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Decentralized Finance regulation to foster competition and economic growth

Regulación de Finanzas Descentralizadas para fomentar competencia y crecimiento económico

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ABSTRACT

In order to make public policy recommendations to efficiently regulate Decentralized Finance (DeFi), we conducted an exploratory study examining the state of the art, organizing the public debate and analyzing real-world applications of this cutting-edge technology. We found that DeFi has the potential to increase efficiency in financial markets, promote competition, improve access to capital and contribute to economic growth. For all its potential benefits, however, the technology also presents substantial challenges in the form of user accessibility, market stability, fair competition and law enforcement. Growth of the emerging DeFi market depends on successfully addressing the concerns of investors, consumers and authorities without simultaneously regulating the technology into inefficiency and disuse. Taking into account the implications of DeFi for antitrust policies and economic growth, we explore the applicability of a *balanced embedded-regulation*, which holds promise as a bridge between innovation and regulation. The main limitation of this study is related to the constantly-evolving nature of DeFi technology. Recommendations for its regulation may vary as new evidence becomes available, but this document may pave the way for further research.

Keywords: DeFi; Finance, Antitrust; Blockchain.

JEL Classification: F3; G1; G2; G3; K2; O3.

RESUMEN

Con el objetivo de hacer recomendaciones de política pública para regular eficientemente las Finanzas Descentralizadas (*DeFi*), realizamos un estudio exploratorio que examina el estado del arte, organiza el debate público y analiza las aplicaciones de esta nueva tecnología. Encontramos que *DeFi* tiene el potencial de aumentar la eficiencia en los mercados financieros, promover la competencia, mejorar el acceso al capital y contribuir al crecimiento económico. Sin embargo,



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también presenta desafíos sustanciales como la accesibilidad para el usuario, estabilidad del mercado, competencia justa y Estado de Derecho. El crecimiento del mercado de *DeFi* depende de abordar con éxito las preocupaciones de inversionistas, consumidores y autoridades, sin sobre regular la tecnología hasta el punto de la ineficiencia y el desuso. Teniendo en cuenta las implicaciones para las políticas de competencia y el crecimiento económico, exploramos la aplicabilidad de una regulación integrada y equilibrada, que promete cerrar la brecha entre innovación y regulación. La principal limitación de este estudio está relacionada con la constante evolución de esta tecnología, sin embargo, este documento puede allanar el camino para futuras investigaciones.

Palabras clave: DeFi; Finanzas; Competencia; Blockchain.

Clasificación JEL: F3; G1; G2; G3; K2; O3.

INTRODUCTION: WHAT IS DeFi?

Decentralized Finance (DeFi) is the application of blockchain technology to financial services, postulating that financial services need not rely on centralized intermediaries (such as banks, brokers or governments) but can be provided directly by final users to final users. This can be achieved through peer-to-peer software grounded on blockchain technology (Schär, 2021). DeFi needs blockchain technology to function securely and effectively since blockchain is a digital decentralized ledger that is transparent, immutable and public in nature (IBM, 2022). Blockchain's decentralized ledger technology (DLT) records transactions and tracks assets, allowing users to see the origin and the end of each transaction without intermediaries. The blockchain's digital ledger is held on the computers (nodes) supplied by users on the blockchain.

DeFi provides an alternative to traditional financial services that avoids the costs of having a third party as an intermediary (Roose, 2022). It offers a distributed innovation process that lets information flow in a managed way between users (Chesbrough, Vanhaverbeke & West, 2014). DeFi seeks to enable individual users to interact with each other through lending, borrowing, managing assets or obtaining insurance without intermediaries (Chohan, 2021). This study is relevant at this time to organize the ongoing public debate of this financial technology disruptor based on blockchain. The final objective and academic contribution of this document is to make public policy recommendations based on scientific evidence to efficiently regulate DeFi.

The main differences between DeFi and traditional finance are automation and decentralization. DeFi runs on a blockchain to replicate its encrypted records on numerous nodes all over the world (Pilkington, 2016). For the most part, this technology remains unregulated since, in some blockchain models, system participation is anonymous, and no central party can decide who can and who cannot participate. It is possible, however, to create a permissioned blockchain where only one or a few participants can grant access to others (IBM, 2022). Table 1 provides a comparison of the main characteristics of traditional and decentralized financial services.

Table 1
Brief comparison between Traditional and Decentralized Finance

Characteristic	Traditional Financial Services	Decentralized Finance (DeFi)
Availability	Office hours	Always available
Cost of service	High	Low
Degree of automation	Low	High
Flexibility	Low	High
Funds transfer speed	Slow	Fast

Investment allocation	Decided by intermediaries	Decided by owner
Regulated	Yes	No
Risk of loss	Low	High
Self-custodial	No	Yes
Structural basis	Centralized	Decentralized
Transparent	No	Yes

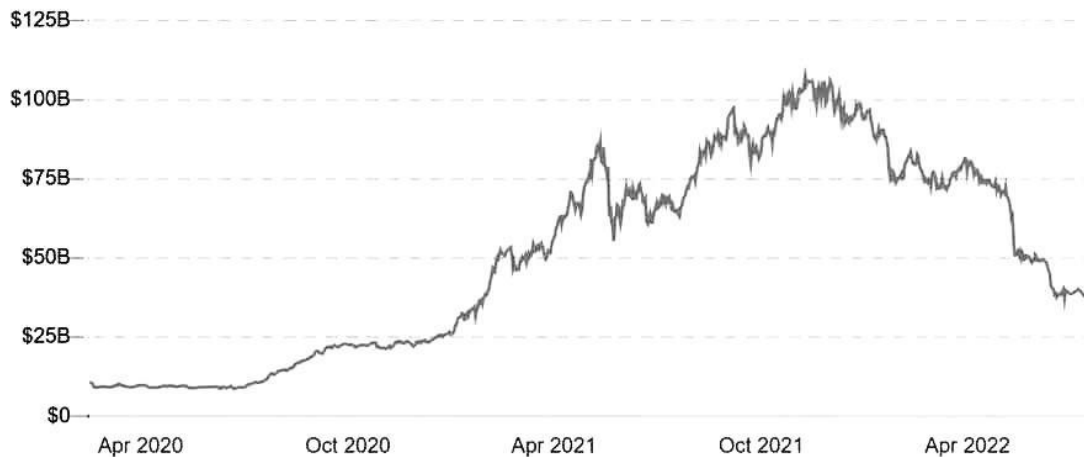
Source: Authors' elaboration based on Schueffel (2021) and Jin & Vinella (2022).

A clear example of how DeFi can impact the real-world financial system is in the purchase of a security, such as stock (a share of a company). In traditional finance, a customer first opens a bank account and transfers funds to that account. Then the customer asks the bank to place a buy order. The bank in turn asks a broker to fulfill the order. The broker then takes the order to the stock exchange and buys the stock for the customer. Finally, the new ownership information flows backward: stock exchange to broker, broker to bank and finally bank to customer. This simple example of how to buy stock in traditional finance demonstrates the need for three intermediaries: bank, broker, and stock exchange. This long buying process represents high costs and time inefficiencies for both, investors, and companies, plus every step of the process is a potential source of error (Schueffel, 2021).

The same security purchase via DeFi would be directly from seller to buyer. Any user can connect through the internet to a DeFi exchange. There, the user can place a purchase order for a token. A token is a digitally codified encrypted property title for any type of asset, such as a security. Another user who owns the stock desired by the purchaser can tokenize that stock and make it available for sale. After the user places the purchase order, smart contracts automatically execute the order as soon as the required parameters are met. As users are the custodians of their own assets, the token signifying ownership of the stock is transferred directly from the seller's wallet to the buyer's wallet (Schueffel *et al.*, 2019). A transaction on a DeFi platform does not require any other intermediary.

According to DeFi Pulse network, as of July 2022, US\$42.98 billion has been locked into DeFi contracts. Image 1 shows the evolution of Total Value Locked (TVL) in DeFi contracts in U.S. dollars (USD). From mid-2020 to October 2022 there has been a tremendous amount of attention and money flowing into DeFi systems. At its highest point, in November 2021, TVL in DeFi contracts reached US\$107.5 billion. The Image 1 reflects both the steep growth of DeFi and the volatility of this cryptomarket in the last two years. Moreover, it can be appreciated that since the beginning of 2021 and up to date, the level of market capitalization has been erratic, with ups and downs, but consistently higher than the plateau of 2020. Actually, the TVL follows the market capitalization of the average cryptocurrency market.

Image 1
Total Value Locked (TVL) in DeFi Contracts in USD



Source: Authors' elaboration with data and software from difipulse.com

All over the world, risks and opportunities for real applications arise from these digital markets. As we write, new companies are creating innovative ecosystems where entrepreneurs and companies can access capital by connecting their real-world assets to a DeFi platform and using those assets as collateral. An example is Centrifuge, a DeFi lending protocol that focuses on making alternative credit more accessible for small businesses and entrepreneurs, offering investors access to liquidity pools with stable yields (Kraken, 2022). Centrifuge's idea of "unlocking liquidity for real world assets" (Centrifuge, 2022, p.1) is a new option where users with traditional assets like invoices, mortgages or streaming royalties can convert those assets into non-fungible tokens (NFTs) and then use those NFTs as collateral for loans at competitive interest rates. Investor-users purchase Centrifuge tokens with stablecoins¹ to create a liquidity pool for loans to business-users (TAXbit, 2022).

We conduct an exploratory study examining the state of the art, organizing the public debate and analyzing real-world applications of this cutting-edge technology, using the deductive method with a qualitative approach to identify the implications of DeFi to antitrust policies and economic growth. Then, we make broad public policy recommendations on how to approach the risks and challenges that DeFi poses to financial stability and economic development in order to successfully regulate its application worldwide.

I. DEFI IMPLICATIONS FOR ANTITRUST POLICIES

According to economic theory, when firms have to compete for customers, competition leads to lower prices, higher quality goods and services, greater variety, and more innovation (The White House, 2021). When there is insufficient competition, dominant firms can use their market power to block potential competitors from entering the market, meaning entrepreneurs and small businesses cannot participate on a level playing field and new ideas cannot become new goods and services. Cetorelli *et al.*, (2007) showed that the share of total bank assets held by the top four U.S. commercial banks increased steadily from 1990 to 2004, signaling a concentration risk in American financial markets.

¹ Stablecoins are a form of cryptocurrency whose value is tied to the value of a fiat currency or a commodity.

Antitrust refers to the laws and policies that regulate the concentration of economic power to avoid monopolies and anticompetitive practices (Cornell, 2022). These laws and regulations provide market stability, social welfare and fair competition. We discuss three competition and antitrust considerations in relation to DeFi: Barriers to entry to financial markets, Open Finance and DAO design.

Barriers to entry

The introduction of DeFi to financial markets is not expected to be smooth, and traditional financial institutions may have an advantage. As in any other market, a new competitor or service must overcome some challenges to gain market share. As Jin & Vinella (2022) recognized, a significant response from current financial service providers is anticipated since they will not simply give up their market share. DeFi faces specific barriers to entry to financial markets such as high initial investment costs.

DeFi entrants also lack the trove of historical data held by incumbent financial institutions. Likewise, consumers may be reluctant to use DeFi services because of the inconvenience and cost of migrating information from, or sharing information with, a traditional financial institution. Finally, a rapid adoption of DeFi services by consumers is not expected. Users normally take some time to learn, trust and adapt to new technologies. When it comes to financial services and the related financial security of consumers, we expect technology to be adopted at an even slower pace.

Traditional financial system actors are powerful and, obviously, financially capable. The traditional financial system is big enough and complex enough to deter any new competitor. According to the Boston Consulting Group (2021), financial assets account for roughly 60% of net wealth all over the world, representing around US\$250 trillion. In the U.S. alone, the FDIC (2022) lists 4,787 bank institutions divided into 82,184 branch offices, managing USD\$24,066 billion in financial assets. Only one bank (J.P. Morgan Chase) has more than 51 million digital customers in the U.S. (Green, 2019). In contrast, the largest DeFi network, Bitcoin, has fewer than 15,000 active nodes all over the world (Jin & Vinella, 2022).

Another entry barrier for DeFi is that not every customer in the financial system trusts or uses computers. Older age groups, poor people or rural dwellers, among other vulnerable groups, may have limited access or understanding of electronic devices capable of engaging in DeFi. Moreover, even if people have access to this kind of technology, they may not have the necessary skills to use it. Internet access may also be a barrier for some. For this reason, DeFi may widen the financial inclusion gap.

Additionally, most people may prefer human contact over automated services. When it comes to finance, personal experience feels more trustworthy than software doing what it is programmed to do (Mims, 2021). Software is not very flexible compared to interacting with another human being. Take for example a phone call. Most people may prefer to speak directly with a company's representative rather than work through a computerized voice menu. Generally, people are change-resistant, so we think that in order for DeFi to be accepted by consumers, trust should be built. Building trust in a technology-based service is another entry barrier compared to traditional financial services that provide human interaction and physical locations.

Moreover, incumbent financial services providers have the capability to build blockchain or DeFi applications themselves. They also could acquire DeFi start-ups instead of competing against them. Big banks in the U.S. are already investing heavily in this area (Bloomberg, 2022) (J.P. Morgan, 2022). J.P. Morgan invests US\$12 billion each year on emerging technology, funding a team of 50,000 technologists (J.P. Morgan, 2022b). In short, new DeFi service providers have to overcome both financial and political challenges in order to succeed in the financial market against incumbent participants.

Open Finance

The term “Open Finance” refers to a movement toward greater transparency, accessibility and shareability of one’s own financial data with the goal of fostering competition in the financial services sector and can be facilitated by DeFi. In short, Open Finance is a data-portability system that allows consumers to share their financial data across providers, reducing data-driven barriers of entry to financial markets and enabling competition. With Open Finance, new companies can use historical financial data to create and offer new services targeting the specific requirements of customers. As Awrey & Macey (2022) noted, Open Finance can level the informational playing field and foster competition among incumbent financial institutions and a new generation of companies trying to satisfy consumers that look to make faster payments, borrow money, invest their savings, exchange currency, manage budgets and so on.

As a policy objective, Zetsche, Arner and Buckley (2020) argue that Open Finance is justified on pro-competition grounds as it addresses market efficiency, economies of scale and situations where data determines competitive strength. Open Finance can prevent industry concentration. American and Chinese information technology (IT) markets have tended towards oligopoly or monopoly in the past decade. Arguably, the main asset of each Google, Facebook, Amazon and Alibaba is its pool of consumer and supplier data (Ramos & Villar, 2018). With this data they can better advertise, determine prices, offer new tailored services and reach more clients. Information and data concentration promote monopolistic behavior and market collusion (Patterson, 2017), leading to higher prices at the expense of consumers.

Open Finance is an opportunity to counter the trend of data accumulation in one or a few entities and to benefit consumers through increased competition in financial markets. If strategically applied by a jurisdiction, Open Finance should enable consumers to quickly, simply, and securely move their financial data between competitors of financial services like banks, retirement funds and insurance companies (Nicholls, 2019). This should make the entrance of new suppliers of DeFi services more feasible by reducing major barriers to entry such as a DeFi platform’s lack of historical financial data for users and the cost and inconvenience to users of switching from traditional financial services to DeFi services.

DAO design

Decentralized Autonomous Organization (DAO) is a concept introduced by Ethereum co-founder Vitalik Buterin in 2014. DAOs are constructed by a series of interrelated smart contracts to achieve members’ objectives. A smart contract is a code that automatically executes transactions on a blockchain network when previously established requirements are fulfilled. “The ideal of a decentralized autonomous organization is easy to describe, it is an entity that lives on the internet and exists autonomously but also heavily relies on hiring individuals to perform certain tasks that the automaton itself cannot do” (Buterin, 2014, p.1).

While DAOs can generate pro-competitive effects, such as increased efficiencies and lower costs for both DAO members and final consumers, they may also present antitrust concerns. Automated decisions made in a DAO have the capacity to fix prices, divide markets, exchange sensitive information or restrain trade. A DAO could also enable coordination across competitors, such as colluding, to decide what products to sell or what pricing strategies to implement. A DAO designed with a profit orientation could engage in automated monopolistic behaviors if it gains a dominant position especially in a particularly small market. While any of those behaviors are equally possible in an organization run by humans, they may be harder to detect in a digital, autonomous, decentralized and potentially anonymous platform. Detecting antitrust violations in a DAO and enforcing antitrust laws will present new challenges for authorities charged with protecting consumers.

In short, DAOs may have several pro-competitive benefits. They can enable businesses to operate more efficiently and have an appealing internal governance via electronic voting arrangements. However, they can raise several antitrust issues that authorities may struggle to address.

II. DeFi IMPLICATIONS FOR ECONOMIC GROWTH

Potential benefits

The Organization for Economic Cooperation and Development (OECD) states that DeFi applications have the potential to deliver significant economic efficiencies through the transfer of value without the need for trusted centralized intermediaries, bringing faster and cheaper automation of transactions (OECD, 2022). With DeFi it is possible to reduce transaction costs and promote transparency because all transactions are publicly available. No human involvement is needed since transactions are triggered by data provided by the protocol or by external nodes known as “oracles.”²

Furthermore, DeFi has a money-multiplier effect. Applications for lending can canalize short-term savings and provide loans immediately, without the solvency and liquidity restrictions of traditional banks. Therefore, entrepreneur funding and short-term lending would be more widely available in the market, promoting new economic opportunities. This could be translated into new business starts, more investment, and, ultimately, expansion of GDP. Even new jobs could be offered as new participants in financial services and other markets become available.

The Financial Stability Board (FSB, 2019), an international organization that monitors and makes recommendations about the global financial system, said that the application of DeFi technology may reduce the financial instability risks associated with traditional financial institutions. The expected dispersion of financial service providers could increase diversification of the financial system and reduce the concentration of suppliers. The too-big-to-fail problem may be moderated in that the bankruptcy of a few institutions is no longer a potentially catastrophic event for the economy as a whole.

DeFi also offers security because it has no central or single attack point. A decentralized setting should be stronger against cyber risks in terms of the integrity of financial records and service availability (FSB, 2019). Furthermore, DeFi’s promise of interoperability could help promote innovation and build a vibrant financial ecosystem (Carter & Jeng, 2021). Most of the benefits mentioned above relate to efficiency, economic expansion, transparency, and security. Next, we assess whether these benefits can outweigh potential risks and challenges.

Risks and challenges

DeFi has several shortcomings. First, DeFi may not promote financial inclusion because those poised to benefit from lower-cost, non-traditional financial services, such small and medium-size business owners and managers, may not have sufficient understanding of DeFi systems to engage with them successfully or at all. Second, crypto-asset volatility may have a significant, negative impact on a user’s finances if it is not fully understood, and an unwitting user may trust a platform that is in fact risky. Third, while proponents of DeFi maintain that the system provides trust through disintermediation and decentralization, it should be considered that users must also trust the creators of the code underlying a DeFi platform and the smart contracts that execute transactions on a DeFi platform. Almost no user would have enough technical skill to evaluate the code of a DeFi platform or a smart contract. Therefore, adoption of DeFi requires users to

² Oracles are entities that connect blockchains to external systems, thereby enabling smart contracts to execute based upon inputs from the real world. Source: <https://chain.link/education/blockchain-oracles>

trust software developers in place of the regulated financial institutions that act as intermediaries in the traditional financial system.

DeFi networks, as such, are not currently regulated by any government. The activity conducted on a DeFi network may very well be subject to law (such as securities law or antitrust law) and fall within the jurisdiction of a regulating body (in the U.S., the Securities and Exchange Commission or the Federal Trade Commission). However, since decentralized networks are automated and community-governed and may exist in multiple jurisdictions simultaneously, it is hard to identify decision-making actors that can be held responsible for network outcomes in any locality. This makes supervision, accountability, and even legal notifications difficult. The current legal system's procedures are designed for centralized decision-making organizations with physical venues, like the incumbent financial institutions. DeFi systems are worldwide structures with no defined physical location or jurisdiction, and those qualities generate uncertainty and challenges for law enforcement (OECD, 2022).

Consumer protection may also be a concern. Even if no minority group can manipulate DeFi networks with governance structures that require more than 50% of community votes, all participants, including consumers, can be affected if most nodes on a network decide to act in an illegal or unfair way. In the worst case, this could mean fraud and misappropriation of assets, since DeFi does not depend on a custodial system. Also, it is not clear for every DeFi project if changes to existing smart contracts can be decided by the community, even with the opposition of some participants. If so, consumers may be exposed to changes of the initial terms of the contract they agreed upon.

DeFi may also present security and reliability issues. Contrary to what DeFi advocates sustain, it is not impossible to manipulate a blockchain. The most vulnerable part of the chain seems to be the oracles, nodes that feed external data into the blockchain. If erroneous or fraudulent information is introduced, it can lead to massive consequences. For example, if manipulated price data is introduced into the blockchain, it can trigger massive buys or sells that otherwise wouldn't happen under the governing smart contract parameters. This could result in considerable losses to some users and windfalls to others. Moreover, the permanent nature of the blockchain renders these frauds irreversible, even when they involve manipulated information or scams.

Today, investor and financial consumers are significantly more exposed to risk of loss in DeFi assets than in assets held in a regulated, centralized financial institution. As far as we know, DeFi users have no recourse after a failure of the DeFi protocol because it would be very difficult to identify the responsible actor. There are no dispute resolution mechanisms nor recovery methods, exposing participants to a potential total loss of their investment. This risk is accentuated given that DeFi projects can be launched by any programmer with no testing or due diligence mandated by law in any known jurisdiction.

Another vulnerability for users on DeFi platforms is the possible existence of an "admin key" to the platform's code. Developers sometimes keep an admin key that enables them to enter and repair the code of a DeFi protocol if it performs in an erratic manner. The existence of an admin key brings significant risks for users since admin keys can be used at any time to access user information or change protocol operation from its roots. Founders or developers could also use the admin key to seize an investor's assets without justification. In short, despite the fundamentally decentralized nature of DeFi, human intervention is still present in governance, which can be affected by concentrated holdings of voting tokens, and through admin keys if they were created.

Finally, DeFi protocols do not necessarily contribute to improved user awareness of financial risks. Even when the platform's code is transparent, the average user would not have the sophisticated technical and financial knowledge required to understand the implicit risks of the system. Users would need both coding skills and deep financial literacy to understand the financial risks of the protocol for themselves (OECD, 2022). Even users at the top of the game could have a difficult time assessing financial risks in

DeFi protocols. Every risk and challenge for DeFi adoption also represents a potential limitation for unlocking the economic growth promised by the advocates of this new financial paradigm.

III. ORGANIZING THE PUBLIC DEBATE

Governments all over the world and the private sector together face numerous challenges to harnessing the potential of DeFi for the benefit of consumers, investors and the economy as a whole. With a substantial amount of capital already locked into DeFi contracts (US\$42.98 billion as of July 2022), the DeFi market is far more developed than the legal framework to deal with it. However, the public debate about whether and how DeFi should be regulated is beginning to organize. We will focus on the United States since it represents not only the biggest economy in the world, but it also has the most advanced financial and technological markets in the world, a breeding ground for DeFi that no other country possesses.

In the United States, the White House, the Securities and Exchange Commission (SEC) and academics have published organizing principles and next steps for assessing and meeting the challenges of DeFi. The White House published the Executive Order on Ensuring Responsible Development of Digital Assets on March 9, 2022. The order is intended to chart a course to reduce the risks that DeFi could pose to consumers, investors and businesses, while promoting financial inclusion and stability, preventing criminal activities and addressing climate change. It recognizes that the United States derives substantial economic and national security benefits from the predominant role that the U.S. dollar and United States financial institutions play in the global financial system. The executive order is an effort to maintain the United States strategic leadership in the global financial system.

According to the executive order, the increased use of digital assets and DeFi exchanges may increase the prevalence of crimes such as fraud and theft, privacy and data breaches, abusive practices, and other cyber risks faced by consumers, investors, and businesses. To tackle these concerns, the executive order requires federal agencies with jurisdiction over economic, legal, environmental, technological and national security issues, coordinate with each other to produce reports to the President within 180 to 210 days of the date of the order. Then, the President will review reports and propose specific changes in legislation and policy within one year.

In their reports, the agencies are required to outline the specific risks and regulatory gaps posed by digital assets and provide recommendations to address the risks, and potential benefits, of DeFi. At the date of this writing, the agencies are in the process of producing their reports and recommendations. The reports are expected to promote high standards of transparency, privacy, and security for DeFi systems that align with the national security and economic interests of the United States to maintain a role as world leader in financial markets. Legal and policy changes are expected in late 2023.

Another important aspect of the executive order is that it encourages the Chairman of the Federal Reserve to research the extent to which Central Bank Digital Currency (CBDC) could improve the efficiency and reduce the costs of payments systems using DeFi structures. Specifically, the Federal Reserve is required to assess whether a U.S. CBDC would enhance or impede the ability of monetary policy to function effectively as a critical macroeconomic stabilization tool for the American economy. The Federal Reserve is also ordered to research the extent to which foreign CBDCs could displace existing national currencies and alter the payment system in ways that could undermine the United States' financial centrality on the global stage.

The SEC delivered a Statement on DeFi Risks, Regulations, and Opportunities, issued by Commissioner Caroline Crenshaw (2021). It states that DeFi participants' current "buyer beware" approach, which discloses that DeFi is risky without providing the details investors need to assess risk likelihood, is not an adequate foundation on which to build the next generation of financial markets. Without a common set of standards and a functional system to enforce them, markets can tend toward corruption, fraud,

information asymmetries, and cartel-like activity. Over time this may reduce investor confidence and investor participation.

On the other hand, well-regulated markets tend to flourish, and the U.S. capital market is a great example. The U.S. has less than 5% of the world's population, yet over half of global investment capital is generated in American markets (Clayton, 2022). Because of its reliability, U.S. financial markets are the destination of choice for most investors seeking to raise capital abroad. American securities laws do not just impose burdens, they provide market certainty. But, in the new "Wild West" that DeFi poses, a robust regulatory framework that delivers significant protection for market participants has not yet been adopted.

In the United States, several federal authorities have prospective jurisdiction over different aspects of DeFi, including Department of Justice, the Financial Criminal Enforcement Network, the Internal Revenue Service, the SEC. However, DeFi investors currently will not get the same level of protection and disclosure that are customary in other regulated markets. For example, "a variety of DeFi participants, activities, and assets fall within the SEC's jurisdiction as they involve securities and securities-related conduct. But no DeFi participant within the SEC's jurisdiction have registered with us [SEC]" (Crenshaw, 2021, p. 2).

Some DeFi projects fit precisely within the SEC's jurisdiction, and others struggle to comply with the regulations as currently applied. DeFi should be regulated to reduce potential for manipulative or fraudulent conduct. Crenshaw (2021) states that DeFi system should let capital flow efficiently to the best projects, rather than being hindered by hype or false claims. In decentralized networks with diffuse control and different interests, regulations serve to create shared incentives aligned to benefit the entire system and ensure fair opportunities for its least powerful participants.

According to former SEC chairman Jay Clayton (2022), the U.S. needs to embrace the efficiencies provided by DeFi, such as fast payments and custody of assets in digital form. The presidential working group, created by the aforementioned Executive Order, should move forward on rules for stablecoins as a means of payment and not as a security or commodity. At the same time, the SEC should issue requirements for the custody of tokenized assets, and the Department of Justice should pursue those breaking the law in order to send a clear message. The worst-case scenario is that the U.S. fails to act, to the detriment of both the American economy and the global financial infrastructure.

IV. LOOKING FORWARD DISCUSSION

The accountability and law enforcement challenges presented by blockchain implementation are fundamental: the difficulty of identifying persons liable for faults in automated outputs of a DeFi network and the complexity of determining the applicable law and jurisdiction. As Zetsche, Arner and Buckley (2020) argue, DeFi could be subject to law either anywhere or everywhere, the latter being so problematic that it could deter participants from engaging in decentralized finance protocols. As the rule of law in financial services is a major concern for all actors, including developers, consumers, and governments.

The issues presently surrounding DeFi are complex, and it is impossible to predict whether its benefits will ultimately outweigh the risks for individual users and the challenges for traditional legal and economic systems. The key is whether free market innovation or government regulation, or some combination of the two, can successfully overcome those risks and challenges. Regulatory technology (RegTech) may be the solution that allows the economic benefits of DeFi to be realized and the concerns of users and financial regulators to be addressed.

RegTech refers to the use of technology (hardware and software) for regulatory compliance and supervision. One form of RegTech is the concept of "embedded supervision," which could provide a regulatory window into a DeFi network. Embedded supervision is a "regulatory framework that provides compliance in decentralized markets to be automatically monitored by reading the market's ledger. This

reduces the need for firms to actively collect, verify and deliver data” (Auer, 2022, p.1). Legal parameters could be embedded into DeFi code to secure regulatory objectives of screening as part of the authorization requirements to enter financial markets. Embedded supervision is, in fact, an automated form of compliance.

Zetzsche, Arner and Buckley go one step further from the embedded supervision concept, and advocate for “embedded regulation” (2020). Under this approach, the key regulatory objectives of market behavior, integrity and stability, would be required to be part of the design of a DeFi system. Every protocol would implement regulatory features as part of its own automated structures, requiring input of specific data, quality conditions and other forms of traditional regulatory standards for the financial system. Embedded regulation could also address the jurisdiction uncertainty of DeFi, if international consensus could be reached. For example, one scenario is that nations would agree that a DeFi network would be subject to the jurisdiction in which the supervisor of the network is located, and the embedded regulation system would have to comply only with the laws of that jurisdiction. Zetzsche *et al.*, (2020) offer insight into how difficult it will be to achieve this broad consensus in the world’s nation-state form of governance.

Legal issues should be addressed worldwide now to take advantage of new technologies like blockchain to decentralize finance. DeFi has the potential to build more efficient financial markets and promote economic growth. Antitrust considerations and RegTech adaptation of embedded rules governing DeFi systems are essential for proper market functioning. We advise financial regulators to begin investing in RegTech research, to be able to properly understand requirements for DeFi systems. Authorities all around the world should be updated and, more importantly, cooperate, since the nation-state model may not be adequate anymore to successfully tackle by its own the challenges of the international financial market.

V. RECOMMENDATION: BALANCED EMBEDDED REGULATION

Excessive regulation may also discourage entrepreneurial pursuits related to DeFi projects and restrict the very aspects that make DeFi unique among financial processes. In order for DeFi to maintain its status as an efficient alternative to traditional finances, it must remain as free as possible of intermediaries and barriers, and unrestricted in its ability to incite innovation. We propose that embedded regulation should only be enforced only to the extent that it provides clarity and security to users of the DeFi protocols. Terms relating to the implementation and use of this technology should be clearly defined and simplified to increase adoption of this promising alternative. Ultimately, a balance must be established between the necessary regulation structure and the freedom to innovate. This is what we call a balanced embedded regulation.

Blockchain technology is heading towards improving security, transparency and saving costs in the financial system via DeFi, but it is still a disordered and mostly unregulated area. We urge financial regulators to invest heavily in designing and testing embedded regulation requirements for DeFi systems going live in the future, but considering a balanced system of regulation that might achieve both objectives: provide certainty to the financial system and promote freedom to innovate. Public policy objectives of consumer protection and financial market competition might be met, while unlocking the potential that Decentralized Finance has to offer in terms of cost-efficiency and availability of funding for entrepreneurs and businesses.

If authorities recognize that excessive regulation would discourage DeFi implementation, a balanced embedded regulation is more likely to be achieved to provide certainty and freedom to a new financial system grounded on the blockchain. If a well-balanced embedded regulation is accomplished, public policy objectives of consumer protection and financial market competition will be met, as well as unlocking the potential that Decentralized Finance has to offer in terms of cost-efficiency and availability of funding for entrepreneurs and businesses. Expected economic growth and its consequent increase in tax collection are quite likely to outweigh the authorities’ investment costs of developing balanced embedded regulation requirements as outlined in this document.

Finally, we must recognize that the main limitation of this study is related to the constantly-evolving nature of DeFi technology. Recommendations regarding its regulation may vary as new evidence becomes available as this is a still unfolding story. However, this document may pave the way as a starting point for further research on DeFi implications, applications and regulation standards. In the meanwhile, we hope this contribution helps to organize the public debate about whether and how DeFi should be regulated, bringing up the balanced embedded regulation concept to academic scrutiny.

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