues before this ecosystem attains systemic importance”.

Further, the Central Bank digital currency (CBDC), a digital currency that is under study and will be issued by central banks, can be used in the future instead of stablecoins in DeFi protocols; this can limit the risks associated with stablecoins and improve the safety and stability of DeFi markets (OECD, 2022b).

The OECD (022b) pointed out that “the use of CBDC could reduce stability risks by avoiding systemic stress that could result from a potential failure of entities issuing dominant stablecoins, with potential spill-over risks to the real economy”.

The use of CBDC will increase institutional investor participation and attract more sophisticated investors, adding more liquidity to DeFi markets and decreasing volatility as the supply increases to meet the demand (OECD, 2022b).

Regardless of the ways regulators find to minimize these risks, entities will have to be creative. They will need to explore and create new ways to ensure that they can enforce the regulations needed to create a space where the users are protected and that these systems are not taken advantage of for easy criminal activity.

5. CONCLUSION

The development of permissionless and public blockchains as an outcome of the 2008 financial crisis led to the development of DeFi, one of the biggest innovations in the finance world. While it tries to replicate most of the financial services that are already in place, it also adds new ones with the feature that an intermediary is not required. Investors can trade products directly with the guarantee that the transactions are assured by smart contracts. DeFi have some characteristics that are similar to that of the traditional financial system, others that are completely different, and some are totally new to this space. Like smart contracts, stablecoins are also new. While the world is used to settling transactions in legal currencies, such as in US Dollars or Euros, stablecoins assume that place in DeFi. Since stablecoins are not legal tenders, most are pegged to currencies like the dollar, which means they have become a perfect bridge to the traditional financial system. This study's objective was to understand how interconnected DeFi is with TradFi at this moment. When analyzing stablecoins, we can see that they are one of the fundamental aspects of DeFi, but are also one of the biggest liabilities to the ecosystem and have the potential to threaten TradFi. Central banks are trying to mitigate that risk with the creation of their own digital currency through which there is a possibility to mitigate some of the risks stablecoins are bringing to the interconnectedness between both markets.

Interconnectedness and systemic risk were the focus of this study. It is noted that one cannot exist without the other. The higher the level of interconnectedness, the higher the potential for systemic risk. The different channels of interconnectedness are identified and the channels through which systemic risk can arise within the traditional financial system are highlighted. It is understood that those vulnerabilities are also present in the DeFi ecosystem. Along with new developments and tools, it is easy to say that systemic risk is present in this market and the increasing interest of financial institutions to participate in DeFi is also resulting in an increase in the interconnectedness between both markets. This increase in the interconnectedness has the potential to cause spillovers from the shocks in DeFi to the markets in TradFi thereby threatening global financial stability in the future.

While DeFi is not big enough to be systemically important yet or to create shocks to the real economy, it is rapidly growing. If it continues to grow at this pace, it can turn into a real threat in the near future. Regulators and policy makers are already paying attention to the evolutions happening within this ecosystem, but further regulations are needed, mainly to prevent and guarantee financial stability and protect the investors from risks. Regulators have ideas on how they will enforce rules but these ideas are not clear yet. They will need to be creative and create new tools to make sure their regulations are enforced and to keep up with all the innovations happening in this space.

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