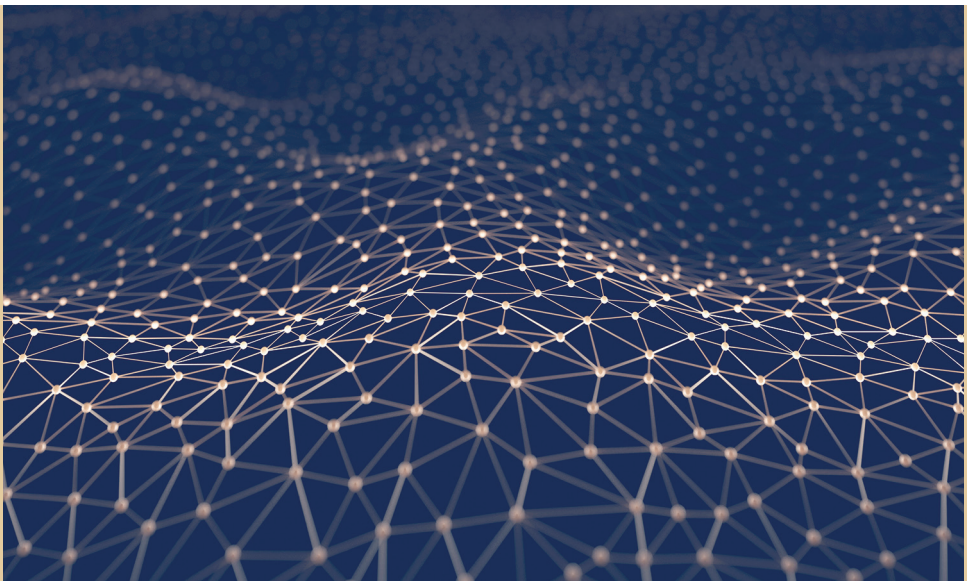
McKinsey Working Papers on Corporate & Investment Banking | No. 12



Beyond the Hype: Blockchains in Capital Markets

December 2015

McKinsey Working Papers on Corporate & Investment Banking are a series of publications presenting McKinsey's latest research and insights on corporate and investment banking. Incorporating a broad range of views from McKinsey partners and experts globally, the papers provide a leadership-level perspective on the opportunities and challenges facing corporate banking, investment banking and capital markets businesses worldwide. Their purpose is to encourage discussion about the future of the industry.

* * *

McKinsey&Company

Beyond the Hype: Blockchains in Capital Markets

Executive Summary

Distributed ledgers, or *blockchains*, have the potential to dramatically reshape the capital markets industry, with significant impact on business models, reductions in risk and savings of cost and capital.

In a blockchain, copies of a ledger are "distributed" and validated by a consensus process, with multiple users independently verifying ledger changes. In Bitcoin, the most well-known blockchain application, tokenized transfers are made directly between payer and payee, effectively eliminating the credit and liquidity risk inherent in the fiat system.

The underlying blockchain technology is likely to deliver a broad range of benefits to firms across the full capital markets value chain, from clearing houses and exchanges to prime brokers and banks. These benefits may include:

- **Faster clearing and settlement:** In a blockchain, once a transaction is confirmed and committed to the ledger, the associated token has also settled in the wallet of the beneficial owner. Faster settlement would lead to reduced costs, and lower counterparty settlement risk and fraud.
- **Ledger consolidation:** Deployment of blockchain protocols at a single institution, with legal entities or branches acting as full nodes, could address regulatory requirements for the consolidation of proprietary ledgers into a single data model for reporting purposes.
- **Consolidated audit trail:** Blockchains contain detailed and precise histories of asset movements that can be made transparent for authorized compliance activities.
- **Reduction in systemic risk:** Distributed ledgers virtually eliminate credit and liquidity risk by requiring pre-funding prior to trading.
- **Operational improvements:** Instrument standardization and alignment of terms in advance of blockchain trading would eliminate a number of middle- and back-office processes.

However, the full potential of blockchain technology will only be realized through cooperation among market participants, regulators and technologists, and this may take some time.

Banks and other financial market participants are likely to face challenges in developing applications. The most pressing relate to the technology itself. As an example, blockchain transactions cannot be amended after the fact. This lack of recourse is in fact an important part of the technology's value proposition, but it represents a hurdle for capital markets participants, who will need to agree on recourse mechanisms that can be pre-programmed. Additional technology challenges relate to the digitization of assets, asset disposition, position netting and computing power. Banks will also face challenges related to market, legal and operational protocols, issues concerning adoption and route to market, and interoperability, as well as internal hurdles related to expense pressures, technology architecture design and cultural resistance.

The blockchain revolution will not happen overnight, and will require cooperation among market participants, regulators and technologists.

Given the challenges, McKinsey expects that adoption of blockchain technology in capital markets will be marked by four stages of gradual development: single-enterprise adoption across legal entities; adoption by a small subset of banks as an upgrade to manual processes; conversion of inter-dealer settlements; and, finally, large-scale adoption across buyers and sellers in public markets.

As they survey the likely evolution of blockchain in capital markets, industry participants should consider four immediate actions:

1. **Assess business impact and plan for the long-term.** Firms should invest now in technology and expertise related to blockchain, and press for industrywide change.
2. **Participate in consortia and work with regulators.** Industry participants will need to work together to design solutions for specific asset classes and processes. Banks and other market participants must form consortia and work with regulators early in the design process.
3. **Capture the internal ledger opportunity.** Internal ledger synchronization is a persistent challenge, and regulatory pressure to consolidate those ledgers is mounting. An enterprise application would allow individual firms to test new technology on systems already being revised.

4. **Go after post-trade and manual processes:** Changes to post-trade activities such as asset booking and transfer can yield significant workflow benefits and be less disruptive to business models.

The blockchain revolution will not happen overnight, and will require cooperation among market participants, regulators and technologists. The unlikelihood of simultaneous, large-scale adoption will initially confine blockchain application to subsets of financial market participants and specific use cases. However, the potential for rapid uptake once open questions are resolved means all market participants must be aware of the potential benefits and threats and have a plan in place to respond.

Defining *Blockchain*

A blockchain is a cryptographic, or encoded, ledger comprising a digital log of transactions shared across a public or private network (Exhibit 1).

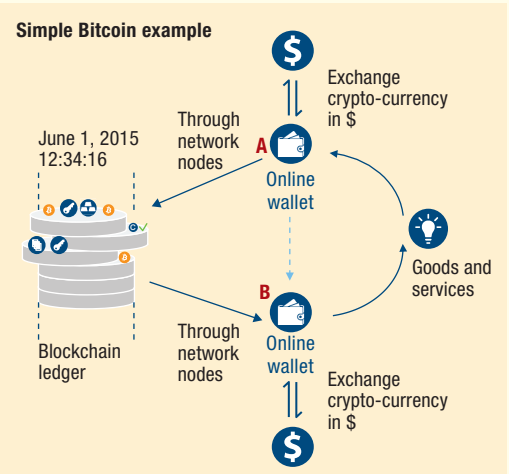
Perhaps the most notable application of the technology is the Bitcoin payment system launched by Satoshi Nakamoto (a pseudonym) in 2009 (Exhibit 2). The Bitcoin blockchain comprises a record of every transaction using the currency, and in September 2015 its market capitalization had grown to $3.4 billion, comprising some 14.5 million bitcoins.[1]

Exhibit 1

The blockchain is one of the most disruptive innovations since the advent of the Internet

The blockchain

- A distributed public digital ledger that maintains, through cryptographic proof, a continuously growing secure list of transactions that is replicated repeatedly.
- A transaction network that potentially can be used by financial institutions and consumers to transact directly.
- Well-suited for applications requiring a rapid, permanent time and date stamp such as:
  - Payments
  - Financial asset transfers
  - Smart contracts
  - Ownership splits and notary services
- A technology that brings substantial benefits in terms of speed, security, transparency, convenience and cost.



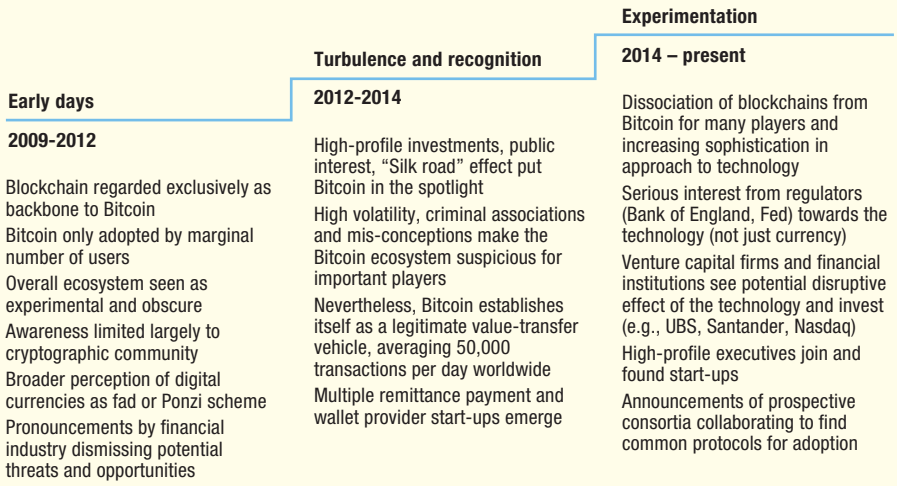
The decentralization of the transaction system will have an important impact on the way business is conducted throughout many industries.

Source: McKinsey & Company

[1] Source: BLOCKCHAIN.info

Exhibit 2

Five years of blockchain development, leading to new applications



Source: McKinsey & Company

The key characteristic of blockchains is that copies of the ledger are "distributed" and validated by a consensus process in which multiple users independently verify that ledger changes are valid. In cryptographic payment systems such as Bitcoin, tokenized transfers are made directly between payer and payee, effectively eliminating the credit and liquidity risk inherent in the fiat system.

The absence of the need for an intermediary is seen as the most disruptive aspect of the technology. However, capital markets participants are equally focused on blockchain's operational potential throughout the value chain.

For financial market assets amenable to digitization, blockchains offer an array of possibilities, from asset booking and transfer to trading and compression of settlement and clearing processes, with minimal middle- and back-office support.

Potential generic benefits include improved efficiency, faster processing times, greater transparency and lower costs. However, the technology remains largely unproven in complex markets.

Operation of a blockchain requires multiple transaction processors (*miners*), full ledger hosts (*full nodes*) and signatories (*wallets*). All hosts hold identical copies of the ledger.

A combination of public and private cryptographic keys is required to prove a transaction has been authentically originated. Each transaction must contain a valid cryptographic signature from the asset sender and may contain fees.

In validating transactions, processors use brute-force computing power to find answers to a puzzle that is probabilistically challenging. In the Bitcoin blockchain an algorithm allows for a valid answer approximately every 10 minutes on average.

Once a transaction processor has solved the puzzle, he or she can add transactions into the official ledger, and may receive a reward.

Different blockchain systems can operate distinct approaches to validation. Authority or voting weight can depend on factors including a proven stake, trust in a central validator or demonstrated computational power. While beyond the scope of this article, consensus and validation methods will be a significant focus in the development of capital markets applications.

Distributed ledgers offer improvements over proprietary ledgers

- a cryptographic transaction network without intermediaries
- consensus on veracity of transactions
- transaction permanence and immutability
- prevention of "double spend"
- no potential for failure of a single node to bring down the entire system
- suited for applications that require a permanent time and date stamp
- scalable to multiple participants, account holders and account entries
- applicable to an array of financial assets

Once validated, blocks of transactions are secured from further revision by a cryptographic proof known as a hash. Changes to the blockchain can only be achieved through additional reversing transactions associated with the "add only" method of bookkeeping.

As many in the industry have begun to acknowledge, blockchain applications may eventually be expanded deep into the commercial territory occupied by capital market infrastructures. In response, there are already numerous industry initiatives aimed at developing blockchain-based solutions, including a joint project by several investment banks to develop common standards and protocols. The revolution is under way.

Blockchains in Capital Markets

Implicit in the development of alternative ledger systems is the belief that the current model, based on a network of centralized ledgers, is imperfect.

Payments between banks require transactions and reconciliation among ledgers, and a series of bank accounts are often necessary to propagate money from ledger to ledger. This introduces dependencies and produces batch-based serial processes, characterized by multi-day transaction times, high costs and operational risks.

Capital markets and investment banking (CMIB) transactions are defined as the exchange of contract rights, obligations and payment flows. On that basis, a decentralized ledger could theoretically be rolled out to almost the entire corporate and investment banking (CIB) business, cutting risk and producing significant savings of costs and capital.

While exploration of blockchain applications is in its infancy, there are several immediate potential benefits, including:

- **Faster clearing[2] and settlement:** In theory blockchain technology could support compression of clearing and settlement, because once a transaction is confirmed and committed to the ledger, the associated token has also settled in the wallet of the beneficial owner. Faster settlement would lead to reduced costs, and lower counterparty settlement risk and fraud, although discrete process steps associated with clearing and settlement still facilitate additional business logic such as netting and margining. Existing blockchains are designed with delays ranging from a few seconds up to a few minutes to facilitate verification before each block is written to the ledger; alternative blockchains currently being developed may provide even faster settlement times. In any event, the delays are considerably shorter than the current T+days settlement cycles in securities trading.

[2] *Clearing* is defined as in U.S. markets and refers to the commitment to a transaction by the beneficial owner which, in process terms, initiates the settlement cycle for delivery or receipt of assets.

- **Retention of documentation:** More complex asset transfers generally comprise bespoke terms and require manual processes through the transaction lifecycle. In blockchains, any authorized party can access and verify ownership records, with vital transaction information and processes embedded in "smart contracts."
- **Ledger consolidation:** Deployment of blockchain protocols at a single institution, with legal entities or branches acting as full nodes, could address regulatory requirements for the consolidation of proprietary ledgers into a single data model for reporting purposes, if not further into a single multi-product, multi-currency record.
- **Consolidated audit trail:** By design, blockchains contain detailed and precise histories of asset movements, which has the additional benefit of being attractive to regulators. With customer and dealer books on the same ledger, requirements relating to anti-money laundering or customer order handling can be efficiently addressed. Blockchains usefully incorporate relative time stamping (or "block height").
- **Reduction in systemic risk:** It is well documented that markets including short-term finance and repo are vulnerable to a liquidity squeeze. In addition, long settlement cycles and mismatches in trade booking make collateral a moving target. Distributed ledgers virtually eliminate credit and liquidity risk by requiring pre-funding (presence of cash and collateral in accounts) prior to trading. The ability of blockchains to reverse/terminate transactions and enter into new ones intra-day holds promise for eliminating the so-called "daylight" risk associated with, for example, collateral substitution in repo.
- **Operational improvements in the middle and back office:** Instrument standardization and alignment of terms in advance of blockchain trading would eliminate a number of middle- and back-office processes, including trade enrichment, error correction, allocations and counterparty matching. Widespread adoption of a single blockchain would also eliminate the need for activities such as reconciliation of proprietary ledgers.
- **Account-handling efficiency:** Blockchains are designed for scalability and security to the level of the individual wallet or account, and may be used to create omnibus accounts that are legally separated and operationally comingled.

- **Redundancy of book-entry systems:** While many assets trade in digital form, they are effectively guaranteed by financial intermediaries who represent that they are backed by physical assets, much as governments at one time guaranteed that currencies were backed by gold reserves. If assets can be represented fully in digital form with finality of settlement and full legal recognition, the current system of book-entry of securities between central securities depositories (CSDs) and "street name" custodians could become unnecessary in some cases. The ledger itself becomes deterministic, without abstraction or the need for a third party to represent it as true.

Challenges to Implementation

Despite the potential of blockchain technologies, banks and other financial market participants are likely to face numerous challenges in developing applications. The most pressing difficulties relate to the technology itself, as well as market, legal and operational protocols and challenges specific to current banking practice.

Limitations of early blockchain technology

Given its widespread adoption, it is practical to identify challenges inherent in the blockchain technology supporting Bitcoin and analogous "altcoins." These include:

- **Recourse:** While the Bitcoin blockchain provides for controls and verification before transfers take place, there is no capacity to directly amend transactions after the fact; instead, a second, opposing and correcting transaction must be recorded. This inability to subsequently edit the historical blockchain database is a critical element of its value proposition. A way forward would be for network participants to agree on recourse mechanisms that can be pre-programmed, tying together trades and exceptions.
- **Digitization of assets:** In the Bitcoin implementation, assets are not so much recorded on the blockchain as contained in it, and assets are re-assigned within the ledger to effect changes of ownership. Developmental design of such digital assets can be achieved in phases: the first challenge related to digitization is for all parties to agree on standard terms and digital descriptors. That is a non-trivial task, and the transaction model and all specific transaction terms must be agreed upon ahead of time. The "finality of settlement" for a digital asset may also require groundbreaking legal and regulatory work.

- **Asset disposition:** As assets are held in-ledger, there is no need for a physical facsimile, meaning that book-entry systems and depository accounts ultimately would be obsolete. If, instead, the digital form in the ledger is treated as an abstract representation of the tangible form, the physical, or "golden copy" of the asset must be retained. True dematerialization of assets could therefore take many years with ongoing requirement for on- and off-ramps to the distributed ledger. As certain hard assets do not lend themselves to full digitization, some blockchain applications will need to synchronize the digital ledger with the physical world.
- **Position netting:** Bitcoin blockchain protocol maintains discrete tracking of assets on a fully-paid-for basis without any fungibility or netting. While this method of accounting is ideal for tracking tax lots and hard assets such as real estate, it runs counter to the current market convention for, say, cleared derivatives and their associated collateral requirements. Failure to address this aspect of the protocol would lead to higher collateral and capital requirements, a critical point for banks seeking to optimize their size and use of resources. To this end, several solutions are now under development.
- **Margin finance:** In many institutional transactions, margin finance allows participants to transact with assets they do not own. The existing Bitcoin blockchain does not provide for leverage, and instead checks for possession of assets before transfer is permitted. As with netting, modifications are being proposed by blockchain technology companies.

McKinsey sees several areas of the existing market, legal and operational framework that would need to be developed for a blockchain-enabled environment.

- **Slower confirmation despite faster settlement:** Bitcoin blockchain confirmation times are purposefully slow (about 10 minutes) to allow for multiple copies of the ledger to be synchronized throughout the network. Other blockchain protocols are considerably quicker, and blockchains may effectively compress confirmation and settlement steps, with a resulting impact on traditional post-trade processes during the settlement period.
- **Block capacity:** At the time of this writing, there is a hard 1 megabyte limit on the block size of the Bitcoin blockchain, which may be an unacceptable capacity constraint in certain applications. As a consequence,

future blockchain designs are being debated which would overcome this limitation.

- **Computing power:** Computational power required by blockchain hashing algorithms is substantial in the Bitcoin application, a potential impediment to applications in financial markets, which have considerably higher transaction volumes. Although computational difficulty is a feature of the Bitcoin blockchain by design, energy consumption may remain a concern.

Market, legal and operational challenges

McKinsey sees several areas of the existing market, legal and operational framework that would need to be developed for a blockchain-enabled environment. These include:

- **Pre-trade agreement on terms:** In many types of securities, traders transact on a fraction of the information required to settle, leaving various terms to be inserted later. Blockchain enforces behaviors that may reduce breaks and exceptions, because all terms must be settled ahead of execution, including allocation of block transactions among sub-accounts.
- **Settlement via delivery-versus-payment (DVP):** A blockchain transaction effects changes of ownership, while its consensus algorithm ensures that assets are not "double spent." Operationally, this is equivalent to segregation in advance of payment, akin to DVP in short time intervals. As a result, the protocol allows the holder of an asset in possession of the account's private key to send the asset to the account of a buyer, once the buyer demonstrates the ability (as opposed to a promise) to pay. While DVP is a common convention, broad adoption as a method of exchange will be required.
- **Cash movements:** Cash must be synchronized with the ledger or moved into the digital realm. There is generally a cash leg to transactions involving an asset transfer, and McKinsey expects, at least initially, that market participants will be inclined to move cash in the traditional manner through existing wire systems. Bridging the gap and synchronizing rails will be challenging. Some have proposed a parallel, digital representation of physical cash to travel within the ledger. Other solutions could include use of a digital currency as a means of conveyance.
- **Proprietary bank ledgers:** As a prerequisite for adoption, banks and regulators must be comfortable with collective responsibility for

distributed, fault-tolerant and secure record-keeping. Regulation of traditional banking products and services would need to be satisfied at the on- and off-ramps to the ledger, and proponents of closed networks must guard against fraud.

- **Legality and enforceability:** The legal framework currently applicable to capital markets must be mapped to the distributed ledger framework, and amended where contract rights are impacted.

Challenges specific to banks

Banks face hurdles to widespread blockchain adoption, including:

- **Expense pressure:** Expense pressure conspires against transformation of current operations. CEOs are in need of information and impact assessment while IT departments lack the funding or business support to change commitments to long-term plans and systems architecture already under development. Operations heads sense value in new technologies and can support pilot investments, but product heads fear disruption of revenue streams and typically seek more immediate returns. While the move to distributed ledgers will undoubtedly bring significant cost reductions in the longer term, the benefits need to be well quantified and demonstrated.
- **Technology architecture redesign:** Data, risk, capital and pricing models are likely to be impacted by use of blockchains, and making the necessary changes to those models, alongside obtaining regulatory approvals, is likely to be costly, with benefits expected over time.
- **Internal deployment:** An institution could deploy the blockchain ahead of the wider market, but may confront challenges related to interoperability with existing ledgers. The institution may also be hostage to later technology advances.
- **Cultural resistance:** Any step toward a potentially disruptive solution may be met with internal resistance. Established businesses may press to preserve the status quo, particularly if change implies lower profitability, product cannibalization or elimination of roles.

Potential Impacts on Business Models

Blockchains have the potential to disrupt business models across financial markets, in some cases improving operational efficiencies and in others undermining current ways of transacting.

McKinsey sees significant disruption (and the greatest benefit) if the technology is adopted in public markets and by all market participants. In the near term, limited, highly-focused adoption is likely to be more disruptive to technology budgets and management priorities than to the business lines themselves.

There is potential for central banks to simplify and de-risk the wholesale deposit and payments processes by facilitating digital settlement for banks. Tokenization of cash movements sanctioned by central banks would amplify current efforts to bring blockchains to specific securities by addressing the cash lag associated with most asset transfers.

In practice, adoption is being most actively explored in over-the-counter markets, where volumes are lower, operations are more manual, contracts are complex and counterparty risk is higher. Early solutions appear to be focused on assets such as syndicated bank debt, unregistered securities, precious metals, title insurance, asset-backed securities and repurchase agreements. In due course, developments in currency trading based on experience in Bitcoin markets may seep into FX businesses as Bitcoin exchanges obtain the licenses to accept cash deposits. Application of blockchain technology in the payments space may move beyond its current retail focus.

Following are considerations relating to the potential impact of blockchains across a range of market participants. The implications of blockchains at full adoption are important to consider, but it is more practical to think about the impact of current industry initiatives.

- **Central Securities Depositories (CSDs):** CSDs serve a critical function of holding assets as well as establishing ownership. In theory, assets fully expressed in the digital domain do not require custody and the ledger itself is infallible. Assets and documents that can be digitized may continue to have an original or "golden" master (including signatures, stamps or other notarization) in physical form that must be secured. The role of CSDs may expand through digitization of more assets. In limited blockchain applications, CSDs may participate in bookkeeping (mining) operations for independent verification.
- **Clearing houses:** While blockchain-driven settlements would remove the need for intermediaries during transfer, clearing houses seem likely to retain their value proposition prior to settlement. McKinsey notes that the failure of Mt. Gox as a Bitcoin exchange was in part attributable to poor accounting of trades. If blockchain speeds can catch up with exchange speeds, clearing house functions could be at risk, but the current state of the technology suggests that clearing would sit on top of a blockchain settlement infrastructure rather than being replaced by it. Clearing houses may also participate in bookkeeping for independent verification. In derivatives markets, where clearing houses act as single counterparty to all participants, extensive development, testing and integration is needed with respect to smart contracts to replace the established benefits of novation to a central counterparty clearing house.

Despite the attractive proposition of peer-to-peer transactions, blockchain technology does not yet offer price discovery or anonymity, two critical services provided by exchanges.

- **Exchanges:** Despite the attractive proposition of peer-to-peer transactions, blockchain technology does not yet offer price discovery or anonymity, two critical services provided by exchanges. In other words, blockchain knows what people own, not where they might sell it. Further, the speed of Bitcoin blockchain postings is not yet adequate to support electronic trade matching for asset classes where sub-second speeds are routine and transactions are numbered in the millions. While Bitcoin-specific exchanges should continue as necessary mechanisms for price discovery, alternative blockchain solutions could spur the growth of competing venues and encourage seller-driven auctions.

- **Clearing brokers:** In cleared derivative transactions, a blockchain's ability to verify the presence of collateral pledges would seem to eliminate the need for clearing brokers as credit intermediaries. If banks decide to finance the activity of a client by lending cash or collateral, such financing may be done on a strictly bilateral basis without putting the clearing house at risk.
- **Custodians:** The combination of central clearing and immobilization of assets at CSDs, or on the blockchain ledger, suggest less need for traditional asset custody. Security and fund-level services would continue to be required, but future competition may include technology firms as well as banks, as credit intermediation and proprietary ledgers are replaced. Custodians typically offer custody and fund services at a single price. While the need for fund and asset servicing will persist, the unbundling of custody fees and competition from pure technology companies touting better analytics and data security could result in a significant reduction in revenue for current players. Activities such as securities financing could also come under pressure for repo or stock loans transacted on a blockchain platform.
- **Prime brokers:** Although prime brokers serve as the de facto custodian for certain hedge fund assets, they have only recently begun charging for the service. They also incorporate many functions of the stand-alone clearing broker. Blockchain would seem to relieve banks of many activities attracting operational and credit risk capital, but also deprive them of opportunities to charge for credit intermediation or liquidity. Bank balance sheets will remain a strong value proposition for those clients that require leverage. McKinsey sees prime brokerage remaining intact for those that can adapt to new methods of booking. Should secured loans of cash or securities themselves wind up on blockchains, balance sheet providers should continue to benefit.
- **Executing brokers:** In agency transactions, McKinsey does not see a major impact on revenues, but does expect reductions in middle-office costs associated with fewer trade breaks and faster confirmation and settlement. While the same efficiencies should be found in principal transactions, the question of whether blockchain-based trading would open the market to new participants or direct transfer among buy-side participants is a lingering concern. Executing brokers may also participate in bookkeeping to build confidence in digital settlements.

- **Market makers:** Impact on this function must be considered by asset class and existing market structure. At its core, blockchain facilitates peer-to-peer trading based on asset ownership that could in some cases reduce the need for market-making. Currently-used blockchain designs like Bitcoin do not support trading "at risk," but that may be developed in new iterations. Banks acting as principal in foreign exchange transactions may see pressure from alternative exchanges. Independent market makers could see increasing opportunities to provide liquidity to venues.
- **Investors and asset managers:** Asset management companies should enjoy the same operational benefits as dealers and intermediaries, with the caveat that their participation may correspond to a leap forward in the impact of the technology, as operational steps such as reconciliation and asset movements are suddenly simplified (with corresponding impact on the traditional providers of these services). High-speed trading strategies will be subject to the same considerations as market makers in liquid markets.

At its core, blockchain facilitates peer-to-peer trading based on asset ownership that could in some cases reduce the need for market-making.

- **Capital markets/investment banking:** Blockchain has no impact on the advisory aspects of investment banking, and revenues tied to the provision of capital in the form of underwriting should not be affected, unless new entrants find it easier to enter the market with balance sheet and capital. Distributed ledger technology could facilitate issuer-led auctions of new debt and equity securities, thereby reducing investment banking fee pools. In two early examples, retailer Overstock.com and the Binary Event Network, Inc. (operator of Pivit probability markets) have experimented with issuance of private, unregistered securities in digital form via blockchain transfer.
- **Corporate banks:** Blockchains applied to loan syndication may automate and accelerate processes. (It is worth noting that current market practice favors "renters" of balance sheets during settlement operations, so not all participants share the same incentives.) Treasury services, particularly payments, could be transformed by adoption of blockchain or, more significantly, digital currency. Economically, these new technologies could eliminate time delay and reduce bid/offer spreads in foreign exchange.
- **Transfer agents:** Search, verification and insurance of hard assets via property title would not be required for assets adequately represented in

a distributed digital ledger, a by-product of cryptographic proof of ownership and related security of transfer. Until this dematerialized digital-only position is realized, transfer agents will be required to ensure that the digital ledger positions match hard asset positions.

- **Messaging networks:** Financial services and technology firms specializing in providing data and messaging through current protracted settlement cycles would find some use cases for their communication network curtailed, and the need for trade enrichment reduced as pre-trade standards take hold. With settlements handled on a blockchain, the need for scheduling, downstream asset movements and correspondent communication could be obviated.
- **Remittance providers:** As cash becomes digitized, transferred and accounted for on distributed ledgers, international settlements and currency exchange could be accelerated, affecting business models that are dependent on time delay and currency exchange on a principal basis. For payees that do not accept digital currency, exchange for fiat currency can increasingly be accomplished on multiple emerging exchanges rather than at dealer-quoted levels.

The Evolution of Blockchains in Capital Markets

Adoption of blockchains is unlikely to happen all at once, and McKinsey expects organic growth to be loosely marked by four stages of development, each of which will give capital markets participants the opportunity to gradually prove viability, solve for complexity and measure benefits:

1. **Single enterprise adoption across legal entities.** To build confidence in new methods of booking and transfer, capital markets players must participate first-hand in "mining" operations. Internal group-wide implementation could distribute the common ledger among legal entities, each acting as an independent node and bookkeeper. Deployment of a common protocol across legal entities will require rewiring of existing platforms, but within an enterprise that owns all books and records and transaction endpoints. Design issues could be internally resolved and modified with experience over time. A consequence of this first step could also be to solve for moving assets into and out of a closed blockchain network.

   Purpose-built ledgers offer the potential to offset many technological limitations, and banks and vendors are already starting to develop and test solutions, both publicly and privately. Among the many projects being pursued:

   - *Digital Asset Holdings* is focused on providing purpose-built blockchain software to market participants, with solutions aimed at specific asset classes.
   - *itBit*, which has a Trust Charter from New York State, is exploring the path of a regulated market participant and operator/owner of a

distributed ledger, and the movement of cash payments that would accompany the transfer of digitized assets.

- *Noble Markets* is developing an open trading, clearing and settlement infrastructure compatible with permissioned blockchains.
- *R3* is convening large global market participants and solutions providers in an effort to establish common standards governing blockchain design and deployment.
- *Ripple* is developing alternative protocols designed to reduce confirmation times and energy consumption associated with hashing activity and facilitate connections between different types of ledgers.
- *Symbiont* is focused on the development of smart contracts.

2. **Adoption by a small subset of banks as an upgrade to manual processes.** Assets traded infrequently and manually over the counter could provide a solid testing ground for blockchains. Small networks of market participants could convene to agree on standards and protocols for booking and transfer with relatively little investment and potential improvement to current operations.
3. **Conversion of inter-dealer settlements.** Standardization is critical to digital asset representation, and standardized products in interdealer-dominated markets could provide the next round of expansion for blockchain technology. Limiting the community will ratify the technology with some degree of insulation for end investors.
4. **Large-scale adoption across buyers and sellers in public markets.** The boldest step for financial markets would be to extend blockchain technology from the dealer community to end investors. Expansion of the network would be a great leap forward and would depend on large-scale conversion of existing systems and adoption by a large number of market participants.

Four Immediate Actions for Capital Markets Players

Capital markets firms in general and banks in particular are under considerable pressure to achieve better operating leverage. If blockchains can reduce cost in technology and operations, as well as capital requirements, the technology represents an important opportunity.

Although McKinsey expects adoption of blockchains to take several years, there are four actions capital markets participants should consider immediately:

1. **Assess impact on your business and plan for the long term:** Firms must invest in technology and expertise, and be willing to press for industrywide change, because many potential benefits are contingent on breadth of adoption. Where disruption is more concerning to parts of the business model, planning is required to mitigate impact.
2. **Participate in consortia and work with regulators.** Shared solutions will require governance and consensus around technology choices. Industry participants must work together to design the right solutions for specific asset classes and processes. Banks and other market participants must form consortia and work with regulators early in the design process. Successful new technologies must also interface with traditional processes and workflow. Banks will need to provide active input, including but not limited to use cases, operational expertise, sample data, interfaces to legacy systems and technology testing environments. In many cases, resources must be shared with competitors and technology providers. The payoff for cooperation over co-opetition may be industry utilities and faster development cycles.

3. **Capture the internal ledger opportunity:** Internal ledger synchronization is a persistent challenge for banks and others, and regulatory pressure to consolidate those ledgers is mounting. An enterprise application would give individual firms the opportunity to test new technology on systems already being revised. Internal applications would also provide users with a means of developing expertise without concern for network issues.
4. **Go after post-trade and manual processes:** Changes to post-trade activities such as asset booking and transfer can yield significant workflow benefits and be less disruptive to business models. In terms of products, exchange-traded securities would seem to have a head start by virtue of standardization, but it may be that exchange-traded business change will be restrained by embedded infrastructures.

* * *

McKinsey sees great promise in distributed ledger technology, but expects that development will require cooperation among market participants, regulators and technologists. The unlikelihood of simultaneous, large-scale adoption will initially confine use of blockchains to subsets of financial market participants and specific use cases. However, the potential for rapid uptake once open questions are resolved means all market participants must be aware of the potential benefits and threats and develop a response plan.

While blockchains have not been imposed on financial markets by regulation, many of the benefits fall into the areas of market oversight. The degree and pace of adoption will likely be set by market participants and the forces of the markets in which they participate. Still, the rising need for operational leverage suggests successful players of the future may be those that embrace new methods of transacting and processing.

Further insights

McKinsey's Corporate & Investment Banking Practice publishes frequently on issues of interest to industry executives. Our recent reports include:

McKinsey Working Papers on Corporate & Investment Banking, No. 11: The Fundamental Review of the Trading Book: Implications and Actions for Banks
December 2015

McKinsey Working Papers on Corporate & Investment Banking, No. 10: Two Routes to Digital Success in Capital Markets
October 2015

McKinsey Working Papers on Corporate & Investment Banking, No. 9: Boosting Front-Office Productivity In Capital Markets
April 2015

McKinsey Working Papers on Corporate & Investment Banking, No. 8: Leveraging the Digital Potential in Corporate Banking
February 2015

McKinsey Working Papers on Corporate & Investment Banking, No. 7: Fixed Income, Currencies and Commodities in Asia: Competing in a Shifting Landscape
December 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 6: Accelerating Growth and Profits in North American Commercial Banking
October 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 5: Improving Capital Markets Profitability: From a Product to a Client Focus
July 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 4: The Brave New World of SEFs: How Broker-Dealers Can Protect Their Franchises
June 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 3: Winning in Transaction Banking in Asia
June 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 2: Sales Transformation in Mid-Market Corporate Banking
March 2014

McKinsey Working Papers on Corporate & Investment Banking, No. 1: Winning in Western Europe's New Corporate Credit Landscape
February 2014

Contact

For more information about this report, please contact:

Tolga Oguz
Principal, New York
tolga_oguz@mckinsey.com

Roger Rudisuli
Principal, New York
roger_rudisuli@mckinsey.com

Matt Higginson
Associate Principal, New York
matt_higginson@mckinsey.com

Jeff Penney
Senior Advisor, New York
jeff_penney@mckinsey.com

Global Corporate & Investment Banking Practice
December 2015

www.mckinsey.com/client_service/financial_services