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The Use of Distributed Ledger Technologies in Payment, Clearing, and Settlement

Remarks by

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Innovation in digital finance, loosely referred to as fintech, is capturing imaginations from Silicon Valley to Chicago to Wall Street. We're seeing a steady stream of announcements of new startups and partnerships, and consumers are downloading fintech apps at an even faster pace.

Financial products, services, and transactions lend themselves to successive waves of technological disruption because they can readily be represented as streams of numerical information ripe for digitization. However, as technological tools used by the industry change over time, it is important to keep sight of their impact on the public, whether it be on families seeking to own their own home, seniors seeking financial security, young adults seeking to invest in education and training, or small businesses attempting to smooth through volatile revenues and expenses.

Current developments in the digitization of finance are important and deserving of serious and sustained engagement on the part of policymakers and regulators. The Federal Reserve Board has established a multi-disciplinary working group that is engaged in a 360-degree analysis of fintech innovation. We are bringing together the best thinking across the Federal Reserve System, spanning key areas of responsibility, from supervision to community development, from financial stability to payments. As policymakers, we want to facilitate innovation where it has the potential to yield public benefit, while ensuring that risks are thoroughly understood and managed. That orientation may have different implications in the arena of consumer and small business finance, for instance, as compared with payment, clearing, and settlement in the wholesale financial markets.

Technological and Organizational Changes in Payment, Clearing, and Settlement

Today, I will focus on newly emerging distributed ledger technologies and related protocols, which were inspired originally by Bitcoin, and their potentially important applications to payment, clearing, and settlement in the wholesale markets.

Successive waves of technological advance have swept through payment, clearing, and settlement over the past two centuries. In the 19th century, railroads and the telegraph helped improve speed and logistics. In the second half of the 20th century, computers were introduced to deal with the clearing of overwhelming volumes of paper checks and stock certificates stimulated by post-war growth. Starting at about the same time and continuing through today, new electronic networks have been established to allow high-speed computerized financial communication. As automation has evolved, payment, clearing, and settlement systems have been developed for conducting and processing transactions within and between firms. However, many of these systems have historically operated in silos, which can be hard to streamline or replace. In some areas, business processes may still rely heavily on manual or semi-automated procedures.

Over time, banks and other firms have organized various types of clearinghouses to coordinate clearing and settlement activities in order to reduce costs and risks. The adoption of multilateral clearing in the United States was a key organizational innovation that began with the founding of the New York Clearing House in the 1850s. This led to notable efficiencies and risk reduction in the clearing of checks. Multilateral clearing was also used early on to improve clearing in the securities and derivatives markets. By the 1970s, the United States turned to technologies based on the centralized custody and clearing of book-entry securities in order to respond to the paperwork crisis in the

equities markets. Following the recent financial crisis, the United States--along with many other countries--expanded the scope of central clearing to help address problems in the bilateral clearing of derivatives contracts.

Today, the possible development and application of distributed ledger technology has raised questions about potentially far reaching changes to multilateral clearinghouses and the roles of financial institutions as intermediaries in trading, clearing, and settlement for their clients. In the extreme, distributed ledger technologies are seen as enabling a much larger universe of financial actors to transact directly with other financial actors and to exchange assets versus funds (that is, to "clear" and settle the underlying transactions) virtually instantaneously without the help of intermediaries both within and across borders. This dramatic reduction in frictions would be facilitated by distributed ledgers shared across various networks of financial actors that would keep a complete and accurate record of all transactions, and meet appropriate goals for transparency, privacy, and security.

At this stage, such a sea-change may sound like a remote possibility, particularly for the high volume and highly regulated clearing and settlement functions of the wholesale financial markets. But profound disruptions are not unprecedented in this arena. In the early 1960s, the use of computerized book-entry securities systems to streamline custody, clearing, and settlement in the securities markets may have seemed like a technologist's pipe dream. But these technologies became an important part of industry-wide changes in the 1970s. Today we rely on these types of systems for the daily operation of the markets.

Given this backdrop, it is important to give promising technologies the serious consideration they merit, seek to understand their opportunities and risks, and actively engage in dialogue about their potential uses and evolution. At the Federal Reserve, we approach these issues from the perspective of policymakers safeguarding the public interest in safe and sound core banking institutions, financial stability, particularly as it pertains to the wholesale financial markets, and the security and efficiency of the payment system.

Distributed ledger technology was introduced for the transfer and record-keeping of Bitcoin and other digital currencies. The essential advantage of the technology is that it provides a credible way to transfer an asset without the need for trust in intermediaries or counterparties, much like a physical cash transaction. To do that, a transfer process must be able to credibly confirm that a sender of an asset is the owner and has enough of the asset to make the transfer to the receiver. This requires a secure system or protocol to transfer assets (the rails), protection against assets being transferred twice (the so-called double spend problem), and an immutable record of asset ownership that can be automatically and securely updated (the ledger). The tokenization of digital assets can facilitate the transfer process.

The genuinely innovative aspect of the technology combines a number of different core elements that support the transfer process and recordkeeping:

- Peer-to-peer networking and distributed data storage provide multiple copies of a single ledger across participants in the system so that all participants have a shared history of all transactions in the system.

- Cryptography, in the form of hashes and digital signatures, provides a secure way to initiate a transaction that helps verify ownership and the availability of the asset for transfer.
- Consensus algorithms provide a process for transactions to be confirmed and added to the single ledger.

While Bitcoin was originally associated with the concept of a universally available, publicly shared digital ledger technology without any central authority, many of the use cases that are currently under development and discussion rely on "permissioned" ledgers in which only permitted, known participants can validate transactions. These in turn can be either public or private in terms of access to the ledger.

The resulting Internet of Value holds out the promise of addressing important frictions and reducing intermediation steps in the clearing and settlement process. For example, in cross-border payments, faster processing and reduced costs relative to current correspondent banking are cited as specific potential benefits. Reducing intermediation steps in cross-border payments may help reduce costs and counterparty risks and may additionally improve financial transparency.

In securities clearing and settlement, the potential shift to one master record shared among participants has some appeal. Having one immutable record may have the potential to reduce or even eliminate the need for reconciliation by avoiding duplicative records that have different details related to a transaction that is being cleared and settled. This also can lead to greater transparency, reduced costs, and faster securities settlement. Likewise, digital ledgers may improve collateral management by improving the tracking of ownership and transactions.

For derivatives, there is interest in the potential for digital ledger protocols to enable self-execution and possibly self-enforcement of contractual clauses, in the context of "smart contracts."

As we engage with industry and stakeholders to assess the potential applications of digital ledger and related technologies in the payment, clearing, and settlement arena, we will be guided by the principles of efficiency, safety and integrity, and financial stability.

Efficiency

Many are excited about the potential for these new technologies to reduce costs and frictions, such as those associated with collateral management and custodial services, reduce settlement risk, enhance security, increase transparency, and offer new services. But there are also concerns about the costs and risks from the early adoption of rapidly evolving and uncertain technologies and technological hurdles in integrating new technologies into legacy systems and achieving interoperability across different ledgers and networks. There are questions about the need for substantial new investments to obtain capabilities like real-time processing where these capabilities already exist at some of the industry's core infrastructures. There are also cautions that realizing the full potential of distributed ledger technologies could take many years.

Much of the case for adopting distributed ledger technologies revolves around achieving greater efficiency and reducing time and risks to post-trade clearing and settlement. But first, important technological challenges will need to be addressed to permit widespread adoption and migration away from legacy systems and networks. These include the need for standardization, the development of protocols that will permit

interoperability between other ledgers and networks, and the reduction of computational intensity and costs.

Moreover, distributed ledgers will have to compete with other options and priorities of financial firms and clearinghouses in a highly regulated financial ecosystem. Thus, a major threshold question for the adoption of distributed ledger technology within and between groups of firms engaging in particular types of transactions is whether the advantages outweigh the costs of replacing legacy systems.

In some cases, where distributed ledger technology can be employed internally within a firm to automate and speed up business processes, traditional business case analysis would presumably lead to efficient technology choices. By contrast, where coordinated industry-level decisions would be needed to develop distributed ledgers shared by multiple firms, the case must be compelling for entire networks of market participants that will need to make the investments, as well as for the broader public interest.

This set of competing considerations suggests there are likely to be a spectrum of cases. At one end are the high-volume, heavily regulated markets that have made large investments in central clearing to provide safe and efficient clearing and settlement for the industry and the public. These markets must always actively consider technological and other enhancements to strengthen efficiency and safety. But as a practical matter, the large-scale adoption of wholly new clearing technologies to replace existing legacy technologies for major markets may face a significant hurdle initially, such that incremental change or delayed adoption until the technology has achieved greater maturity and standardization may be more likely.

At the other end of the spectrum, there appear to be some markets or segments where clearing practices are relatively cumbersome and outmoded, and the network hurdles to the adoption of new technologies are lower. Improvements in smaller markets would also provide an opportunity for market participants to gain operational and business experience with distributed ledger technologies that could help inform and strengthen the case for broader applications over time.

A middle case would involve the application of distributed ledger technologies to bilateral clearing even where improvements have already been made since the financial crisis. A threshold issue will be the design and safety of new technologies and whether firms will want to share a distributed ledger to manage transactions with their different counterparties and customers. No doubt much will depend not only on cost but also on a host of business, technical, security, and other issues. Even so, change might hold promise for improving bilateral clearing, and might also help us think about the long-run trade-offs between bilateral and central clearing.

An assessment of the longer-term potential for deployment of distributed ledger technology naturally raises questions about whether it might ultimately impact the organizational structure for clearing and settlement. As multilateral clearing organizations have strengthened and spread across many of the major asset classes traded in the markets, they have enabled coordinated action on governance, rules, technology, and risk management. It is possible that new technologies could substantially change the way these functions are pursued, but it would be surprising if they would obviate the need for multilateral clearing in the major markets. Governance, in particular, is a core function that is inescapably necessary if multilateral activity, even activity dealing with

distributed ledgers, is to operate effectively. Indeed, if new technologies could lower the costs of multilateral clearing relative to bilateral clearing in new market segments, multilateral clearing could even grow.

Today's clearing houses will likely continue to play a central role in highly regulated markets and be well positioned to evaluate and implement new clearing technologies, while continuing to provide core governance functions in the market. Nonetheless, it is also possible that if distributed ledgers ultimately cross asset classes and even industries, traditional clearinghouses serving specific market segments might have to evolve or new organizations might develop to provide an optimal approach to implementation. Moreover, in principle, the use of distributed ledgers in new market segments may call for new clearing arrangements more in tune with new technologies. Similarly, organizations that can provide governance or other coordinating functions in bilaterally cleared markets may also require organizational structures somewhat different from traditional clearinghouses. We will be following these issues with interest.

Safety, Integrity, and Financial Stability

Safety and integrity in clearing and settlement is a critical, long-standing public policy objective of the Federal Reserve, and is critical for broader financial stability. Regardless of the technologies employed, if risks to clearing and settlement are not identified and addressed, then banks, dealers, and other firms will not be able to manage their obligations and market functioning may be impaired. This is a key reason why major clearing and settlement systems are highly regulated. Hence, the fundamental threshold test for new technologies will be whether they can be deployed and operated safely, with the requisite high degree of operational and financial integrity, security, and

resilience across a wide range of adverse scenarios. Regulators and the public need to know that if adverse scenarios do occur, there will be robust management and governance to respond effectively.

Digital ledger technologies will need to be able to address the range of issues revolving around the confidentiality and security of firm and client records and data on the one hand, as well as law enforcement requirements and issues on the other. New technologies must be robust in practice, not just in theory, to attacks on security, and must be able to maintain appropriate confidentiality for records and data.

In addition, it will be important that digital ledger technologies can meet the requirements of law enforcement and other regulators to address money laundering, terrorist financing, and other key law enforcement concerns. Indeed, there is some potential that the new technologies could enable improved authorized access to certain data records in a much more efficient and comprehensive manner than has previously been possible, thereby potentially reducing costs associated with complying with the Bank Secrecy Act.

Overall we should be optimistic that a range of new technologies hold the promise of providing more robust security, resilience, and information. We cannot afford to assume that change necessarily equals greater risk. Of course, much will depend on the technology itself, its scalability, its level of maturity, the controls and environment surrounding it, the standardization and accessibility of transactions data, the quality of management and governance, and the policy environment in which it is deployed.

Key Challenges Going Forward

Today, many industry participants are experimenting with distributed ledger technology in controlled, permissioned environments. If some of these experiments bear fruit, it will be important to address the challenge of how they would scale and achieve diffusion. In addition, determining exactly how the different distributed ledger technologies interoperate with each other, and legacy systems, will be critical. New and highly fragmented "shared systems" may create unintended consequences even as they aim to address problems created by today's siloed operations. Since distributed ledgers often involve shared databases, it will also be important to effectively manage access rights as information flows back and forth through shared systems. There may well be a tradeoff between the privacy of trading partners and competitors on the one hand, and the ability to leverage shared transactions records for faster and cheaper settlement on the other hand. And of course, development of sound risk-management, resiliency, and recovery procedures will be necessary to address operational risks. The Federal Reserve will continue to engage actively with the industry, stakeholders, and our regulatory colleagues as the industry works through these challenges and the technology evolves.

I want to close by remembering a simple point that central bankers and markets have learned through hard lessons over many years. The daily operation of markets and their clearing and settlement functions are built on trust and confidence. Market participants trust that clearing and settlement functions and institutions will work properly every day. Confidence has built over time that when market participants trade, accurate and timely clearing and settlement will follow. Any disruption to this confidence comes at great cost to market integrity and financial stability. This is a matter

of fundamental public interest. In safeguarding the public interest, the first line of inquiry and protection will always rest with those closest to the technology innovations and to the organizations that consider adopting the technology. But regulators also should seek to analyze the implications of technology developments through constructive and timely engagement. We should be attentive to the potential benefits of these new technologies, and prepared to make the necessary regulatory adjustments if their safety and integrity is proven and their potential benefits found to be in the public interest.