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Blockchains: A review and research agenda for international business

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ABSTRACT

A growing number of firms around the world are adopting blockchain technology. However, international business literature has devoted little attention to blockchain despite its potential to transform the field. Our study seeks to provide a thorough understanding of blockchain and the implications of the technology as it represents a new way to produce and maintain trust between organizations. We also provide a comprehensive discussion of the implications of blockchain for international business research. Specifically, we evaluate how blockchain can help firms overcome gaps in trust and increase transparency in supply chains, improve inter-organizational relationships, and reduce the need to internalize activities by lowering transaction costs. We also discuss how blockchains are transforming capital raising activities and accelerating the speed with which firms internationalize. We conclude with research opportunities for international business scholars to pursue to better understand the implications of blockchain technologies.

1. Introduction

A growing number of firms around the world are adopting blockchain. While such adoption is mostly motivated by considerations of data integrity, other reasons that drive organizations to adopt blockchain include a desire to improve efficiencies and enable new revenue models like supply chain track-and-trace, customs documentation, fraud or tampering detection, smart contracts, payment support processes, and digitization of document flows. A recent EY survey (Brody, 2019) found that while private blockchains are popular currently, there is considerable interest around the world in public blockchain networks. Deutsche Bank (DB) forecasts that by 2027, blockchain systems will record transactions for about 10% of worldwide GDP (Krause, 2018). Analysts anticipate blockchain adoption to grow at a compounded rate of 56% in the period from 2022 to 2029 reaching over $163 billion by 2029 (Fortune Business Insights, 2022). Despite its growing popularity, blockchain and digital currencies are among the least researched subject areas (Alhenawi et al., 2022).

Today a growing number of multinationals are actively leveraging blockchain technology across a wide range of industries, including the financial sector (Böhme et al., 2015), healthcare (Mettler, 2016), and logistics (Hackius and Petersen, 2017) for a variety of reasons such as compliance (Anjum et al., 2017) and data protection (Finck, 2018). In their review, Torres de Oliveira et al. (2020) point out that the emergence of digital technologies has supported new business models (Foss and Saebi, 2017; Rachinger et al., 2019),

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enhanced the degree of trust among market agents (Urena et al., 2019), and brought about new products and services (Matt et al., 2015). As blockchain technologies transform international business practices, it has the potential to change the nature of interactions among firms worldwide (Hooper et al., 2020; Klarin, 2020).

Trust forms the cornerstone of international business (IB) relationships, and is a central theme in international strategy research (Zaheer and Zaheer, 2006). Trust is essential in collaboration (Luo, 2002), and for conflict resolution in cross-cultural environments (Sullivan et al., 1981). It constitutes an important component in strategic alliances (Cullen et al., 2000), and multiple studies have demonstrated its importance in facilitating transnational business (Child, 1998, 2001). Trust is particularly important in the IB context because of differences in culture, distance, and informational asymmetries between transacting parties. Building trust is especially challenging across geographical and cultural borders, and in countries where institutional trust is declining (Carucci, 2018).

Blockchain's importance to IB is rooted in its ability to mitigate issues of trust between organizations. Some common issues associated with lack of trust with business partners include uncertainty about the future, risk of losing something of value, and lack of control over the behavior of partners (Parkhe, 1998). Blockchain is essentially a distributed and consensus-based ledger of transaction records (Appelbaum and Smith, 2018; Notheisen et al., 2017; Pilkington, 2016). Put simply, blockchain is a decentralized database that enables real-time verification and communication of information (Appelbaum and Smith, 2018). Among their advantages, blockchain can enable firms to achieve higher levels of disintermediation where suppliers can transact directly with customers, along with efficient tracking of assets and assuring the integrity of data (Lacity, 2018). Due to the consensus-based validation, blockchain eliminates the need for a trusted third party.

Our paper makes several contributions. First, Buckley et al. (2017) calls on IB researchers to do more to make sense of critical global phenomena. In response, our study provides an in-depth discussion of blockchain and the implications of the technology to IB scholars and practitioners as it represents a new way to produce and maintain trust between organizations. Specifically, there are two main types of blockchain (permissioned and permissionless) and the one the firm adopts depends on a multitude of factors. Every company interested in moving their processes to a blockchain evaluates their needs and goals when selecting a particular type of distributed ledger. A firm does not just choose one form of blockchain for the entire organization. Instead, organizations often choose a variety of blockchains that are process-specific. Also, we show how the prevalence of trust and uncertainty in international business scenarios motivates the adoption of blockchain for different applications. To illustrate the role of trust in a blockchain economy, we study the antecedents that produce trust in both traditional institutions and contrast it with the antecedents of trust in blockchain applications.

Our research contributes to international business research by providing a comprehensive discussion of the implications of blockchain. In doing so our study answers Doh's (2017) call for more phenomenon-based research in IB. For instance, with industry-specific domains, we evaluate how blockchain can help firms overcome gaps in trust and increase transparency in supply chains. We also discuss the implications of blockchain to interorganizational relationships and how firms operating with varying levels of interpersonal trust can use blockchains to mitigate trust issues. Further, we discuss the implications of blockchain to the capital raising by young firms, and also how born-globals are utilizing blockchains to engage in rapid internationalization. We discuss how

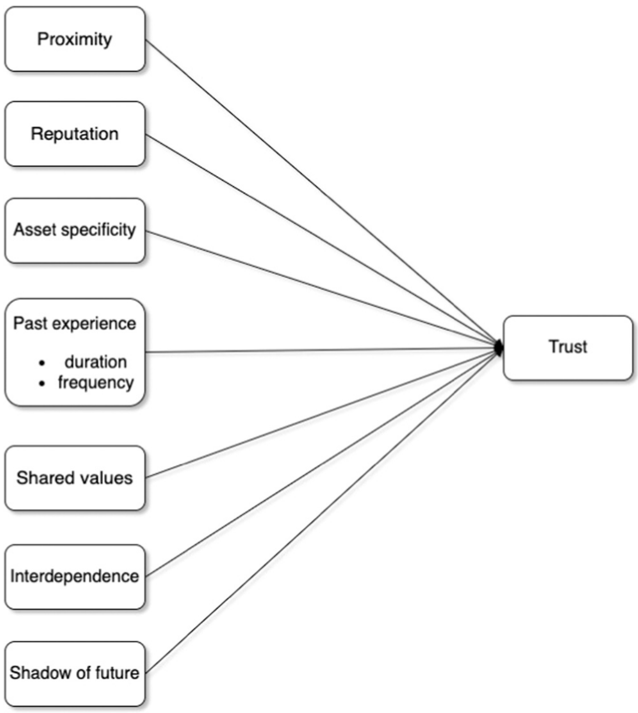

Fig. 1. Traditional antecedents of trust.

firms take advantage of blockchains to reduce transaction costs and reduce the need for firms to internalize transactions. We highlight how blockchains enable more efficient coordination of activities, and how they enhance creativity and global product design and development. We also discuss how institutional environments can either enhance or negate the benefits of blockchains. Our paper concludes with research opportunities for IB scholars to pursue to better understand the implications of blockchain technologies.

2. Blockchain technology

2.1. Trust: conventional antecedents

Any relationship between two organizations or two individuals is subject to two types of uncertainties (Krishnan et al., 2006). Behavioral uncertainty relates to the difficulty in ascertaining how the other party will behave. Environmental uncertainty relates to how changes in circumstances would affect the actions of the parties involved. Organizations cope with behavioral uncertainty either through trust or through contractual safeguards. In the case of nonrecurring transactions between two parties, the structural perspective emphasizes complex contracts to reduce the likelihood of opportunistic behavior. However, for recurring transactions between two parties, the relational perspective emphasizes the production of trust to reduce transaction costs (Faems et al., 2008). A large body of research has investigated the antecedents of trust in interorganizational relationships. The antecedents of trust identified in prior literature include cultural, cognitive, and social proximity (Bruneel et al., 2007), mutual communication (Bstieler, 2006), partner's reputation (Daellenbach and Davenport, 2004), irreversibility or specificity of assets invested in a relationship (Lui et al., 2006), shadow of the future (Poppo et al., 2008), past experience (Seppanen et al., 2007), interdependence, duration of the relationship, shared values (Ybarra and Turk, 2009), and frequency of interaction. Fig. 1 provides a graphical representation of the antecedents of trust from a relational perspective.

2.2. Trust: blockchain antecedents

In a blockchain mediated interaction between two parties, trust is created neither through legal safeguards nor through legally binding contracts. Instead, the foundation of trust is based on the verifiability of the actions of each party. Cryptographic hash functions which provide fixed-length, unique representations of data are the underlying mechanisms for immutable record-keeping. In addition, the relationship between data and its hash is obscured by complex cryptographic functions which cannot be reverse engineered, thus creating the foundation for non-repudiation and data integrity, since the records of transactions are protected by tamper-proof hashing functions.

Blockchain fosters trust due to several features inherent in the technology. Blockchain is a peer-to-peer network comprising of nodes that receive information from users about various transactions that they have engaged in. Nodes receiving this information have to determine the verifiability and sequence of these transactions. At fixed intervals of time, nodes submit their own block of transactions for potential addition to the blockchain. Consensus algorithms running at every node determine if this proposed block will be added to the blockchain, since the information about the proposed block is broadcast to the entire network. This mechanism of algorithmic consensus ensures that malicious nodes do not insert fraudulent transaction data onto the blockchain, since the data on blockchain which is stored in the form of records in blocks is voted upon by consensus. Algorithmic consensus also serves to mitigate problems related to double-spending where an asset is spent twice before being recorded on a block (Iqbal and Matulevičius, 2021). Thus, decentralized record-keeping in blockchain is achieved with the help of consensus algorithms, hash functions, and a peer-to-peer network architecture. The immutability of transactions in the blockchain coupled with hash-based verifiability creates a system of records that stretches from any block to the genesis block offering a verifiable ledger of records. Since the information about transactions can be readily verified by any interested stakeholder, blockchain has emerged as a powerful tool for reducing the information asymmetry that is inherent in large, multi-party, complex business transactions where access to records has conventionally been a bottleneck in transaction processing.

The security of these transactions is enabled by public key cryptography, which uses a key[1] pair consisting of a public key and a private key to enable a user to engage in a transaction. While the public key is openly available for anybody to access, a user's private key should be kept secret for that user. Security in blockchains is thus reduced to the problem of securing private keys. A variety of key-securing mechanisms exist, which include hardware wallets, key storage services, and offline storage services.

Trust is produced in blockchain transactions through its basic characteristics such as decentralization of decision making, distributed processing, reliability, peer-to peer transmission, immutability of data, automaticity, low transaction fees, transparency, non repudiability (irreversibility), and speed (Treiblmaier, 2018; Nakamoto, 2008; Narayanan et al., 2016; Bahga and Madisetti, 2017; Iansiti and Lakhani, 2017). Decentralization refers to control and decision-making being moved from a single individual or organization to a distributed network. Decentralized networks reduce the ability of individual participants from controlling others in ways that degrade the functionality of the network. Decentralization has been a key component of blockchains to democratize trust (Chu and Wang, 2018). Strong decentralization helps ensure the trustworthiness of the whole system (Chu and Wang, 2018). Decentralization also improves data reconciliation. In every instance in which a company exchanges data with their business partners there is an opportunity for either data to be lost or for incorrect data to be introduced. A decentralized architecture eliminates central points of

[1] A key is represented by a string of random symbols.

failure since copies of the database are available on multiple nodes. Thus, if any given node is offline, the distributed architecture ensures that a copy of the data that was present on the offline node is also present on other nodes in the network.

The recordkeeping aspect of blockchain also fosters trust. For example, the immutability of blockchains ensures that open access to the data is not detrimental, and so any entity can view the data without the danger of tampering with the data. Thus, blockchain eliminates bottlenecks to data access and allows for transparency of record-keeping. Blockchain is considered reliable because complete copies of the blockchain ledger are maintained by multiple active nodes. Another key characteristic is that communication occurs peer to peer rather than through a central node. Also, once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record that came before them. This immutability and irreversibility of records is achieved through the deployment of cryptographic algorithms and ensures that the recording on the database is permanent, chronologically ordered, and available to all others on the network. Fig. 2 provides a graphical representation of the elements that contribute to trust in a blockchain transaction.

Within the blockchain, every block not only contains a digital signature for itself but also for the previous one. This ensures that blocks are retroactively coupled together and ensures that no one can intrude in the system or alter the data saved to the block. The non-repudiation (irreversibility) of blockchain indicates that no one can deny transaction contents created by himself (Peng et al., 2020). Due to the characteristic of non-repudiation, as long as a transaction exists in the blockchain, it must be initiated by its signer itself, and the node cannot deny that it has published the transaction (Peng et al., 2020). Thus, blockchain addresses the issues of lack of accountability and problems associated with inconsistent record-keeping inherent in large-scale networks. In the next section, we offer a deeper look into the types of blockchains that are available for adoption by organizations. As we shall see, the underlying issues of trust and uncertainty drive the development and consequent adoption of different blockchain architectures.

2.3. Types of blockchain architectures

There are broadly two types of blockchains, permissioned and permissionless. A permissioned blockchain needs prior approval before using, whereas a permissionless blockchain lets anyone participate in the system. Both types are distributed ledgers which means that there will be multiple versions of the same data that are stored in different places and connected through some network. Secondly, the data stored in both types cannot be modified or altered without having sufficient power over the network. Finally, both types of blockchain make use of consensus mechanisms in that they have a way for multiple copies of the ledger to reach an agreement on what they must all look like.

Permissionless blockchain, also known as public blockchain, is completely open and allows for anyone to join and participate in the network. The data in these blockchains are publicly available, and complete copies of the ledgers are stored across the globe. In light of this, it is harder to censor or hack permissionless blockchains. Moreover, this type of blockchain is not centrally controlled, and one can remain relatively anonymous as there is no need for identifying themselves to get an address and perform transactions. The permissionless blockchain model is used by Bitcoin, Ethereum, and Litecoin and is essentially considered to be the original distributed ledger structure.

In permissionless blockchain architectures, the ability to participate in the consensus mechanism is offered to any node. Consequently, such architectures tend to attract larger participation resulting in longer chains. The nature of anonymity available on permissionless blockchain can be best explained with the help of Bitcoin transactions. Bitcoin addresses are hashes of public keys, so a user does not have to use her real name to engage in a Bitcoin transaction. A Bitcoin address, therefore, is pseudonymous, since the association between the user and her address is hard to make. Further, a user can have multiple addresses. Since the blockchain

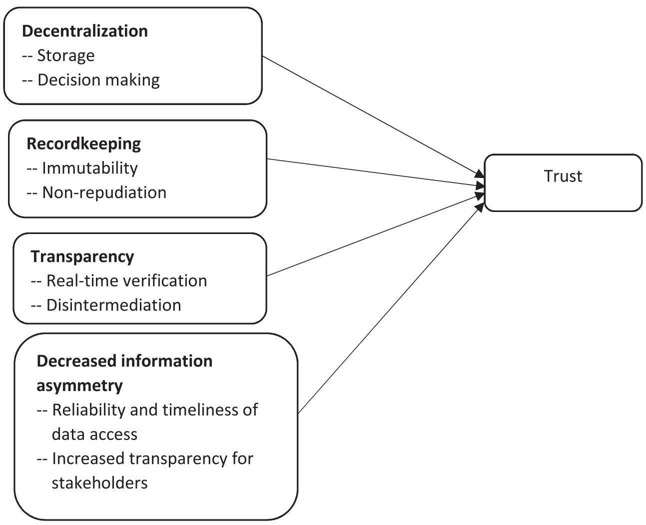

Fig. 2. Antecedents of trust in blockchain.

underlying Bitcoin is public, anyone can look up every single Bitcoin transaction related to a certain address. If one can make an association between a user and a Bitcoin address, the complete set of the user's transaction history is now available for public consumption. Although one could make the case that it is hard to infer the identity of a user from her Bitcoin address, the presence of side channels could reveal valuable inferential information. For example, linking publicly available information on social media about the times/patterns of activity with the trading information associated with a Bitcoin address might lead to deanonymization. Thus, public blockchain applications have to be particularly vigilant about how de-anonymization can reveal private information about the users behind the addresses. As an unintended consequence of de-anonymization, a user who gets paid in Bitcoin might have their salary information go public. Further, the compensation structure of a firm might reveal valuable information to peer firms who could develop better compensation packages to lure away employees.

The alternative to this scenario is to develop truly anonymous applications on the blockchain. They, however, tend to be technologically very complex. Firms may deal with the issue of complexity in public blockchain by choosing to use existing public blockchains instead of building a public blockchain from scratch. The tradeoff here is compelling. While the public blockchain offers the benefits of a low barrier to entry, it also comes with the risks of potential denonymization, the potential for slow transactions, and lower security. Therefore, it is reasonable to suggest that public blockchains are best suited for applications where the transparency of the blockchain does not compromise private data.

There are several advantages to the permissionless blockchain. First, every node in the system has as much freedom to join, read and write transactions as any other, making the public blockchain not only decentralized but also fully distributed. Secondly, this type is considered to be the most reliable in terms of security. There are a high number of nodes present in the network, and anyone in the network will be able to access the ledger and check the correctness of transactions or see if the data entered is consistent.

Permissionless blockchains also have several disadvantages. The transparency afforded by complete openness offered in public blockchain offers very little or no privacy for transactions and has a weaker concept of security. Another disadvantage is the substantial amount of computing power needed for the maintenance of the large public ledger. There are plenty of public blockchains, and they are actively adopted by such industries as fintech, gaming, logistics, and beyond. However, for some organizations, it may not make sense to move certain processes and businesses to the public blockchain due to the comparatively low speed of transaction execution and high costs in the public blockchain. Indeed, every transaction requires consensus of the entire network, which is both time and resource-intensive. Public blockchains also present a challenging use case for regulation, since no single entity owns the chain. Hence, in industries where compliance or regulation is required by law, public blockchains miss the mark since they cannot be modified to meet regulatory requirements.

In contrast to public blockchain, private blockchains are usually owned by a single entity and are deployed in a *permissioned* manner (Helliar et al., 2020). Their level of transparency depends upon the inner organization of businesses. Members of this blockchain are free to negotiate and come to a decision about the level of decentralization the network can have. Secondly, they can only be accessed by those who are allowed access. Anyone interested in validating transactions or viewing data on the network needs to get approval from a central authority. In order to gain access to a private blockchain network, an entity must be invited and then validated by the blockchain developer/owner (Peck, 2017). Each entity on a private blockchain is assigned permissions of varying scope that conform to the specific rules that were put into place by the owner or developer of the private blockchain. The smaller size of the private blockchain also lends itself to a higher speed of transaction processing and increased security (Polge et al., 2020). While private blockchains may appear to be the reasonable choice to use as they are faster, cheaper, and protect the privacy of their members, in certain contexts, transparency may be more crucial than the speed of transaction approval.

Permissioned blockchain architectures are the preferred solution when an organization wants to limit participation in its blockchain in order to preserve the privacy of records, enhance transaction speed, incorporate regulation, or increase the capacity of the blockchain to store records. In permissioned blockchains, the upfront cost of investment is higher than for permissionless blockchains. Permissioned blockchains have been deployed widely in diverse domains ranging from supply chain management, healthcare records, and mining of rare elements. Each of these applications has at least one element that needs to be kept shrouded from public view – be it intellectual property, user data, or organization-specific processes. Since the entities that can participate in a permissioned blockchain are pre-selected, mistakes can be traced back and confidential information can be protected from potential de-anonymization.

Permissioned blockchains, therefore, tend to be faster, since there are fewer nodes in the network (Wüst and Gervais, 2018). This leads to faster transaction processing times, lower latency, and high data storage capabilities. The technologies employed in permissioned blockchains are also simpler since the identities of the participating entities are limited and already known (Henry et al., 2018).

The benefits of a private blockchain also include lower complexity, and they offer more flexibility and a controlled environment that can incorporate regulatory requirements. Additionally, since private blockchains are constructed with pre-selected nodes, there is no requirement to offer these nodes incentives for participating in mining or the consensus operation. Thus, tokens created on private blockchains are faster to process in transactions and are stable on the networks in which these blockchains are deployed.

Since private blockchains are owned/developed by a single entity or small group of firms, they can be more easily modified to suit evolving applications. This is in contrast to public blockchains, where the underlying code for the blockchain is maintained and developed by a core set of developers. Changes to public blockchain operations result in forks to the blockchain, where dissenting nodes split off to create a separate blockchain and a different community that abides by a different set of rules. Thus, private blockchains offer confidentiality, privacy, lower complexity, and higher flexibility in operations.

2.4. Choosing between blockchain types

Choosing the ideal kind of blockchain to be used is ultimately a product of decisions along several dimensions. These dimensions include the ability to be tokenized, cost, latency of transactions (speed), storage capacity of individual blocks, interoperability concerns, data privacy and protection, data access, and data integrity requirements. But beyond their technical characteristics discussed thus far, blockchain choice may also be affected by the institutional environment and other transaction characteristics which we discuss later.

Transactions involving multiple countries are typically characterized by lower levels of trust than intra-country transactions where the transacting parties largely adhere to the social norms of that society. The standard prescription in transaction cost theory is that when there is a high level of uncertainty surrounding a transaction, a firm will tend to internalize the transaction. The adoption and choice of the specific type of blockchain may be based on both the level of trust between the transacting parties and the need for trust in a specific transaction, and these factors have significant implications for the transaction costs of firms doing business across borders.

In making the decision to adopt blockchain, organizations have to consider several factors including the network size, transaction fees, and processing speed. For example, Bitcoin, the first and most visible application of blockchain for cryptocurrencies, features variable processing times and associated fees. According to Blockchain.info, the average transaction time for a Bitcoin transaction with miner fees to be included in a mined block ranged from 13 min to 8 h during the period from October 2020 to December 2020. Bitcoin's transaction speed is due to the network activity and transaction fees. Higher transaction fees and lower network activity are conducive to a higher transaction speed. Cryptocurrency transaction times are in sharp contrast to the transaction times for fiat currencies. For example as of 2022, Visa is capable of processing around 65,000 transactions per second, while the top five cryptocurrencies have the following speeds in terms of transactions per second (tps): Bitcoin (4.6 tps), Ethereum (15 tps), USDT/Tether (1000 tps), USDC (1000 tps), Binance Coin (15 tps).

3. Implications of blockchain for international business

Blockchains have significant implications to key areas of IB that are salient to both research and practice. This is due to the ability of blockchains to produce trust, enhance transparency, and overcome behavioral uncertainty. In this section we describe two IB levels – firm and industry - that are likely to be impacted by blockchains. Table 1 shows an overview of this taxonomy of these IB areas in each of the dimensions.

3.1. Firm level

Blockchains represent a major technological development that has profound implications for the future of international business. Digital platforms and their associated ecosystems have become vital for the success of individual firms operating globally. One of the main reasons for firms to invest abroad are the advantages gained from internalizing activities. Institutional factors also significantly influence the choice and ability of firms to operate abroad. We discuss the implications of blockchain to both of these factors affecting international business below.

3.1.1. Internalization advantages

Digital platforms have become global in the sense that they have no boundaries in terms of national borders, locations, or even industries. Digital platforms allow firms in different countries and industries to collaborate to create value and the main competition is increasingly between platforms than between firms. While one of the key reasons firms invest abroad are the advantages gained from internalizing activities, today those advantages of internalizing have become more limited. With blockchain, firms can gain all of the benefits associated with internalization without actually owning most stages of production. In other words, through electronic integration a firm can have vertical control without vertical ownership.

3.1.2. Institutions and blockchains

Institutions are defined as the "cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior." (Scott, 1995: 33). There is a long line of research in strategic management and international business that recognizes the important role played by institutions (Peng et al., 2009). International business, by definition, involves business activities in multiple countries with very different institutional environments. When it comes to blockchain adoption, the most salient institutional dimension is the regulatory dimension. Given that blockchains involve the flow of data across national boundaries, the regulatory

Table 1
Implications of blockchain for international business.

Firm Level	Industry Level
• Internalization • Institutional processes • International entrepreneurship • Liabilities of foreignness	• Capital raising • Tokenization of assets • Inter-organizational relationships • Supply chain management • Transaction costs

regimes of individual countries can either facilitate or impede such flow. The regulatory environment can also have an influence on the type of data used, where it is stored, and how it is transferred across countries.

The advances in digital technologies have been so rapid that regulatory and legal frameworks of countries have found it hard to keep pace with them. While the European Union has developed fairly detailed laws for cross-border transfer of data, majority of the countries are in the process of developing such laws. The existing legal frameworks of many countries are not easily adaptable to the new digital era. The two major concerns of national governments involve issues of privacy protection and national security. The demands by various governments to store data relating to their citizens and firms in their country and to be given the right to access such data due to national security concerns can potentially hamper the adoption of blockchains for international business.

It is reasonable to assume that for a firm doing business in countries characterized by institutional similarity, it would be relatively easy to design blockchains that could be deployed across countries. The European Union is one such example where more than two dozen nations follow similar institutional frameworks. As institutional distance or dissimilarity increases, it becomes increasingly difficult to comply with varying regulatory frameworks. In such cases, private blockchains are more likely to be adopted than public ones. Such private blockchains are likely to be limited in scope, subject to access by permission, and most likely internal to a firm. However, institutional dissimilarity could create challenges for the design of blockchains.

There is considerable variation across countries with respect to property rights and their enforcement. Blockchains can be helpful in protecting and transferring property right through digital property record-keeping and electronic governance. For example, pilot projects for land-registry systems on the blockchain have been successfully completed in Estonia, Georgia, and Sweden. The Exonum blockchain framework is one of several permissioned blockchain frameworks that offers the ability to incorporate compliance requirements in its transaction processing procedures. Exonum's framework allows for multiple applications to be implemented on its blockchain including document timestamping, cryptocurrencies and property rights registries. Its private, restricted network also means faster transaction processing of up to 7000 transactions per second (tps), compared to 7 tps available with Bitcoin. Successful projects built on the Exonum blockchain include the land titling registry in Georgia, seized property registry in Ukraine and healthcare and software deployment applications. The flagship application of permissionless blockchain architectures is cryptocurrencies, with Bitcoin being the most popular cryptocurrency. Closely trailing is Ethereum, which has gained widespread institutional support for its ability to offer opportunities for anybody to create decentralized applications (dapps) for diverse domains on its blockchain.

3.1.3. International entrepreneurship

An important development in the field of IB in recent years is the phenomenon of "born global" firms (Oviatt and McDougall, 1994). Firms whose strategies are based on blockchains constitute a pure form of born globals, because by their very nature these organizations are decentralized and globally distributed. Born global blockchain based firms engage in the production and distribution of both physical and information goods although for obvious reasons information goods are the favored domain of blockchain firms. Information goods are goods whose value is derived from the information it contains. Information goods differ from physical goods in a number of important ways. First, they have high upfront fixed costs but negligible marginal costs and they have nearly infinite economies of scale. They can be consumed by multiple consumers at the same time, and the value of information goods to a consumer increases as more people consume it. This is referred to as the "network effect" (Rochet and Tirole, 2003). Because blockchain start-ups are able to tokenize their products and create platforms that connect users (Wang and Vergne, 2017), rapid internationalization is not merely a choice but an absolute condition for survival and growth for such firms (Zalan, 2018). Blockchain founders aggressively seek global scale right from the beginning because the economics of information goods and the power of global network effects require that a critical mass of globally dispersed users adopt the product early and simultaneously (Zalan, 2018). Lastly, born global blockchain based firms tend to take advantage of administrative arbitrage opportunities by incorporating in countries with more relaxed tax laws and regulations (Zalan, 2018).

3.1.4. Liabilities of foreignness

Blockchains also have implications for firms attempting to overcome liabilities of foreignness. IB scholars consider liability of foreignness (LOF) as the "fundamental assumption driving theories of the multinational enterprise" (Zaheer, 1995: 341). However, these liabilities extend beyond product markets (Filatotchev et al., 2016). In order to reduce LOF, firms engage in additional vetting procedures and pre- and post-transaction checks. This is where blockchains can play an important role. Tokenization of transactions serves to bridge a gap in the level of uncertainty involved in international business transactions, and paves the way for migration of the transaction to the blockchain environment. By tokenizing transactions, both parties to the transaction are able to view previous records, determine provenance and availability of resources and eliminate the intermediaries involved in the transaction. Thus, the ability of an international business transaction to be tokenized could be inversely related to the LOF, and could facilitate seamless end-to-end transactions over the blockchain. There are no technical restrictions on blockchain deployment because it is open sourced, decentralized and globally distributed by its very nature, and a start-up's developer teams, funders, users and exchanges can be located anywhere around the globe (Zalan, 2018).

3.2. Industry level

Blockchain technology has many implications for industries such as raising capital, tokenization of assets, facilitation of interorganizational relationships, supply chain management, and reduction of transaction costs. We discuss each in the following sections.

3.2.1. Capital raising

Blockchains technologies have financial implications for firms competing internationally. Firms, especially start-ups are hard-pressed to raise capital, and these challenges are more pronounced in an international setting. In recent years, many firms have attempted to raise capital through Initial Coin Offerings (ICOs) using blockchains. An Initial Coin Offering (ICO) offers institutional and individual investors a way to invest in digital tokens using blockchain technology, much like IPOs are used to offer shares of a private corporation to the public with the goal of raising funds. Unlike IPOs which undergo rigorous evaluation and vetting procedures, ICOs are characterized by the use of white papers, online sources (websites, blogs, social media), and code repositories such as GitHub to disseminate information about the technology and influence investors (Samieifar and Baur, 2021).

ICOs create opportunities for newer cryptocurrencies to be traded in the form of tokens in exchange for fiat currencies or existing, steady cryptocurrencies such as Bitcoin or Ethereum (Fenu et al., 2018). Tokens are analogous to stocks in IPOs, and can be divided into two categories: security tokens and utility tokens. Security tokens are similar to traditional equity investments in the sense that they can be traded, and the investor is acquiring an underlying investment asset. Security tokens confer a degree of ownership by offering additional coins (similar to dividends) in the event of future profitable earnings. Utility tokens, on the other hand, provide investors with a right to redeem the tokens for the products or services of the firm once developed. Utility tokens are designed to enable users to interact with the company's services.

While the legal issues surrounding ICO regulation continue to be debated (Conley, 2017), several ICO success stories exist with a few even making it to the rare ranks of unicorns, or private startups with a valuation of more than a billion dollars. As of this writing, the blockchain industry is reported to have at least eleven unicorns worldwide (Khatri, 2019), containing a wide range of firms in domains of cryptocurrency (Ripple), cryptoexchanges (Coinbase), decentralized cloud (Dfinity), and blockchain application developers (Block.One).

3.2.2. Tokenization of assets

Smart contracts are contracts that are created and executed in code. Assets are represented as tokens, and each token's rights and responsibilities are translated into software code and placed on the blockchain. Assets could represent a wide range of entities, including but not limited to currency, real estate, business processes or intellectual property. One example of the use of smart contracts in international trade is the case of a pharmaceutical company producing in Europe that ships a globally-patented cancer treatment drug to Latin America (Hojlund and Nielsen, 2019). This is a complex process that involves trust-related risks. The lack of mutual information about the trustworthiness between the importer and exporter leads to possible scenarios involving non-payment of funds and questionable quality of drugs. The drugs require specialized transportation and handling process to preserves their efficacy, and this involves complex insurance contracts that factor in the risks of damage or loss of cargo. The payments involved in this transaction span entities located in multiple countries, thus posing the risk of loss due to currency change variabilities, market volatility, and fluctuating derivatives markets. The international nature of these transactions also presents challenges for dispute resolutions, since the varying jurisdictional issues create problems for seamless arbitration, enforceability, and litigation. Blockchain provides opportunities for improving efficiencies in every one of these areas, by creating smart trade finance contracts, smart insurance contracts, smart derivatives contracts, and smart legal contracts.

The primary driver of smart contracts is the tokenizability of assets which represents the ability of an asset's features to be translated into software code for storing on a blockchain. Tokenization can impart value to a wide range of objects and their behaviors, creating opportunities for encoding these objects and their interactions with other objects on the blockchain (Laurent et al., 2018). For example, the title document denoting ownership of a car or a home can be encoded as an object with attributes such as date, previous owner, current owner, transaction ID, price, and other elements found on the title document. Tokenization of the title document allows for a digital record that can be placed on the blockchain, and the immutability and distributed nature of the blockchain allows for future retrieval of the document without the need for intermediaries.

Smart contracts can be best analyzed from a principal-agent perspective. Agency problems arise out of information asymmetries between the principal and the agent. Agency theory suggests that the two basic approaches to mitigating the agency problem are monitoring and incentive alignment. But both these mechanisms entail substantial costs for the principal. Given that most contracts are incomplete and monitoring is expensive, mutual trust can also greatly reduce agency costs.

However, blockchains change the principal agent relationship in two fundamental ways. First, blockchains, by their very nature, are transparent and equally accessible to the principal and the agent. Thus, information asymmetry is greatly reduced if not completely eliminated. Second, the easy verifiability of transactions eliminates the need for costly mechanisms for producing trust (Treiblmaier, 2018). Thus, blockchains address agency costs through the reduction of, if not the elimination of, information asymmetry and the generation of system trust (Schmidt and Wagner, 2019).

3.2.3. Interorganizational relationships

Blockchains have implications for the nature and form of relationships between firms. Every organization is embedded within large networks with other organizations. From joint ventures and supplier relationships to interlocking board memberships, network relationships are pervasive in organizational life. Blockchains can bring about greater electronic integration among transacting parties in the case of both direct and indirect relationships. For example, in buyer-supplier relationships, a buyer can have access to all relevant information not only about the supplier but also about the suppliers of suppliers and all the way to the very origins of the value chain. The transparency, non-repudiability, and verifiability of all transaction specific data make electronic integration across organizations possible to a degree that was not possible before.

Blockchain, due to its features of a distributed, cloud-based, immutable ledger, has a built-in ability to better bridge the trust gap and also offer the requisite transparency to ensure the timely flow of relevant information. The fact that these tasks can be accomplished on a network in a paperless format makes the use of blockchains a significant enabler for international business. The use of blockchain by Barclays showed how the time it takes for issuing a letter of credit could be reduced from 10 days to 4 h (Kelly, 2016). As global trade becomes increasingly interdependent, the use of blockchain has a pivotal role to play when it comes to industries where the origin of the product is vital to ensure authenticity. This may be particularly salient in certain industries. For example, in the pharmaceutical industry, consumers need to have confidence in the products they consume.

Schmidt and Wagner (2019) describe how blockchains create a true "system state" via networked computation and consensus rules and results in personal trust being replaced by system trust. By ensuring the authenticity of transactions, blockchains reduce the need for such practices and generate a high level of trust even if the transacting parties have no prior knowledge of each other. Hence, the adoption of blockchains and the choice of the specific type of blockchain may be based on both the level of trust between the transacting parties and the need for trust in a specific transaction.

3.2.4. Supply chain management

One area of IB where blockchains have had a significant impact is supply chain management.

An example of the versatility of blockchain for supply chain management in international business can be found in the Mobile Open Blockchain Initiative (MOBI). MOBI is a non-profit consortium of automakers, suppliers, utilities, governments, and international institutions such as the World Economic Forum. MOBI's membership spans across continents, with member institutions based in the Americas, Asia, Europe, Middle East, and Africa. As of this writing, five automakers - BMW, Ford, GM, Hyundai, and Honda, are members of MOBI. MOBI has several working groups, all of which are focused on harnessing the power of blockchain for mobility use cases. For example, the Vehicle ID (VID) working group chaired by BMW and Ford is working on global standards for vehicle registration and maintenance traceability. The aim of this working group is to create mechanisms for a fully automatic network with diverse use cases such as the ability to create and maintain detailed automobile records, auto financing, and vehicle data exchange through the VID framework. Another working group called the Supply Chain (SC) working group is investigating the applications of blockchain for automotive supply chain management, creating a network that is accessible by procurement, logistics, and suppliers. The goal of the SC project is to enable provenance, auditing, and transparency in the automotive supply chain.

Thus, while firms engaged in legitimate trade grapple with overcoming the trust gap, they also have to ensure that there is an adequate amount of transparency to reduce the time it takes for products to move through the global supply chain. A number of factors have increased the need for transparency in recent years. For example, the increase in terrorism and activities that support terror organizations have put a significant amount of pressure on international trade in terms of the amount and type of inspections that need to be undertaken by governmental agencies to ensure that the products are safe and there were no violations of rules in the global supply chain. Similarly, compliance with human rights, environmental, and labor regulations increases the need for transparency. However, such compliance, while critical, adds to the cost of doing business in terms of the time it takes to accomplish the goal.

A recent example of the application of block chain technology in the supply chain area is Fishcoin, a blockchain solution that uses a platform approach to the seafood industry which employs nearly ten million people worldwide. Traceability is critical in this industry for accurately identifying contamination and providing transparency in the supply chain. Fishcoin provides advanced monitoring by gathering data using at-sea technologies such as cameras and sensors and leverages a traceability protocol for first-mile traceability, rewards fishermen and farmers for sharing traceability data, and also rewards producers, supply chain intermediaries, blockchain application developers, IoT sensor makers for sharing data about fishery operations. Other examples of blockchain applications in the seafood industry include IBM Food Trust, which is a collaboration between IBM and Raw Foods for sharing information about the origin of scallops, date of harvest, and quality of scallops. Initial results of this collaboration showed a 30% increase in the sales of scallops as consumers are being increasingly mindful of the "stories" behind what they eat. Likewise, the Blockchain Tuna Project is a collaboration between the World Wildlife Fund in New Zealand and the Blockchain Supply Chain Traceability Project to track fish from vessel to supermarket and seeks to prevent illegal, unreported, and unregulated (IUU) fishing.

3.2.5. Reduction of transaction costs

A considerable body of research in IB points to differences in interpersonal trust between countries (Zaheer and Zaheer, 2006). Trust is one of the most important antecedents of social capital (Coleman, 1988). High levels of trust in a society can greatly reduce transaction costs and make business transactions easier. Transactions involving multiple countries are typically characterized by lower levels of trust than intra-country transactions where the transacting parties largely adhere to the social norms of that society. Traditionally, this meant that in international transactions, trust had to be produced through cumbersome devices like letters of credit or detailed contracts.

Blockchains have the potential to reduce transaction costs in many ways. For example, a clear implication of the reduction in transaction costs is that firms are more likely to adopt market mechanisms for more activities instead of internalizing them. Blockchains may also make the services of many intermediaries that facilitate transactions redundant. For example, there would be less need for intermediaries for activities such as clearing, trade settlement, or regulatory reporting (Harwood-Jones, 2016). Thus, it seems promising to apply insights from transaction cost theory to analyze both the changing boundaries of the firm as well as the very structure and internal organization of the firm. Similarly, given that there are a variety of costs that constitute the total transaction cost, it is important to investigate which specific components of transaction costs would be most affected by blockchains.

Blockchains can reduce, but not eliminate, uncertainty through information sharing and transparency. When information is transparent and shared between transacting parties, it reduces the level of uncertainty experienced by them. For example, in a transaction involving a supplier firm and a buyer firm, each firm's inventory position, production data, and sales information are shared by both parties enabling them to avoid unpleasant surprises.

Prior research provides compelling evidence that blockchains have significant advantages in eliminating intermediaries and thus reducing the transaction costs. They can, for example, significantly reduce the time taken to process customs information by providing irrefutable real-time information about the country of origin of the products and how the product has moved throughout the supply chain. As McDaniel and Norberg (2019) indicate, Maersk, one of the leading logistics firms in the world, discovered that at times the cost of documentation could easily exceed the cost of transportation. While blockchains can reduce the transaction costs and alleviate the problems faced by firms such as Maersk, the question from an internalization perspective is whether the firm should invest in a private blockchain or a public blockchain (outsource). The answer to this question depends on careful consideration of three important characteristics of the transactions under consideration. These are: 1) the value of the transaction, 2) the need for trust in transactions, and 3) the need for transparency.

4. Directions for future research

Blockchain holds promise for revolutionizing international business and presents IB scholars numerous opportunities for research. While there has been a growing body of research on blockchain and their applications for businesses, so far there has been limited examination of its power to transform international business. In the following sections we outline opportunities to examine the implications of blockchain to several areas of IB research.

4.1. Liabilities of foreignness and tokenization

One opportunity is in the tokenization of transactions, which serves to bridge a gap in the level of uncertainty involved in international business transactions, and paves the way for migration of the transaction to the blockchain environment. By tokenizing transactions, both parties to the transaction are able to view previous records, determine provenance and availability of resources and eliminate the intermediaries involved in the transaction.

Evaluating LOF and the blockchain ecosystem represents a significant research opportunity for born global firms. As prior research shows, LOF exist not only in product markets but also in financial markets (Bell et al., 2012). Future research on blockchain should explore how the liability of foreignness could be overcome by firms seeking capital by participating in blockchains with a special focus on the type of blockchain such as permissionless/permissioned vs. private/public. Further, could the ability of the blockchain for rapid tokenization eliminate or minimize the liability of foreignness?

4.2. Rethinking OLI paradigm

The widespread adoption of blockchains by firms have implications for both the process of internationalization and the theories of internationalization. Firm internationalization decisions have been mostly explained based on the benefits of internalization. Dunning's (1980) OLI paradigm is built on the triad of advantages of ownership, location, and internalization. However, as Nambisan et al. (2019) point out, in an era when international operations are increasingly based on intangible flows of data and information, greater importance of digital infrastructure, and instant access to knowledge and expertise, the rules of the game of international business have changed and we may need to rethink IB theories in light of these developments. Digital platform ecosystems create shared resources that contribute to value creation and capture and hence ownership advantages need to be reconceptualized in terms of ecosystem-specific advantages (Nambisan et al., 2019). Similarly, context-specific advantages may be more relevant today than location-specific advantages. Within an ecosystem, a competitive advantage does not come from owning all resources, but from organizing, synthesizing, and integrating all globally available resources suggesting a shift away from resource ownership and towards resource orchestration. The choice of the type of blockchain and subsequent implementation of the blockchain will need to be done keeping in mind its fit with the digital platform and ecosystem characteristics and its potential to facilitate further resource sharing among members of the ecosystem. Indeed, blockchain's impact could be evidenced by new ways of internationalization, new ways of building knowledge and relationships, and new ways of creating and delivering value to global customers (Nambisan et al., 2019). Hence, IB scholars should reconsider the OLI paradigm to accommodate the changing nature of international competition. This certainly suggests the need for further theoretical development in international business to keep pace with the technological transformation that has already taken place.

4.3. National culture and blockchains

International business scholars should examine how national culture could play a major role in the adoption and deployment of blockchain. Although cultures are enduring, they also evolve over time in response to changes in the environment. There are cultural factors that hinder as well as facilitate the adoption of blockchains. Would blockchains become the norm for international transactions where cultures/systems are weak and more prone to corruption and abuse? This is especially relevant in contexts where the international pressures from consumers of the product/service call for sustainability and traceability of the supply chain. We suggest that investigations into how national culture could hinder the adoption of blockchain are also needed. In many cultures, informal trust is more important than formal relationships. Would blockchains simply not reach the critical mass in such cultures to be viable? Would imposition of the use of blockchains in such a culture increase the cost of doing business? How would such a cultural setting impede the frequency of transactions through blockchain?

4.4. Networks and ecosystems

Firms today are embedded within large networks that are often referred to as ecosystems (Iansiti and Levien, 2004). Ecosystems are defined as "intentional communities of economic actors whose individual business activities share in some large measure the fate of the whole community" (Moore, 2006, p. 33). Many of the new ventures succeed not by tapping into existing ecosystems but by creating entirely new ecosystems (Zalan, 2018). Blockchains make the development of such ecosystems easier, particularly for new ventures. But for ecosystems to succeed, some degree of informal coordination within the system necessary. This is where blockchains can play a facilitating role. It is possible that instead of pure market modes of governance that we suggested earlier, we may have increasing prevalence of quasi-integration among a large number of firms within a network. Thus, an interesting research question is under what circumstances blockchains will result in market modes of governance versus network modes of governance. Our conjecture at this point is that permissionless blockchains are more likely to lead market modes and permissioned blockchains may lead to greater electronic integration and network modes of governance.

4.5. Blockchain bundles

Another promising area for future research is examining how blockchain bundles could offer benefits to firms that might not have the expertise to individually vet various blockchain solutions and determine how to combine them. A firm might choose a private blockchain for its supply chain efforts, a different private blockchain for product insurance, and a public blockchain for accepting cryptocurrency and programmable currency payments. As blockchain applications evolve, certain blockchains might offer better interoperability benefits, which would enable blockchain bundles to be developed for specific application domains. The seamless interaction between private and public blockchains, including the potential for blockchain bundles to be shared among peer institutions in a consortium-based blockchain approach could offer a new lens through which both organizations and nations could view and partake in early adoption and sustained use of blockchains.

4.6. Institutions and governance

As there is general anticipation that there will be rapid growth in the adoption of blockchains by firms, future research should look at the salient factors that drive adoption, both from an organizational and national perspective. Are there certain geo-political conditions that lend itself to rapid adoption and proliferation of certain types of blockchains? Are these salient to certain sectors of the economy? Could a lack of set standards lead to a bottleneck when it comes to reaping the benefits of blockchain? Could regulations hinder or act as a catalyst in blockchain adoption? Are there first mover advantages that accrue to firms and nations in setting the standards of blockchains? Finally, do blockchains provide a means for firms to work around institutional weaknesses or overcome institutional voids?

4.7. Principal-agent conflicts

Although agency problems exist in all contexts where there is a principal and agent, it is unlikely that in all such situations, agency problems can be mitigated by blockchains. Instead, a good starting point would be to identify the industries and specific types of relationships within those industries that are most amenable to blockchain based solutions. In industries where long lived, trust-based relationships are the norm, blockchains may have limited potential to reduce agency problems because agency problems are small or non-existent to begin with. Does the blockchain alter the principal and agent relationship? What country and firm-level factors associated with blockchain are responsible for altering the principal - agent relationship?

Longitudinal examinations of how the relationship between a principal and agent changes over time once a blockchain is introduced can provide us with greater insights about the specific characteristics of blockchains that have the most impact on principal-agent relationships. Investigations into the extent to which blockchain reduces the level of trust needed in business relationships also merits examination.

4.8. The role of intermediaries

Yet another area for future research is the role of intermediaries. As we explained earlier, blockchains can replace several types of intermediaries in transactions. We have already seen this trend clearly in the case of cross-border trade transactions. But the elimination of intermediaries can potentially occur in all mediated markets. Capital raising by firms, for example, currently involves a large number of intermediaries such as investment banks and underwriters. ICOs can disrupt capital markets by firms directly going to investors around the world without any of the intermediaries or the costs associated with them. However, as we have observed in the case of many other types of intermediaries, disintermediation is often followed by reintermediation by a new set of intermediaries who provide a different set of services than the old intermediaries. It is important to identify these new intermediaries and the role that they will play in the future.

5. Risks in blockchain adoption for international business

While blockchain advocates see blockchain as a panacea for many institutional issues, skeptics point to the fragility of cryptographic keys that hold the blockchain together. The guarantees of immutability, transparency, and decentralization have positioned blockchain technology to be a promising candidate for improving the operation of international business (Hooper and Holtbrügge, 2020). However, these very same attributes could also be the source of several challenges for firms for whom traditional databases would be a better solution in terms of cost, speed, privacy, and predictability (Peck, 2017). Below, we offer an overview of risks posed by the adoption of blockchain technology.

5.1. Conflicts, forks, and uncertainty

Regardless of the public or private architecture of the blockchain, the source code that enables the running of the blockchain and the applications that sit atop it are managed by a small core group of software developers. Bitcoin, for example, has an open-source contributor ecosystem where anyone can contribute code. It has a very small group of maintainers who are able to review the code contributions of developers and add it to the source code. Conflicts among stakeholders regarding policy, philosophy, design, implementation, and attacks on a blockchain have created the concept of forks, where the original blockchain is split into two. The new blockchain then operates according to its own set of rules, some of which may be derived from the parent blockchain. Forking is most prevalent in public blockchain architectures, where the large userbase is more conducive to the formation of conflicts than in private or consortium blockchains where user participation and user privileges are determined based on pre-determined rules of engagement. Forked blockchains have been shown to undermine trust and introduce uncertainty among the various stakeholders (Schär, 2020; Andersen and Bogusz, 2019).

5.2. The risks of immutability

Blockchain enables trust between unfamiliar entities by providing transacting parties a guarantee that non-repudiation can be achieved with computational effort without human intervention. In legal literature, non-repudiation requires the recipient party to verify and provide the proof for a paper-based signature that is being contested. However, the cryptographic environment shifts the burden of providing proof of a digital signature to the owner of the private key (McCullagh and Caelli, 2000). This shift of burden poses a distinct challenge in the case of identity theft or when the private key is stolen. Reconciliation of the legal and technical implementations of the concept of non-repudiation is an important concern for international business.

5.3. Risks associated with transparency and pseudo-anonymity

In blockchains, because transactions can be traced all the way back to the genesis block, they only offer pseudo-anonymity and not complete anonymity of user accounts and transactions (Heires, 2016). For example, heuristics gathered from multiple accounts, corresponding addresses and transactions, aided by the transparency of Bitcoin's public ledger have been used to link accounts to user's real-world identities (Henry et al., 2018). This problem of pseudonymity is not a major problem on private blockchain architectures. However, in public blockchain architectures, the lack of anonymity of users coupled with the historical access to transaction records creates challenges relating to privacy, security, and anonymity. Depending on the kind of data that is stored in the blockchain, the risks of the lack of complete anonymity could include the exposure of personally identifiable information, intellectual property, or other proprietary information in the context of international business.

In blockchain technologies, the reversal, modification, or elimination of a transaction is fraught with issues relating to the philosophy, design, and implementation of the blockchain itself. For example, Atzori (2015) cautions against the use of public blockchains for storing records of government services. Further, if users accidentally upload sensitive information to the blockchain, there is no way to erase or obfuscate that information due to the immutability of the blockchain. Other issues include protection of copyright works that are uploaded to the blockchain. Due to the structure of the blockchain, multiple copies of the copyrighted work are created on the blockchain violating the terms of the copyright.

5.4. Blockchain security

Tampering with the consensus algorithm and exploiting flaws in smart contracts require technically sophisticated attack vectors. However, a different kind of attack, which is akin to stealing passwords, is that of stealing private keys. These keys could be hacked, compromised, or simply forgotten. Indeed, the security of any kind of blockchain application can be compromised if the private key that gives users access to the blockchain is stolen. There are several options for private key storage such as requiring the user to store or remember a private key, employing the services of key escrow providers, or to use electronic wallets (akin to password vaults) that store user keys belonging to multiple accounts in multiple blockchains. Ironically, this last option has also become an emerging area of attack in blockchains where hackers attempt to compromise the security of wallets (Orcutt, 2018). Also, looming on the horizon are quantum computing algorithms whose tremendous imminent computing speed have the potential to dismantle current cryptographic algorithms, including the ones used by blockchain.

In the context of international business, blockchain technology is largely implemented in the form of smart contracts. Vulnerabilities in smart contracts mirror many of the vulnerabilities found in software code in non-blockchain applications, including software bugs, lack of randomness, and flawed programming techniques. On public blockchain architectures, attackers can disrupt the connections of nodes to the rest of the network severely altering a node's view of the network and thereby compromising the consensus operation.

5.5. Legal and operational risk

Traditionally the legal frameworks under which the firms operate provide a set of checks and balances to deter, halt, and punish undesirable transactions. However, in the case of blockchains trust is produced through cryptographic mechanisms, and not human intervention. Trust can be disrupted when the software code fails to account for implementation or design flaws in the blockchain's underlying algorithms. Werbach (2018) highlighted how this problem of algorithmic trust can succumb to pressure for accidental or intentional malicious activities, and recommended that blockchain developers should work in conjunction with, and not in avoidance, of regulatory activities.

The liability risks in blockchain transactions include violation of data privacy, insider trading, and identity theft arising from the transparency of the blockchain (Zetzsche et al., 2018). Additional sources of risk are introduced by cybersecurity breaches and implementation flaws leading to operational risk. International business environments incorporating blockchain technology should be cautious in identifying the sources of risk in their applications and applying adequate oversight while incorporating blockchain technology.

6. Discussion and conclusion

Since 2008, when Satoshi Nakamoto made his Bitcoin whitepaper public on a cryptography mailing list, its underlying blockchain technology has seen immense growth, both in the field of cryptocurrencies and beyond. The net worth of cryptocurrencies exceeds more than a trillion dollars, and blockchain has been touted as the harbinger of the Web 3.0. This version of the World Wide Web will be driven by distributed technologies, of the kinds seen in blockchain and the Internet of Things. This behooves all kinds of firms to rethink their strategy and operations, similar to how firms had to rapidly adapt when Web 1.0 heralded the power of the Internet for searching information archived in search engines and again, when the Web 2.0 transformation signaled the start of the social networking age. In a little over a decade, blockchain has shown tremendous potential as a disruptor in diverse domains. Although the development of blockchains and their adoption by firms is a relatively recent phenomenon, it has already had a profound and lasting impact on firms and their strategies. Blockchain technology is a major milestone in our march towards a digital economy and the full implications of its transformative potential are only beginning to be understood. In this paper, we have provided an introduction to its basic characteristics, discussed its implications for the strategies of firms, and suggested a number of promising research questions.

Every firm, whether it is small, mid-sized, or large has records of various kinds. The creation, maintenance, and modification of these records were at the heart of the first revolution in software development. The development of desktop publishing software, database software, and ultimately web-based front-end interfaces that enabled users to enter their information for storage in backend company databases was a direct result of the need to work with records efficiently. This is why blockchain has emerged as a disruptor. The promise of blockchain to offer a mechanism to store records in a decentralized manner with a network-wide consensus protocol that eliminates the need for intermediaries offers a powerful tool to conduct transactions with higher levels of trust.

A firm's adoption of blockchain cannot happen in a vacuum. Since blockchain is developed entirely in code, the adoption of blockchain by individuals, firms, and governments around the world will require the development of new policies, legal codes, and perhaps even a rethinking of property rights and privileges. For policymakers also blockchain represents challenges that their current policy frameworks cannot cope with. In most cases, the evolution of regulatory frameworks lags years behind the introduction of new technologies. The creation and widespread adoption of cryptocurrencies threaten the power of central banks in areas such as money supply and exchange rates. The existence of cryptocurrencies that can be created using mathematical algorithms and their widespread circulation among the public and acceptance by a growing number of firms present unprecedented challenges to policymakers. It has always been the privilege of governments to issue currencies but we now have currencies of uncertain, if not dubious, provenance whose fluctuations in value defy our predictive abilities. Only time can tell whether this represents a democratization of monetary policy liberated from the power of authorities or a free for all in the wild west of monetary history.

The widespread adoption of blockchains holds the promise of transforming our business landscape in multiple ways. First, it helps in ushering in a truly borderless world because digital platforms are not bound by national borders. Second, it fundamentally transforms the production of trust. Trust has always been a function of the frequency of interaction among transacting parties as well as the passage of time. There was also considerable variation in trust levels across cultures. Blockchains have suddenly transformed the process of trust-building into an instantaneous, relatively costless, and technology-mediated activity. Third, blockchains are not homogenous and there are different kinds of blockchains. A firm's choice of a specific blockchain is based on its specific circumstances and needs.

Further, their expertise in blockchain development and use allows these early adopter firms to be able to potentially lease their blockchain technologies and expertise to other firms who intend to venture into this space. Indeed, the development of current Blockchain-as-a-Service applications is a formidable step in that direction. Firms will have to continue to wrestle with the technological implications of blockchain – complexity, cost, and a host of other factors related to privacy and security. The birth of decentralized autonomous organizations challenges our theories about the internal organization of firms as well as the very concept of firm boundaries.

Many of our theories of internationalization, as well as traditional theories of organization, require rethinking in an era when theories cannot keep pace with unfolding technological developments. Most importantly, we may have to rethink the very concept of the organization itself in an era when competition is not just among firms but among entire ecosystems built around highly differentiated technological platforms. The first investors in cryptocurrency bear the distinction of being the first to see the potential of blockchain technology, and in a short time, their investments have seen massive returns. It remains to be seen if the early institutional adopters of blockchain will reap similar benefits in the coming years. Continuous refinement of the technology over several iterations will help them to customize blockchain for various applications.

For practicing managers, blockchain has opened up enormous possibilities to not only improve their efficiency, but also to enhance interfirm coordination, and build ecosystems involving symbiotic relationships among firms within an ecosystem. Therefore, the initial choices firms make in terms of the type of blockchain they adopt and the platform they join may have lasting implications for their survival and success. However, blockchain technology is not for all businesses. Nor is it the solution for all problems. Current challenges related to costs, speed, scalability, regulation, security, and privacy present obstacles that may limit widespread adoption. Technology maturation and standardization efforts will help to cope with some of these challenges and may lead to more widespread adoption in complex environments such as those in international business.

International business encompasses a variety of stakeholders in different jurisdictions, industry verticals, and products and services. Globalization has allowed people all over the world to benefit from the results of international business by having products and services from one part of the world being made available to everyone, everywhere. Despite the progress in the development of a global economy, several challenges in international business remain. Fundamental to these challenges is the issue of trust, where participating entities in a business transaction are operating with limited information about the end-to-end nature of the transaction. Thus, risk in transactions is a direct outcome of the lack of symmetrical trust in transactions. Conventional methods of producing trust are laborious, opaque, and time-consuming. Our paper makes the case that the emerging applications of blockchain technology help to mitigate the issues surrounding trust in international business transactions, thus facilitating transactions by minimizing transaction costs, reducing uncertainty, and improving speed.

Author statement

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

Data Availability

No data was used for the research described in the article.

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