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In this article, Lanotte explores the development of digital technologies in the EU as a means to boost sustainable competitiveness, support innovation, and drive a clean transition.

Introduction

The digital divide, typically characterized by unequal access to technology, is a crucial issue within the realm of digital assets, in which financial institutions play a pivotal role. As digital assets like cryptocurrencies and blockchain-based financial products continue to gain traction, the divide extends beyond just access to technology; it encompasses the ability to comply with the complex regulatory landscape governing these assets. This situation presents both challenges and opportunities for financial institutions. In this light, the European Commission's Savings and Investments Union (SIU)[1] outlines a strategy to promote citizens' prosperity, strengthen the EU's economic competitiveness, and address the existing fragmentation of EU financial markets to fully exploit the potential of the single market.[2] This strategy is crucial to the EU's plan to secure its growth against a backdrop of significant global changes. The communication highlights Europe's untapped potential, currently hindered by market fragmentation and inefficiencies in intermediation. It also makes several references to the current geopolitical situation, while placing slightly less emphasis on the twin (green and digital) transitions compared with previous communications.[3] The commission underscores the need for stronger member state involvement in driving the SIU forward. Building on the achievements of the capital markets and banking unions, the SIU is a key initiative to strengthen EU prosperity and competitiveness.

The Digital Divide

The digital divide in financial services is multifaceted. On one hand, there's a divide between those that have access to digital financial services and those that do not. On the other, there is a gap in understanding in the use of digital assets because of a lack of education and resources. This can prevent some populations, particularly in underbanked or unbanked regions, from participating in the digital economy. Further, as digital assets grow, the regulatory environment

[1] "The SIU aims to create better financial opportunities for EU citizens while enhancing the financial system's capability to connect savings with productive investments. This will lead to more choices for savers who wish to grow their household wealth and allow businesses across Europe to grow." European Commission release, "Commission Unveils Savings and Investments Union Strategy to Enhance Financial Opportunities for EU Citizens and Businesses" (Mar. 19, 2025).

[2] Building on the Draghi report and the Competitiveness Compass, the SIU document contains few surprises. Most of the policy measures outlined had already been anticipated or flagged in recent months. The document mentions the important role of distributed ledger technology, tokenization, AI, and new technologies, as well as support for EU tech-oriented investment programs like Tech.eu and the European Tech Champions Initiative 2.0.

[3] Antonio Lanotte, "A Transformative Vision for Europe: The Energy Transition and Digital Transformation," *Tax Notes Int'l*, Nov. 20, 2023, p. 1099.

becomes increasingly complex. Compliance requires not just access to digital tools but also sophisticated understanding and implementation capabilities. Financial institutions must bridge this gap to ensure that all stakeholders are compliant, particularly those that may lack the resources to do so on their own. In this context, financial institutions can play a significant role in reducing the digital divide by developing and providing digital tools to a broader population. This includes offering educational resources and tools to help individuals and smaller entities understand and manage digital assets.

The transformation of global finance is being significantly influenced by financial institutions' strategic shift toward digital assets and blockchain technology. This shift is characterized by several key initiatives that are not only reshaping the traditional banking sector but also merging it with the rapidly evolving digital finance ecosystem. Therefore, financial institutions are increasingly partnering with cryptocurrency (digital) firms to harness the potential of blockchain technology and digital assets. These collaborations allow traditional banks to offer services related to cryptocurrencies, such as trading, custody, and payment processing, expanding their service offerings and staying competitive in the digital age.[4] By working with crypto/digital firms, banks can bridge the gap between conventional finance and the decentralized finance (DeFi) space. This enhances customer offerings and also paves the way for new financial products that blend the security and trust of traditional banking with the innovation of digital assets. As these initiatives gain traction, the once clear boundary between traditional banking and the digital finance ecosystem begins to blur. Conventional financial institutions are increasingly adopting technologies and practices that were once the exclusive domain of fintech and crypto companies. This convergence is reshaping the global financial landscape, creating a mix of opportunities and challenges for financial institutions, regulators, and consumers.

The New Global Financial Landscape

The new landscape offers immense opportunities for innovation, efficiency, and inclusion.[5] However, it also presents significant challenges that need to be addressed to ensure the stability, security, and fairness of the financial system. As traditional financial institutions, regulators, and consumers navigate this evolving landscape, they must focus on balancing the benefits of innovation with the need for robust regulatory frameworks, security measures, and market stability. This will be key to unlocking the full potential of the digital finance revolution while mitigating the associated risks. As traditional finance converges with the digital finance ecosystem, the new landscape will present significant potential for innovation, inclusion, and efficiency, but also brings about complexities in regulation, security, and market dynamics. The integration of digital assets and blockchain technology into traditional banking operations is creating a more holistic and interconnected financial ecosystem that offers a wider range of services combining the stability and regulatory oversight of traditional banking with the innovation and efficiency of digital finance. As financial institutions adopt digital assets, regulators are evolving to address the unique challenges and risks associated with these technologies. This includes developing new regulatory frameworks that ensure safety and soundness while fostering innovation. Collaboration between regulators and financial institutions is critical to a smooth transition.

The involvement of established financial institutions in the digital asset space is also helping to build consumer trust in these new technologies. As more consumers and businesses gain confidence in digital assets, adoption is likely to accelerate, further driving the integration of conventional and digital finance.

Digital assets and blockchain technology can provide financial services to populations that have been traditionally underserved by the banking system. With lower barriers to entry, individuals in remote or economically

[4] Lanotte, "The Impact of AI: Opportunities and Risks of Artificial Intelligence in Finance," Medium (Apr. 2023).

[5] Lanotte, "How Technology Will Shape the Future of Taxation Systems," *Tax Notes Int'l*, Oct. 9, 2023, p. 245.

disadvantaged areas can access digital wallets, remittances, and lending platforms, fostering greater financial inclusion globally.[6] DeFi platforms, which operate without intermediaries, enable users to engage in financial activities such as borrowing, lending, and trading, with minimal costs and restrictions. This democratizes access to financial services, particularly in regions where traditional banking infrastructure is weak or nonexistent. In fact, blockchain technology can significantly enhance the efficiency of financial transactions by reducing the need for intermediaries, lowering transaction costs, and speeding up processes like cross-border payments and trade finance. Smart contracts automate complex financial agreements, reducing the potential for human error and fraud. The digital asset space has given rise to innovative financial products, including tokenized assets, stablecoins, and non-fungible tokens.[7] These products offer new investment opportunities, enable fractional ownership, and create new markets, broadening the scope of financial markets and asset classes. In other words, the convergence of traditional finance and digital assets is leading to the creation of more integrated financial ecosystems that combine the security and trust of traditional banking with the innovation and speed of digital finance, offering a more comprehensive range of services to consumers and businesses.

Digital assets enable more seamless cross-border transactions, reducing the friction and costs associated with currency conversion and international banking. This can facilitate global trade, investment, and economic integration, opening new opportunities for businesses and investors worldwide. However, in terms of challenges, the rapid development of digital assets and blockchain technology has outpaced regulatory frameworks in many regions. The lack of uniformity in regulations across jurisdictions creates uncertainty for financial institutions and investors, which complicates compliance and risk management efforts. As regulators catch up with technological advancements, financial institutions face the challenge of adapting to an evolving regulatory environment.[8]

This includes ensuring compliance with anti-money-laundering (AML) laws, know-your-customer (KYC) requirements, and data protection regulations, all of which can vary significantly across different markets. The digital nature of assets and transactions introduces significant cybersecurity risks, including hacking, phishing, and other forms of cyberattacks. Financial institutions must invest heavily in security infrastructure to protect digital assets and customer data from breaches. Further, fraudsters can exploit the pseudonym and irreversibility of blockchain transactions, leading to scams, market manipulation, and other illicit activities. Safeguarding the integrity of digital financial markets requires robust security measures, monitoring, and enforcement mechanisms.

Digital assets, particularly cryptocurrencies, are known for their price volatility, which can lead to significant financial losses for investors and pose risks to market stability. The lack of inherent value backing many digital assets adds to this, creating challenges for risk management and financial planning. As digital assets become more integrated into the global financial system, they could potentially introduce systemic risks. For example, a major failure in a widely used blockchain network or a collapse in the value of a significant digital asset could have ripple effects across global financial markets, similar to the effects of traditional financial crises. Finally, in terms of technological and infrastructural challenges, as adoption of blockchain technology grows, so do concerns about the scalability and interoperability of different blockchain networks. Ensuring that these networks can handle a growing volume of transactions without compromising speed or security is a major challenge.

[6] International Association for Trusted Blockchain Applications (INATBA), "DeFi Self-Regulation: A Proposal for the Industry" (Feb. 2025).

[7] INATBA, "Decentralized Finance — 'Staking Activities' Brief" (Nov. 2024).

[8] Lanotte, "The Crypto-Assets Landscape," Medium (July 2024).

Digital Asset Strategies

Financial institutions have been exploring and implementing a variety of digital asset strategies that leverage blockchain technology and cryptocurrencies. These strategies enhance service offerings, improve operational efficiency, and position the institutions competitively in the rapidly evolving financial landscape. Financial institutions are actively experimenting with a broad range of strategies involving blockchain technology and cryptocurrencies to stay competitive and meet evolving market demands. Ranging from blockchain-based payment systems to the tokenization of assets and the development of digital asset custody services, these strategies are reshaping the financial services industry. While the potential for innovation and growth is significant, these institutions must also navigate the challenges of regulatory compliance, security, and market volatility to successfully integrate digital assets into their operations.[9]

Financial institutions have been using blockchain technology to streamline cross-border transactions. Traditional cross-border payments can be slow, costly, and complex because of multiple intermediaries and currency conversions. Blockchain-based systems, such as Ripple's XRP, allow for near-instantaneous settlement, reduced costs, and improved efficiency and customer satisfaction. Some banks are experimenting with stablecoins — cryptocurrencies pegged to a stable asset, like the U.S. dollar — to facilitate payments and reduce volatility. Also, there is increasing interest in central bank digital currencies, which are government-issued digital currencies that use blockchain technology. Central bank digital currencies modernize payment systems, improve monetary policy efficiency, and enhance financial inclusion.

As the demand for digital assets grows, financial institutions are developing custody solutions to securely store cryptocurrencies and other digital assets on behalf of clients. These services are designed to protect against theft, loss, and fraud — leveraging multisignature wallets, cold storage, and other advanced security measures. Banks and financial firms are focusing on offering institutional-grade custody services that meet stringent regulatory and security standards. These are crucial for attracting institutional investors that require a high level of trust and compliance in handling digital assets.

Tokenization and Decentralized Finance

Financial institutions are experimenting with tokenizing traditional assets such as stocks, bonds, real estate, and commodities. Tokenization involves converting these assets into digital tokens on a blockchain and enabling fractional ownership. This improves liquidity and simplifies transferability. It opens up new investment opportunities and markets by lowering barriers to entry. However, placing assets on-chain may expose markets to manipulation and security risks or provide venues for illicit actors to layer funds.[10] Some institutions are exploring the DeFi space, in which traditional financial services like lending, borrowing, and trading are offered through decentralized platforms using blockchain. While still in its early stages, DeFi presents opportunities for banks to innovate and offer new products, though it also poses challenges in terms of regulation and risk management.[11]

Trade and Supply Chain Finance

Trade finance is an area ripe for disruption by blockchain technology. By digitizing and automating trade finance processes, blockchain can reduce paperwork, lower fraud risks, and enhance transparency in the supply chain. Smart contracts, self-executing contracts with the terms written into code, are being tested for automating trade finance processes. These contracts can automatically release payments when certain conditions are met, reducing the need for intermediaries and speeding up transactions.

Financial institutions are also exploring blockchain as a tool to enhance supply chain finance by providing greater supply chain

[9] Lanotte, "Crypto Lending and Securities Tokenization Process," Medium (Oct. 2023).

[10] Lanotte, "The Tokenization of Assets for a Decentralized Future in Europe," *Tax Notes Int'l*, Feb. 20, 2023, p. 987.

[11] INATBA, "De-Fi Self-Regulation," *supra* note 6.

visibility. Blockchain's immutable ledger ensures that all parties have access to the same information, reducing disputes and delays. This transparency can also improve trust between suppliers, buyers, and financiers. By leveraging the data available on a blockchain, financial institutions can offer more efficient and accurate financing solutions. For instance, blockchain can provide real-time data on inventory levels or shipment status, enabling banks to offer supply chain financing with reduced risk.

Cryptocurrency Investment Products

To cater to growing investor interest in digital assets, some financial institutions have launched cryptocurrency investment products such as bitcoin exchange-traded funds, cryptocurrency index funds, and managed portfolios that include digital assets. These products provide investors with exposure to the cryptocurrency market without the need to directly manage or store the assets themselves. In addition to offering crypto investment products, banks and financial firms are also providing advisory services to help clients navigate the complexities of investing in digital assets. This includes guidance on asset allocation, risk management, and regulatory compliance. On the regulatory and compliance side, blockchain is being used to enhance KYC and AML processes by providing a secure and transparent way to verify identities and track transactions. Shared blockchain-based, know-your-customer platforms allow financial institutions to access verified customer information, reducing duplication and improving efficiency.

Blockchain technology can also streamline regulatory reporting by creating an immutable audit trail of transactions. This ensures that financial institutions can easily demonstrate compliance with regulatory requirements, reducing the burden of manual reporting and improving accuracy. Further, in terms of partnerships and ecosystem development, many financial institutions are partnering with fintech start-ups, technology companies, and blockchain consortia to codevelop solutions. These partnerships allow traditional banks to leverage the expertise of innovators in the digital asset space while providing the stability and trust of established financial institutions. Some banks have also established or invested in digital asset exchanges to facilitate the trading of cryptocurrencies and tokenized assets. These platforms provide a secure and regulated environment for buying, selling, and managing digital assets, catering to both retail and institutional investors.[12]

Qatar New Regulatory Framework

The Qatar Financial Centre (QFC) recently launched a comprehensive regulatory framework for digital assets, marking a significant milestone in the country's financial sector.[13] This initiative, known as the QFC Digital Assets Framework 2024, establishes a robust legal and regulatory environment for digital assets, including processes like tokenization, legal recognition of property rights in tokens, and the use of smart contracts. It is part of Qatar's broader strategy to become a leader in digital finance, aligning with international best practices and setting high standards for transparency and security.

The framework was developed in close consultation with a diverse group of industry stakeholders, ensuring it meets the needs of the global financial community. QFC officials have emphasized that it was built on rigorous standards, particularly concerning asset tokenization processes. It is underpinned by a trusted technology infrastructure designed to guarantee a secure and transparent environment for digital asset transactions. These measures are intended to build confidence among consumers, service providers, and industry stakeholders, aligning Qatar's digital asset ecosystem with global best practices.

The development of these regulations involved extensive consultation with an advisory group composed of 37 domestic and international

[12] U.K. Chartered Institute of Taxation, "Blockchain & Cryptocurrency Implications," Diploma in Tax Technology podcast (Feb. 27, 2025).

[13] Qatar Financial Centre, the Qatar Financial Centre Authority (QFCA), and Qatar Financial Centre Regulatory Authority (QFCRA) have announced the launch of the QFC Digital Assets Framework, a comprehensive and innovative regime for the creation and regulation of digital assets in the QFC. The development of the framework achieves an important goal under the Third Financial Sector Strategic Plan. *See* QFCRA release, "Qatar Financial Centre Issues Digital Assets Framework" (Sept. 2, 2024).

organizations. This collaborative approach highlights Qatar's commitment to establishing a comprehensive and inclusive regulatory framework for the rapidly evolving digital asset landscape. By providing clear and robust guidelines through the QFC Digital Assets Framework 2024, the QFC positions itself as a favorable destination for digital businesses. The initiative is designed not only to ensure a secure and transparent digital asset environment but also to promote the growth of the digital asset sector within Qatar's jurisdiction. The framework's focus on high standards for asset tokenization and its trusted technology infrastructure are key elements in attracting both local and international crypto firms. By establishing a legal foundation and offering a supportive regulatory environment, the QFC hopes to draw in businesses looking for stability and clarity in the often-volatile digital asset market. This, in turn, is expected to stimulate innovation and economic growth within the sector, further cementing Qatar's role as a hub for digital finance.

The QFC is also actively fostering digital innovation through the Digital Assets Lab, which launched in October 2023. This initiative has already attracted over 20 start-ups and fintech firms, providing them with a platform to develop and commercialize their crypto asset products. The lab is a key component of Qatar's strategy to become a leader in blockchain technology and digital finance, reflecting the country's commitment to nurturing this emerging sector. The QFC offers a distinctive operating environment for companies, including 100 percent foreign ownership, full profit repatriation, and a competitive 10 percent corporate tax rate on locally sourced profits. These business-friendly policies, combined with the new digital asset regulations, significantly enhance Qatar's appeal as a destination for crypto firms.

The QFC has begun accepting applications from companies seeking licenses to operate as token service providers. This initiative is expected to draw a wide variety of digital businesses to Qatar. By providing a clear regulatory path, QFC aims to attract both established and emerging digital firms. This move is part of a broader global trend in which jurisdictions develop specialized regulations to govern the rapidly growing digital industry. By introducing a comprehensive framework, Qatar is addressing central issues such as consumer protection and market integrity — concerns that have often hampered the widespread adoption of cryptocurrencies in many regions.

The QFC's framework is designed to balance innovation with regulatory oversight, offering the necessary clarity and security that both businesses and consumers require in the evolving digital economy. As Qatar positions itself as a digital-friendly jurisdiction, it is likely to set a precedent in the Middle East, potentially influencing neighboring countries to develop similar regulatory frameworks. This could lead to increased regional competition as countries vie to attract crypto and digital asset businesses and investments. Qatar's proactive approach reflects a broader global trend where jurisdictions are creating specialized regulations to support the growth of the digital industry. By offering clear regulatory guidelines, robust legal frameworks, and a business-friendly environment, Qatar is not only attracting digital firms but also establishing itself as a leader in digital finance within the region.

Dubai Tokenization Regulatory Sandbox

The Dubai Financial Services Authority (DFSA) has announced the launch of its tokenization regulatory sandbox, "a dedicated initiative to support firms exploring tokenized investment products and services within the [Dubai International Financial Centre]."[14] The sandbox consists of two phases: "expression of interest on tokenization" and "innovation testing license (ITL) tokenization cohort." During the first phase, firms "can signal their interest in developing tokenized products or services within the [Dubai International Financial Centre]," while the second phase will allow selected firms to "test their products and services in a controlled

[14]The Dubai Financial Services Authority (DFSA), the independent regulator of the Dubai International Financial Centre (DIFC), is inviting firms to express their interest in participating in the DFSA's Tokenisation Regulatory Sandbox, an initiative designed for firms seeking to offer tokenized investment products and services.

regulatory environment through the DFSA's ITL program." The DFSA is inviting "firms engaged in tokenization-related financial services" to participate, including firms exploring the issuing, trading, holding or settling of tokenized investments; existing "DFSA authorized firms looking to expand into tokenization"; and "firms with a strong understanding of the applicable legal and regulatory requirements."

European Digital Capital Market Union

The vision of creating a European Digital Single Market using blockchain-based technology, specifically distributed ledger technology (DLT), is a forward-thinking approach to modernizing and unifying the EU's economic infrastructure. The digital single market can be created on a blockchain-based network, a DLT in which all stakeholders, including revenue agencies, customs agencies, peripheral tax offices, and other agencies, will have defined roles. Challenges of this magnitude must be tackled with unity and cohesion, as Europe has shown itself capable of doing with this historic agreement, highlighting the ability of member states to overcome differences to build a common space for the benefit of all.

The member states, with their actions today and tomorrow, will increasingly influence not only the common destiny, but above all a new European way of thinking characterized by a policy of confrontation and growth in facts. Digital technologies can play a transformative role in developing a digital capital markets union within the EU. By leveraging digital tools, the capital markets union can enhance efficiency, transparency, and accessibility, leading to more integrated and competitive capital markets. Digital technologies have the potential to significantly enhance the efficiency, transparency, and accessibility of the EU's capital markets. By embracing these technologies, the EU can accelerate the development of a digital capital markets union, fostering a more integrated, competitive, and innovative financial ecosystem that benefits both businesses and investors. Integrating digital technologies into physical infrastructures can lead to leaner, more efficient systems.

For instance, smart cities can optimize energy use, reduce waste, and improve public services through the Internet of Things and data analytics. Therefore, digital tools can enhance accessibility to government services, making administrative processes less burdensome. This can reduce the need for physical offices and paperwork, thus minimizing environmental impact and improving convenience. By using digital platforms and communication channels, governments can maintain a strong presence without the need for extensive physical infrastructure. This can lead to more inclusive governance, in which citizens can easily access services and participate in decision-making.

Blockchains represent a particularly transparent and decentralized way of recording lists of transactions. A blockchain-based solution generally involves the exploitation of a platform in which participants can perform certain functions resulting in the writing or reading of data on a distributed ledger system, whose governance and control can be decentralized and accessed by entities connected to a peer-to-peer network. The mechanism, in simplified terms, envisages that when an entity requests to carry out a transaction, the request is propagated on the network that verifies its legitimacy, placing it in a block of information awaiting validation. This process, which for public blockchains such as those of bitcoin is called the independent verification process, precedes the actual validation process that will take place with the mining of the block, and is carried out by each individual node, without yet worrying about what the others are doing at the same time (and perhaps on the same transactions). At this stage, each node does not worry about reaching that distributed consensus that will happen later with the validation of the block in which the verified transactions are inserted.

Blockchain participants will only update their copy of the ledger with the new block validated by an entity (the so-called validating node) that obtains the trust of all, in the form of a distributed consensus achieved through the adoption of common rules and thanks to a system of incentives or governance rules accepted by each entity. Each block, when validated, will be cryptographically linked to the previous node by

means of a system of time stamps, forming a chain of validated blocks, a blockchain. Ultimately, the blocks structured in this way will contain an ordered sequence of verified and validated transactions, the truth of which has been accepted by the participants that have adopted the same distributed consensus protocol rules.

Blockchain technology comes in three types:

1. Public, such as those hosting cryptocurrencies and requiring enormous processing power.
2. Private, companies that want a smaller network create them by granting authorizations to participants: read-only, limited transactions, etc., as in a traditional corporate database. Note that the company must reintroduce the central authority itself but still benefits from the blockchain's unique accuracy and transparency, potentially even allowing for real-time checks by regulators.
3. Common consortia in the banking sector, which may grant reading rights to many or even all persons, but which limits the consent mechanism to a few trusted parties, resulting in faster processing.

A blockchain-based technology also has the following characteristics:

- Distributed system: A blockchain is a system distributed over a large network of nodes whose recorded data are protected from attack because the same information is replicated, verified, and validated through the adoption of different protocols (or rules) commonly accepted by each entity.
- Immutability of the transcribed information: In a blockchain, recorded and validated data cannot be modified because each new piece of information is inextricably linked to the history of previous transactions. Any manipulation of data would therefore be immediately highlighted, preventing subsequent validation.
- Network participation and governance permission.
- Reading and writing power associated with the various users.
- Trust between network participants.
- Validation mechanism of operations.

For centuries, banks have used ledgers to keep databases of accounting transactions, and governments have used them to keep records of land ownership. Changes to transaction records are managed by a central authority, be it a bank or a government office, so that it is possible to identify who owns what, at any time. In this way, it is possible to check that new transactions are legitimate. Because users trust that those operating the ledger will properly verify transactions, people buy and sell without having met and in the absence of mutual trust. The intermediary also controls access to the information contained in the ledger and can decide who may access the identity of a building owner but only allows account holders to check the balance.

These ledgers are centralized (there is an intermediary, trusted by all users, who has full control over the system and acts as a mediator in every transaction) and closed-box (the functioning of the ledger and its data are not fully visible to its users). Digitization has made ledgers faster and easier to use, but they continue to be centralized and closed-box. The blockchain offers the same recordkeeping functionality but without a centralized architecture. The problem is verifying the legitimacy of a transaction in the absence of a central authority to carry out the necessary checks. Blockchains solve this problem by decentralizing the ledger, so that every user has a copy. Anyone can request that a transaction be added to the blockchain, but such a request will only be accepted if all users agree on its legitimacy — that is, the request comes from the authorized person; that the seller of a property is still the owner; and that the buyer still has the necessary sum. This check is performed reliably and automatically on each user's behalf, creating a very fast and secure ledger system that is highly resistant to tampering.

Each new transaction to be recorded is combined with other new transactions to form a block, which is added as the last link in a long chain of chronological transactions. This chain forms the blockchain ledger held by all users. This work is called mining. Anyone can become a miner and compete to be the first to solve the complex mathematical problem of creating a valid, encrypted block of transactions to add to

the blockchain. There are several ways to incentivize people to undertake this task. Adding a new block to the blockchain means updating the ledger held by all users that will accept a new block only after all its transactions have been verified as valid. If a discrepancy is detected, the block is rejected. Otherwise, the block is added and will remain in the chain as a permanent public record; no user can remove it. Destroying or damaging a traditional ledger requires attacking the intermediary. In the case of a blockchain, it would be necessary to attack every copy of the ledger simultaneously. A fake ledger cannot exist, as all users are in possession of an authentic version that they can use for comparison.

Trust and control in blockchain-based transactions are not centralized and closed-box, but decentralized and transparent. These blockchains are defined as permissionless because there is no special authority that can deny permission to participate in the control and addition of transactions. It is also possible to configure permissioned blockchains, in which a limited group of actors retain the power to access, control, and add transactions to the ledger. In this way, traditional actors, such as banks and governments, can retain substantial control over their blockchains. Blockchains with authorizations are less transparent and decentralized than their counterparts without authorizations and therefore embody somewhat different social and political values.

Ledgers have several innovative and interesting functions compared with centralized ledgers. However, in addition to recording date, time, and transaction details, they can also play a more active and potentially autonomous role in the management and execution of transactions. By embedding code in the blockchain, transactions can be executed automatically when certain conditions are met, providing an execution guarantee. Smart contracts with automatic execution, based on this functionality, are being rapidly developed. A smart contract is the translation or transposition into a code (set of instructions) of the elements of a contract to be stored on a blockchain so that the fulfillment of certain conditions (control of basic contract data) is automatically verified, followed by the realization of predetermined effects.

The term "smart contract," however, can be misleading. Even considering the differences in regulatory systems, in some cases it is not possible to speak of contracts in a strictly legal sense, but rather as if/then functions embedded in software or computer protocols. For example, if there is a deadline, then payment starts. In other words, through smart contracts there can also be a "computerized" transposition of agreements that are concluded outside of the technological platform. Thus, in the case of a smart contract relating to the purchase and sale of products, the obligation to deliver the goods and the related obligation to pay by bank transfer would be recorded on the blockchain; once the delivery of the goods is recorded, the instruction to the bank to make the payment would be automatically activated. This instruction could, in turn, trigger other instructions in additional smart contracts, relating, for instance, to currency exchange or the placing of other orders further down the supply chain. Because the blockchain ledger is immutable, the agreed code (and thus the agreed contract) can only be canceled or modified within the terms already allowed in the code. Traditional contracts provide a choice between paying what is owed under the contract or terminating the contract with the resulting consequences, including legal action. However, if payment is automated within the framework of a smart contract, this choice is no longer possible because the transaction is performed automatically.

Building a Digital Capital Markets Union[15] involves creating a cohesive and efficient framework for capital markets across Europe. It requires leveraging digital technologies to enhance integration, accessibility, and transparency, and developing and implementing consistent regulations across member states that ensure a level playing field — including harmonizing rules for digital securities, investor protection, and market conduct.

It also requires cooperation among national regulators to address cross-border challenges and streamline regulatory processes. Member states

[15]European Court of Auditors, "Capital Markets Union — Slow Start Towards an Ambitious Goal," Special Report 25 (2020).

must establish policies that support the development of digital infrastructure, such as secure data storage, high-speed internet access, and blockchain networks.

On the technological side, blockchain can streamline processes such as securities issuance, trading, settlement, and custody. DLT can enable real-time, peer-to-peer transactions, reducing the need for intermediaries and the associated costs and delays. For example, smart contracts can automate compliance and settlement, ensuring transactions are executed seamlessly according to predefined conditions. Also, AI can optimize trading strategies, risk assessment, and portfolio management. Machine learning algorithms can analyze vast amounts of data to identify trends and opportunities, improving decision-making and reducing manual intervention.

The DLT has the potential to transform tax and financial interactions between taxpayers and tax administrations by simplifying complex processes, ensuring faster execution of transactions, improving transparency, creating auditable operations, and lowering costs after the initial implementation phase. Its applications could even include introducing a central bank digital currency or "digital euro."

The creation of a digital single market can empower all relevant parties thanks to a large-scale, groundbreaking system that offers benefits in the form of fairer taxation, efficient reporting tools, transparent and streamlined information, and the capacity for precise calculation of taxes. The digital single market can be established on a blockchain-based network in which all stakeholders (agencies, customs, peripheral tax offices, and other agencies) will have defined roles. Each entity will function in line with its respective field of responsibilities — for example, by giving consensus (effectively checking and monitoring the streamlined information in the digital value chain) in matters of indirect and direct taxation. Key issues include identifying and defining the market, access and exit points on the value chain, and the target data needed for tax purposes. Tax or other competent authorities thus receive necessary data, which is transmitted by counterparties via the blockchain. AI-run mechanisms can help collect information to issue tax returns or similar acts and can eventually establish a profile of the taxpayers. Because of the resulting decentralization, the digital transformation of the public authorities may alleviate most of the tax and administrative task burdens for external stakeholders, including companies.

In addition to being cost effective and time saving, the digital chain will bring transparency to the entire tax process while granting its users autonomy and security. Innovative companies and multinational enterprises are also moving items of value across blockchain networks. Tokenization — converting the rights to an asset into a digital token within a blockchain with one token representing an intangible asset or a defined portion — plays a considerable role in the exchange of information. For example, using blockchain to issue digital invoices allows value-embedded assets to be sent across multiple network participants, ensuring all parties receive the same information at the same time. Everything is recorded on the distributed and decentralized ledger, which increases trust and transparency between counterparties.

Lifting responsibilities from the companies that have been granted access to a public and permissioned blockchain allows both taxpayers and tax authorities to focus on their respective businesses and obligations. They can also anticipate their future objectives and projects by using smart contracts. Within a complex system like taxation, blockchain can offer the ability to provide reliable information in real time to a large group of people. This would create a system in which both taxpayers and tax authorities have equal confidence in the veracity of the data collected. According to the EU's General Data Protection Regulation, there is an underlying assumption that for each piece of personal data in a system, there must be at least one natural or legal person that serves as the data controller. Data subjects have the right to approach this data controller to enforce their rights under EU data protection law. Data controllers are obligated to adhere to the requirements set forth in the GDPR. Blockchains, on the other hand, are decentralized databases that typically achieve these requirements by replacing a single central authority with multiple participants or entities. There is a lack of agreement on how joint

controllership should be defined, which makes it challenging to determine and assign responsibility. Further, the GDPR operates on the assumption that data can be altered or deleted when required to meet legal obligations, as outlined in articles 16 and 17 of the GDPR.

Blockchains, in contrast, deliberately make it difficult to unilaterally alter data, which maintains data integrity and enhances trust within the network. Also, blockchains highlight the difficulty of meeting the demands of data minimization and purpose limitation in the data-driven economy. To some extent, the GDPR needs to be modified to include the latest disruptive technologies like blockchain, AI, or quantum technology; it is impossible to accomplish the reverse because the technology will always be a step or two ahead of legislation. The next step will be to add or further develop the concept of digital identity, which will become more standard in a Web3 scenario, in what is called a dynamic informed digital consent in the zero-knowledge proof (ZKP) described below.

Dynamic Informed Digital Consent

There is another critical consideration in the context of blockchain-based solutions. Blockchain technology can provide individuals with greater control over their personal data, enabling them to manage and share it transparently and ethically. Smart contracts and other blockchain-based tools can enable individuals to specify the terms and conditions under which their data is shared. A digital ID would give citizens a personal wallet through which they can access public services, by using ZKP technology, which reveals only the necessary data in a transaction to protect users' privacy.

The electronic identification and trust services regulation must be future proof and able to support the societal and economic developments that have recently emerged. Among these are electronic ledgers, which provide an innovative addition to the trust service landscape. ZKP[16] is a method by which one party (the prover) can demonstrate to another party (the verifier) that something is true without revealing any information beyond the truth of the specific statement. In this light, Web3 will become a human-centric trust machine — an open and decentralized gate to the metaverse, publicly accessible, and (in some cases) privately designed, in which tokens represent the keys to access and interaction, producing social, economic, and political effects. ZKPs have transformative implications for privacy and security in the digital world. They can validate statements without sharing sensitive information, revolutionizing fields like cryptocurrencies, data privacy, and identity management.

The core concept is knowledge without disclosure. ZKP technology is a subset of cryptography that helps blockchain projects overcome the scaling and privacy limitations inherent to many layer-1 blockchains. This technology enables blockchain projects to facilitate greater transaction throughput, protect user data without losing the ability to verify identities, and support complex computation, while also allowing enterprises to adopt blockchain technology without risk to their intellectual property.

Looking to the Future

To navigate the complex and rapidly evolving crypto landscape, financial institutions must leverage blockchain technology to enhance compliance, risk management, and operational efficiency.[17] Blockchain's inherent transparency, traceability, and immutability offer powerful tools for detecting and preventing financial crimes, ensuring that institutions can safely engage with digital assets. By establishing comprehensive compliance programs, creating internal centers of excellence (CoEs),[18] and prioritizing scalability and risk management, financial institutions can capitalize on the opportunities presented by digital assets while mitigating potential risks.

[16] Lanotte, "The Tokenization of the Assets: The Keys for a Digital and More Inclusive Ecosystem," Medium (June 2023).

[17] Lanotte, "Keys to Maintaining Trust and Credibility With Stakeholders," *Tax Notes Int'l*, Feb. 5, 2024, p. 689.

[18] EU Blockchain Observatory & Forum. Welcome to the European Blockchain Observatory and Forum, a European Commission initiative to accelerate blockchain innovation and the development of the blockchain ecosystem within the EU and so help cement Europe's position as a global leader in this transformative new technology.

In this dynamic environment, the ability to adapt and innovate is crucial. Financial institutions that embrace blockchain proficiency and proactively address the challenges of digital asset compliance will be well-positioned to thrive in the future of global finance. The successful integration of digital assets into traditional banking not only enhances financial services but also reinforces the stability and integrity of the financial system. But the complexity of the crypto ecosystem's rapidly evolving technology, unique risks, and emerging control mechanisms poses significant challenges for financial institutions, particularly in the realm of compliance.

To effectively navigate these challenges, the creation of an internal CoE dedicated to digital assets and blockchain technology can be a crucial strategic initiative. The CoE would centralize expertise, standardize risk management practices, and ensure the consistent application of best practices across the organization. A CoE should be composed of representatives from various functions within the organization, including compliance, legal, IT, risk management, and business operations. This cross-functional approach ensures that the CoE can address the multifaceted nature of digital assets, drawing on diverse perspectives and expertise to develop comprehensive compliance strategies. Further, given the volatility of crypto-asset prices, market swings in adoption and volume tend to be sharp and dramatic. It is, therefore, not surprising that many enforcement actions against crypto-asset service providers have cited failures in compliance programs to keep pace during periods of high customer onboarding. These surges, along with sudden spikes in trading and transaction volumes, often led to backlogs in various elements of their anti-money-laundering programs.

To effectively manage these fluctuations, institutions should evaluate whether their policies, procedures, and surveillance mechanisms can swiftly adapt to sudden increases in customers and transactions. While current processes that are highly manual and hands-on might offer the comfort of conservative approaches, they inevitably introduce process risks if they cannot scale efficiently. The digital asset regulatory environment and regulatory expectations are likely to continue evolving for the foreseeable future. As regulations evolve, the associated risks will change, often at an even faster pace, as illicit actors exploit technological innovations. Therefore, institutions should focus on building defenses against current and emerging risks rather than solely complying with existing regulations. This proactive approach to digital asset compliance enables financial institutions to identify and mitigate risks early, better protecting themselves from emerging threats and maintaining a strong compliance posture. ■