Association for Information Systems
AIS Electronic Library (AISeL)

Research Papers ECIS 2018 Proceedings

11-28-2018

X-BORDER PLATFORMS: THE IMPLICATIONS OF DISTRIBUTED LEDGER TECHNOLOGY

Juan Giraldo
Copenhagen Business School, jgi.digi@cbs.dk

X-BORDER PLATFORMS: THE IMPLICATIONS OF DISTRIBUTED LEDGER TECHNOLOGY

Research paper

Giraldo, Juan, Copenhagen Business School, Copenhagen, Denmark, jgi.digi@cbs.dk

Abstract

Distributed Ledger Technology (DLT) has been argued to play a vital role in facilitating cross-border payments and improving the financial ecosystem at a global scale. This research builds upon digital platform literature to frame cross-border payment organisations and uses a case study within the remittance industry to review the potential shapes of DLT within these platforms. Findings suggest that DLT can play a role at removing inefficiencies and promoting financial inclusion in developing countries by being used as a settlement mechanism, as a standardised communication channel and as a way for consolidating data located within the boundaries of different platforms. This study contributes to digital platform and DLT literature by suggesting three potential implications that this phenomenon can bring and their relevance to payment platforms.

Keywords: Distributed Ledger Technology, Blockchain, Digital Platforms, Cross-Border Payments, Developing Countries

1 Introduction

Cross-border payments can be traced back to the 1300s when the rise of the House of Medici took place and gave birth to Holographic Bills of Exchange which facilitated the movement of money across borders within the family's bank branches (Ferguson, 2008; Wikipedia, 2017). In 1851, at a time where cross-border payments were done between different financial institutions, a further innovation was initiated. The New York and Mississippi Valley Printing Telegraph Company was founded with the aim of offering higher standardisation and improved telegram communication, by 1861 the company provided the first transcontinental telegraph line and gained a telegram network market dominance in the middle of the 20th century. This organisation is known today as Western Union (Western Union, 2017) and their Telegram technology influenced the operational foundations of the Society for Worldwide Inter-bank Financial Telecommunication (SWIFT) (Scott & Zachariadis, 2012). While SWIFT has become the standard inter-bank cross-border payment communication channel, Western Union's telegram network is now the largest remittance provider (Western Union, 2017).

The industry's technological foundations and current governing architectures, however, have played a part in constraining innovation across cross-border payment systems leading to high prices and the intervention of The World Bank and The United Nations. Remittances, for example, play a key role within cross-border payments and are currently aiming to reach a volume of more than 600 Billion Dollars this year from which 70% is paid out in developing countries (The World Bank, 2017a). These payments are essential for the development of emerging markets (Acosta et al., 2008; Agyepong & Twinomurinzi, 2016) and current costs are on average 7.32% of the amount transmitted, while the United Nation's target for these prices aim for an average cost of 3% by 2030 (The World Bank, 2017b).

Today's digital technologies have given birth to new organisational arrangements which are currently transforming the financial industry (Puschmann, 2017). Distributed Ledger Technology (DLT) is one of these technologies which has been argued to drive innovation within cross-border payment systems and improve the financial ecosystem on a global scale. The World Economic Forum (2016), for example, has reviewed the potential of the technology within different financial services, including global payments, and The Bank of England has considered the technology within its newly released Real-Time Gross Settlement System Blueprint (Bank of England, 2017). Moreover, SWIFT has recently introduced a proof of concept to test the potential of the technology (SWIFT, 2016), and new DLT-based projects such as Ripple are currently entering the inter-bank cross-border payment market (Rosner & Kang, 2016).

However, developments around remittances are still limited and are centred around the use of Bitcoin as an intermediary currency and settlement mechanism (Glaser & Bezzenberger, 2015; Kazan et al., 2015). Additionally, while research from the IS field is required to understand the implications of this technology, studies that place DLT within specific contexts are scarce (Notheisen et al., 2017). For this reason, this research aims to initiate an understanding of the implications of DLT within cross-border payment systems by taking a bottom-up approach and focusing on the remittance industry. Following this argument, the research questions guiding this study are:

> *How do cross-border payment platforms operate and what shapes can Distributed Ledger Technology take within these platforms?*

This study builds on digital platforms literature to frame cross-border payment systems and subsequently develop an understanding of the shapes that Distributed Ledger Technology (DLT) can take within these systems. This study contributes to the digital platforms literature and the nascent conceptualisation of DLT by suggesting three implications that this phenomenon can bring along with their potential impact on digital platforms. The structure of this research is as follows: First, an overview of DLT is presented followed by the theoretical background of this study where a research model for understanding the architecture and governing structures of cross-border payment systems is introduced. Thereafter, the research method is discussed before presenting the case findings and having a discussion. Lastly, some concluding remarks summarise this study.

2 Distributed Ledger Technology

The high malleability offered by software along with the rapid increase in computational power has loosened the coupling between devices, networks and information, which in turn has unleashed enormous flexibility (Tilson et al., 2010a). This trend, has fostered new technological arrangements that have the potential to transform the financial industry. DLT is one of these technologies which was born in the post Internet era with Bitcoin, and have boosted new developments in the industry while being applied for a range of uses. The technology can be viewed as a distributed data structure mechanism that allows for the creation of distributed software applications in which the need for an intermediary and central authority is reduced (Nakamoto, 2008; Walport, 2016). In essence, DLT works by setting rules at the database transaction level while managing integrity with a network of participants that support the system (Ruckeshauser, 2017; Walport, 2016). Cryptography is used as a way to develop a chronological link between transactional data, and through a public key infrastructure (PKI) it is used for the authentication and validation of new data entries (Nakamoto, 2008).The value of this decentralised architecture is at its core to provide validated immutable transactions with no single point of failure (Glaser, 2017).

The overall advantages and limitations of this technology, however, depend on the architectural mechanisms underlying the distributed ledger. For this reason, in this work, the term Distributed Ledger Technology is viewed as the fundamental concept of distributed software developments that follow a decentralised database architecture, which can achieve consensus over its state without having a single point of failure. Blockchain, on the other hand, is viewed as one of the DLT architectures which has specific advantages and limitations (Walport, 2016).

Blockchain was initially introduced with Bitcoin to solve the double spending problem, the difficulty of preventing a digital currency token from being duplicated and spent more than once, and in turn set the foundation of fully decentralised digital assets (Nakamoto, 2008). In Blockchain architectures, transactional data is grouped in Blocks that are cryptographically linked together while at the same time linking transactions with a merkle tree structure which allows for traceability of connected transactions grouped in different Blocks (Nakamoto, 2008). However, more recent DLT developments such as Ripple, IOTA and Swirlds have moved away from Blockchain to facilitate scalability and performance (Baird, 2017; Popov, 2017; Schwartz et al., 2014); issues currently present in Blockchain architectures (Beck et al., 2016; Notheisen et al., 2017).

2.1 Governance

The performance and architectural designs of DLT are also, in great part, linked to its governance structure which at the same time is dependent on the level of trust among the participants involved (Walsh et al., 2016). Building on Walport (2016) and Walsh el al. (2016), this work suggests the following taxonomy for understanding the governance of DLT at a macro level (see Figure 1).

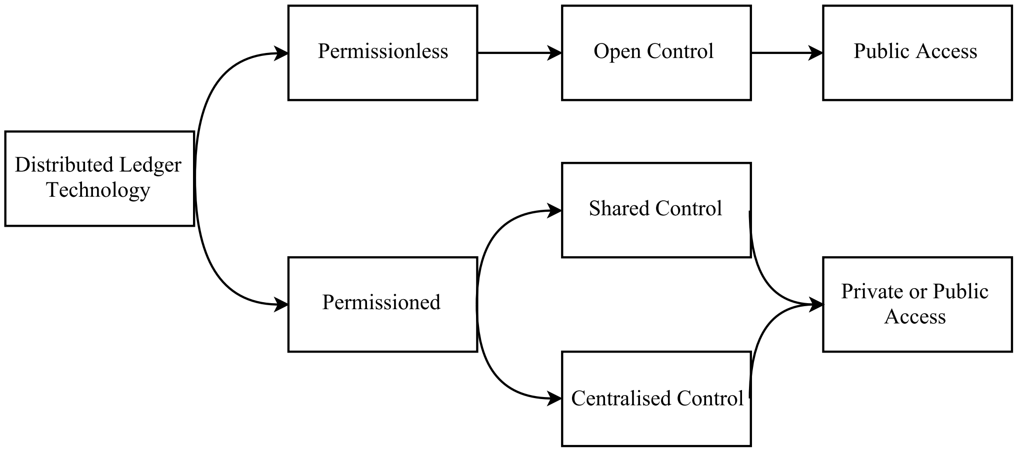

Figure 1. DLT governance at a macro level

Figure 1 shows that DLT can be governed by permissioned access where control is held through a central authority or shared among a group of participants supporting the technology. When DLT is centrally controlled, there is a central authority safeguarding the network, for example, by taking the role of a certificate authority supporting the Public Key Infrastructure (PKI). When control is shared, a group of participants with common interests govern the DLT, changes in its architecture and the PKI. Permissioned DLT, can allow for public access to the applications supported or it can also be private where applications' access is granted to preselected users. On the other end, DLT can also be permissionless where control over the network is open to anyone interested in taking part. In this case, access to the DLT and its applications is publicly open.

Glaser (2017) division of DLT systems into two different layers serve as a lens to further understand the governance structure presented in Figure 1. The author identifies a fabric layer where the core code of the DLT takes place and comprises the PKI, data structures, communication layer and the coding environment in which applications are developed; and an application layer where the creation of services take place. At the fabric layer, control can be open, shared or centralised as previously argued, while at the application layer access can be public or private. Importantly, as argued by Glaser (2017), the governance of the fabric layer sits at a higher level and plays a key role in the further changes and developments of the applications sitting on top of it.

Moreover, the governing structure behind the fabric layer influences the consensus protocol of the system; the algorithm that allows the network to achieve a common state and prevents the Byzantine General's Problem (Lamport et al., 1982). The higher the decentralisation in DLT the lower the trust between the parties involved and consequently the higher the risk of an attack. Accordingly, the consensus is driven by the trust among the parties involved. While public DLT projects focus on consensus protocols where not trust is assumed, more closed systems such as Ripple are based on the assumption that a certain level of trust among the participants involved takes place which materialises on improved scalability (Schwartz et al., 2014).

2.2 DLT Implications

Glaser (2017) highlights that DLT enables the creation of applications that digitalised value through the use of tokens, applications that automate processes and services improving coordination among networks, and application that move control towards individual users while consolidating their data located within the boundaries of different organisations. By building on these three areas identified, this work frames the following three implications for the use of DLT: the digitalisation of value, coordination improvement, and the consolidation of data.

2.2.1 Digitalisation of Value

The digitalisation of value came after the double spending problem was solved facilitating the creation of cryptocurrencies or digital tokens, which can freely move across digital environments without the need of an intermediary. These digital tokens can be further classified into three types: (1) community backed tokens where the value of the token is supported by a community and their usage of the token (e.g. Bitcoin), (2) asset backed tokens where the token's value is directly linked to an asset such as a commodity, debt or equity products, or other forms of assets, and lastly, (3) currency backed tokens where their value is directly linked and represented by a currency issued and approved by a governmental regime. This categorisation builds on previous studies that aim to differentiate the different types of tokens along with their properties and implications (Glaser, 2017; Glaser & Bezzenberger, 2015). Moreover, it is relevant to clarify that within the presented classification, asset backed tokens and currency backed tokens are assumed to be sitting within the regulatory frameworks connected to the asset or currency behind the token. For example, currency backed tokens can be approached from an electronic money, commercial bank money, and central bank money regulatory frameworks.

In contrast, community backed tokens don't necessarily have legal tender. From a central bank perspective, community backed tokens are viewed as virtual currency schemes defined as 'a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community' (ECB, 2012). Within this context, these currency schemes have been further divided into three types depending on their properties: type 1 which includes closed schemes such as the ones used for online gaming, type 2 where a conversion rate to purchase the virtual currency exist and type 3 where there is a buy and sell rate for the virtual currency (E.g. Bitcoin) (ECB, 2012).

2.2.2 Coordination Improvement

In addition to the digitalisation of assets, DLT also allows for an improved coordination. Xu et al. (2016, p. 3) approach the technology as a "complex, network-based software connector, which provides communication, coordination (through transactions, smart contracts and validation oracles) and facilitation services". The author takes a technical view and approaches DLT as a software connector that facilitates the transferability of data, transferability of control and interaction between different components of a system. In turn, the technology can be viewed as a tool to foster further standardisation and automation among not only devices but also business and peer-to-peer networks.

Within device networks, such as the Internet of Things, the technology can foster the standardisation and automation of interactions among devices with the use of smart contracts. In this case, smart contracts can be viewed as scripts where future scenarios are taken into account predetermining the range of possible actions based on pre-established possibilities. Hence, smart contracts can be approached as stored scripts that are analogous to stored procedures in relational database management systems (Christidis & Devetsikiotis, 2016). These contracts have the potential to enable independent devices that can validate their software updates and even transact among each other if a form of token is introduced. In the energy sector, this improved standardisation would allow for a peer-to-peer market where machines can buy and sell energy automatically according to some pre-defined criteria (Christidis & Devetsikiotis, 2016).

In the case of business networks, DLT can facilitate processes that involve various organisations such as supply chains and financial trading contracts. Within supply chains, the technology can serve as a shared information infrastructure to solve issues currently present within large operational networks such as the container industry, where the current infrastructure relies on fragmented systems that ultimately lead to high prices(Jensen, et al., 2017; Korpela et al., 2017). Lastly, in the financial industry, the use of smart contracts can automate the way in which multi-party derivative agreements are conducted, while minimising disputes through a shared and open process (Egelund-Müller et al., 2017).

2.2.3 Data Consolidation

Following the improved coordination that can take place through the use of DLT, this work also views the technology as having the potential to consolidate data without the need for a centralised data repository. Within the accounting industry, for example, the use of Distributed Ledgers can facilitate the reconciliation processes between organisations reducing the need for auditors and improving the integrity of information. Brandon (2016) discusses the potential of DLT in business transactions placing the technology in relation to relational databases and NoSQL databases. The author argues that Blockchain can support current database systems to offer better confidentiality, integrity and availability of business transactions by consolidating the data located within the boundaries of different organisations. Moreover, DLT also allows consolidating tangible and intangible objects' data such as land register records and diamonds transitioning life. This consolidation of data has the potential to minimise corruption and ensure the validity of these objects (Walport, 2016). Finally, the technology can also be used to consolidate users' data, such as Know Your Customer data, and reduced operating costs for organisations (Moyano & Ross, 2017).

2.2.4 Summary

Table 1 summarises the potential implications of DLT. It is important to note, however, that these three outcomes are interlinked and while some applications will place emphasis on one or two of them, these outcomes can work together or independently to transform industries. The result of the interaction among these implications can be visualised in the different views that promote a trust-free economic systems where no intermediaries are needed for transactions to take place (Beck et al., 2016; Notheisen et al., 2017; Worner et al., 2016). Importantly, different distributed ledgers are expected to be created, and interoperability among these ledgers (Thomas & Schwartz, 2016) will allow applications to take advantage of the three implications identified.

Digitalisation of Value	Community Backed Tokens Asset Backed Tokens Currency Backed Tokens
Coordination Improvement	Device Networks Business Networks Peer-to-Peer Networks
Data Consolidation	Organisations' data Objects' data People's data

Table 1. Implications of DLT

3 Theoretical Background

From a fundamental stand point, cross-border payment systems can be viewed as digital platforms (Hedman & Henningsson, 2015; Kazan & Damsgaard, 2014; 2016; Staykova & Damsgaard, 2016) that aim to solve a fundamental issue of double coincidence of wants; the difficulty of two parties finding each other and having the need for transacting the same value in different currencies. Subsequently, payment platforms can be approached as layered modular architectures (Baldwin & Woodard, 2009; Kazan et al., 2016; Yoo et al., 2010) governed by a one or multiple organisations (Tiwana et al., 2010) which facilitate the interaction among multiple user groups by combining technical elements along with organisational processes and standards (de Reuver et al., 2017; Tilson at al., 2011). Building upon this view on digital platforms, the following sections provide an overview of the architecture of these artefacts and their governing arrangements. Thereafter, a research model is introduced combining these two elements to understand at a high level how cross-border payment platforms operate.

3.1 Platform Architecture

From an architectural perspective, platforms are formed by a set of components that allow for variety and flexibility within the platform core functions while also being stable enough to support linkages with further components or modules (Baldwin & Woodard, 2009). This interplay between standardisation and flexibility can be traced back to information infrastructures where standardisation allows to black boxed the infrastructure's different layers while its flexibility would facilitate modularisation and further decomposition across and within these layers (Hanseth et al., 1996). Tilson et al. (2010b) approach this conflicting interplay with the paradox of change where platforms are required to have a solid foundation and remain stable while at the same time being flexible to support new functions and growth. Lastly, Yoo et al. (2010) introduces the layered modular architecture as a hybrid between a modular architecture and a layered architecture to explain these trends which sit at the core of today's digital ecosystems. The authors illustrate four layers: content, device, service and network, while also highlighting how a layered-modular architecture allows for various digital services to be part of different design hierarchies among other products and services.

Following the layered modular architecture concept and previous payment systems studies (Kazan et al., 2016), cross-border payment platforms can also be framed using this architecture to provide an initial overview of the architectural components of these platforms. Table 2 provides an overview of SWIFT's architecture and the different components of the platform. It is important to note that the network, service and content layers are more tightly coupled than the device layer for which the platform can be adapted according to its competitive environment (Kazan et al., 2016).

Network Layer	SWIFT's standardised messaging service offers the data transmission channel
Service Layer	Banking institutions provide the cross-border payment service
Content Layer	Payment data
Device Layer	Smartphones or computers

Table 2. Platform layers and modules of SWIFT

3.2 Platform Governance

From an organisational lens, platform governance can be viewed as the alignment of the IT function and organisational structures, which has been argued to follow one of three governing structures, centralised, decentralised or a mixture of both (Kazan et al., 2016). Accordingly, as highlighted by Kazan (2016), decisions in centrally governed platforms are made by the platform owner, and the platform follows a tightly coupled layered modular architecture. While for distributed governance, decisions are made by more than one organisation, and the platform layers are more loosely coupled. The distribution of platform governance among more than one organisation has also been highlighted by Tiwana (2010) where the author distinguishes between platforms that are proprietary to a single organisation or shared by multiple owners.

Further views on platform governance have also considered the interaction among stakeholders and the dynamics of control. For instance, in the case of open source platforms, changes are reviewed by a hierarchical model within its participants, which is followed when solving problems and implementing changes to the platform (Felin & Zenger, 2014). On the other hand, proprietary platforms deal with power disputes among its participants which result in releasing some of the control from the platform's owner(s) (Eaton, 2012; Eaton et al., 2015).

3.3 Research Model

From a technical perspective, systems can be viewed as centralised, where their computing power is located on one site, as decentralised where their computing power sparse between different locations and there is no standardised communication network. And as distributed where their computing power sparse over different sites, while sharing a common communication network (Ahituv et al., 1989; Leifer, 1988). By building on the aforementioned literature and the understanding of centralised, decentralised and distributed systems, cross-border payment platforms can be framed by considering their governing structure along with the impact that these governing structures have over the network, service and data layers of the platform (Yoo et al., 2010). Following this argument, Figure 2 presents three structures that serve as a lens to approach cross-border payment platforms and to develop an understanding of the potential implications that DLT brings.

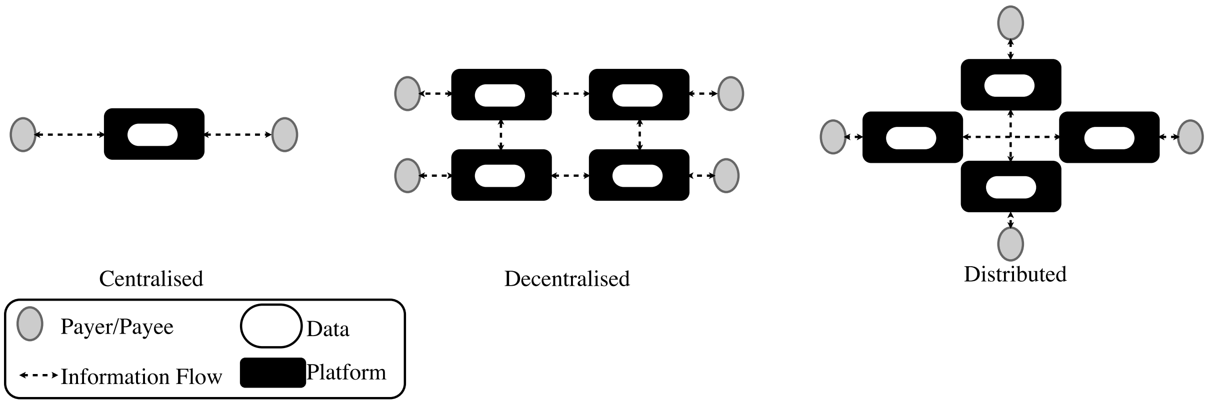

Figure 2. Cross-border payment platforms structures

Following the conception of cross-border payments as two-sided markets, centralised payment platforms govern their system and have control of how the cross-border payment takes place (e.g. Western Union) (Kazan et al., 2016). The data transmission channels, platform boundaries and how the service is provided are predefined by the platform owner (Tiwana et al., 2010). Additionally, payment data is located within the platform and is fully controlled by the platform owner who predefines how this data is moved within the different modules of the platform. On the other hand, in decentralised structures the service is governed by two or more organisations who take part in the cross-border payment and whose systems communicate to be able to accomplish the service. Under this structure, data is moved between the different platforms involved, and the communication channel used for this data transmission can follow different standards (Ahituv et al., 1989). Lastly, under distributed platform structures, the service is governed among different platforms who shared a standardised communication channel to move data sitting within the platforms' boundaries (e.g. SWIFT) (Leifer, 1988). Under this structure, changes within the communication standard can involve a further coordination between the different platforms taking part in the network.

The unit of analysis for the defined structures is the cross-border payment along with the system's boundaries. The cross-border payment can be viewed as the transaction of money and information that take place between customers and the cross-border payment provider(s) while the system's boundaries can be visualised as the extension of the software codebase. For example, two organisations might be involved in the cross-border payment, but one of them might be using the other party's software. In this case, the party using the software becomes a module within the platform and the party offering the software becomes the platform (Baldwin & Woodard, 2009; Staykova & Damsgaard, 2015; Tiwana et al., 2010). In contrast, in decentralised structures two systems are present and a communication channel is agreed between the platforms' owners. Lastly, in distributed structures, two different systems are present, but an industry standard is used for communication (see Figure 2).

These structures do not represent a holistic view of platforms studies but a guiding framework to understand the dynamics of cross-border payment platforms and the potential impact that DLT can have on these systems. Additionally, in complement to using these three structures, which centre attention on the network, service and data layer of cross-border platforms, the three implications of DLT previously identified also serve as a lens of analysis for understanding the different shapes the technology can take within these platforms.

4 Research Method

To understand how cross-border payment platforms operate, and the potential shapes that DLT can take within these platforms, this research uses an interpretative case study with participatory observations (Klein & Myers, 1999; Walsham, 1995). This method was found relevant for the development of this exploratory research where previous theory regarding the potential implications of DLT is still nascent (Notheisen et al., 2017) and where the complexity of the context demands being close to the unit of analysis (Dubé & Paré, 2003).

Data collection took place in the UK within a cross-border platform offering remittances from the UK to Latin America, where decentralised structures are common. The case selection was decided based on the three structures previously defined and a decentralised structure was found to serve as a unique case (Dubé & Paré, 2003) for understanding the different shapes that DLT can take among cross-border payment platforms. Field observations with field notes were conducted inside the cross-border payment platform, where access to review their system and documentation, which included more than 30,000 items, was granted. However, the focus was on the network, service and data layer of the platform and emphasis was placed on 500 documents representing 17 integrations that this platform had conducted with other platforms located in different regions. Lastly, an additional field observation took place at the International Association of Money Transfer Networks conference in 2017 where representatives from more than 100 organisations including cross-border payment platforms, regulators and new entrants met for two days to discuss general challenges and opportunities.

The unit of analysis considered for this study was the life of the remittance from the cross-border platform perspective, which later drove the study towards understanding the flow of capital of these transfers to untangle the service layer and further data generated across the life of the remittance. The data collection and analysis followed three stages as highlighted in Table 3. A first stage, where the technical documentation of the integrations was compared, a second stage, where observations of the life of a remittance complemented with financial documentation were conducted to understand the flow of capital and additional data linked to the payment. And a third stage, where observations within the conference mentioned previously took place in order to validate findings and review the industry's state.

	Data Collection	Data Analysis
Stage 1	500 documents providing the technical documentation of 17 integrations with other platforms. The documents included: - Network connectivity standards (e.g. SFTP) - IP Addresses - BATCH files for the remittance data along with their fields structure - BATCH files for the remittance' statuses along with their structure - Pay-out network details	Comparison between the technical documentation across the 17 integrations to draw at a broad level the operation of these platforms.
Stage 2	Field observations within the cross-border payment platform where the remittance's flow of capital was reviewed along with the additional data derived from the payment (e.g. compliance and settlements data).	The flow of capital of the remittance was traced while annotating the further documentation a remittance requires. Findings were compared with the previous stage.
Stage 3	Field observations with field notes were conducted at an Industry Conference. In the conference, incumbent players alongside new entrants and regulators, discussed the use of DLT as well as current regulatory concerns in the industry.	The three implications of DLT were introduced and findings were validated and reviewed based on the data collected at this stage.

Table 3. Data collection and analysis

5 Case Findings

Cross-border platforms within the remittance industry operate between the interbank cross-border payment market and the local currency payment market of two different countries. The main role of these platforms is the accumulation of small payments in order to benefit from economies of scale while at the same time relying on the interbank cross-border payment infrastructure. Accordingly, three levels of payments can be defined, a local payment which includes the payment from the payer to the platform on the sending side and the payment from the platform to the payee on the pay-out side. The remittance payment, which involves the movement of information between the two platforms involved in the process. And a settlement payment which involves a balance clearing between the two cross-border payment platforms.

These multi-payment process involves three currencies, the sending currency, the pay-out currency and the settlement currency which is used to settle and cleared payments between the platforms involved. In this perspective, the sending platforms become efficient in exchanging from the sending currency to the settlement currency and the pay-out platform in exchanging from the settlement currency to the pay-out currency. Within the 17 integrations studied it was found that 90% would use USD as settlement currency and 10% would use EUR. These major currencies facilitate the interbank payment, and maintain the system efficient for cross-border payment platforms.

Furthermore, after reviewing the integrations' documentation, at the network layer, it was found that most of these organisations use SFTP as means of communicating remittances' data. At the data layer, the remittance data includes payer and payee details along with the pay-out platform's fees, exchange rates and pay-out details (e.g. amount and payment method). While at the service layer, these platforms intend to offer reachability and flexibility of pay-out options which include bank deposits, cash payments and even home delivery in some countries (e.g. Dominic Republic). However, after conducting further observations, it was found that the information flow and communication channels used between the platforms would include email and additional data was linked to the remittances transmitted. This data included Know Your Customer (KYC) information, which would be collected depending on the risk involved in the transaction, and further settlement data which included the reconciliations of the remittances sent and pay-out between the two platforms. Figure 3 illustrates at a broad level the way in which these platforms operate. For simplicity, the figure shows the movement of money between the users and the platforms, however, it is important to note that this movement of money will include their banks and further parties operating within the local payment infrastructure. Additionally, the parties involved within the SWIFT message can include numerous institutions.

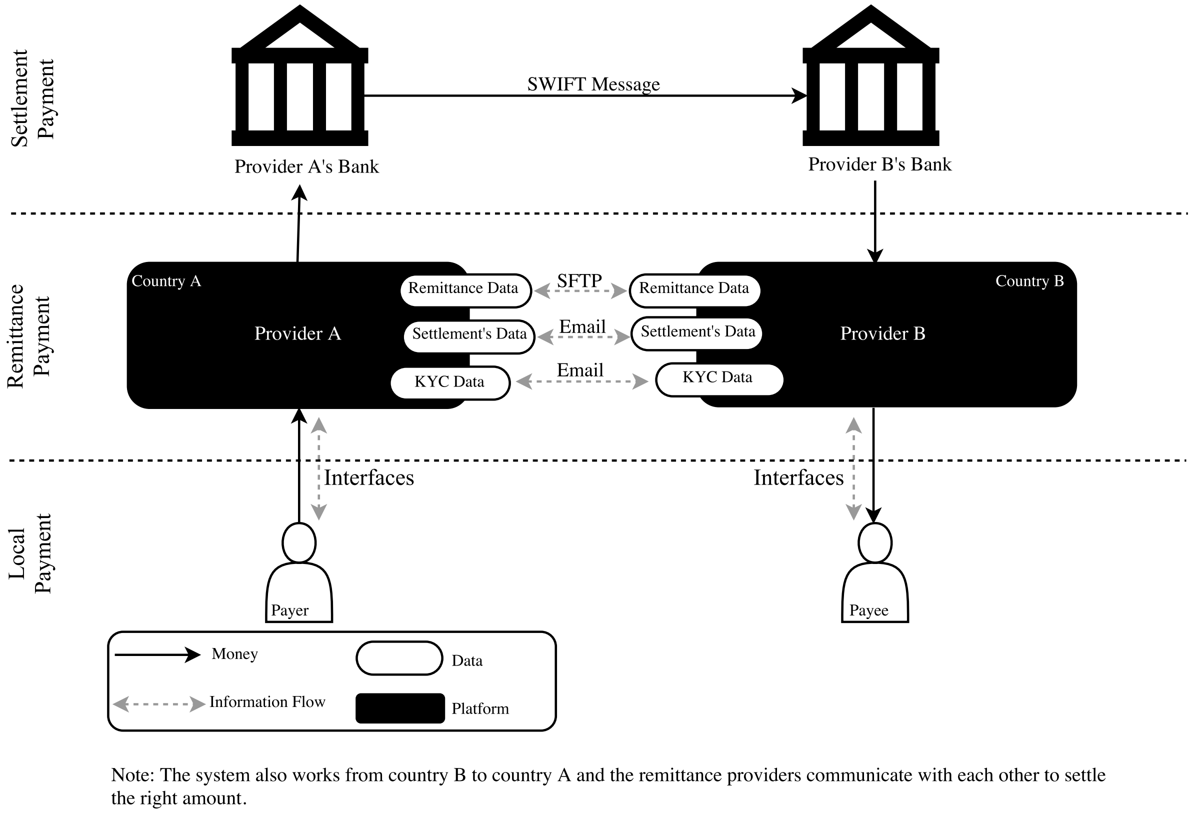

Figure 3. Decentralised cross-border payment platforms within the remittance industry

Overall, decentralised cross-border payment platforms within the remittance industry can be seen as connections of platform-based businesses that aid at moving information to verify the transition of money, which is represented as a liability across different organisations. Importantly, these platforms rely on other payment platforms sitting at a higher hierarchical layer within the cross-border payment infrastructure and benefit from inefficiencies across this layer. Following this understanding of the operations of cross-border payment platforms within the remittance industry, this work now reviews the possible shapes DLT can take across these platforms.

5.1 DLT's Digitalisation of Value

Digital Tokens can play a part in the settlement payment layer allowing for improved efficiencies. As mentioned previously, cross-border payment platforms across the remittance industry rely on the cross-border payment market provided by banks and their interbank communication system SWIFT. Payments sent across this system can take up to 3 days to be cleared at the pay-out platform's bank generating additional credit risk, and demanding high working capital for the platforms operating at the remittance payment layer. For example, for every 1 GBP received from a client, the sending platform in the UK would have to have another 1 GBP available as prepayment or credit channel with the pay-out platform, and another 1 GBP safeguarded on a separate account (e.g. a segregated back account) until the remittance is paid out. The latter is a regulatory requirement, which can be managed assuming that the local payment is efficiently cleared and made available in the platform's bank.

Digital tokens can offer an alternative settlement mechanism, allow for a minimised credit risk and a minimised capital requirement, which would translate on a more efficient service. Community backed tokens such as Bitcoin are already being used across various organisations (Glaser & Bezzenberger, 2015; Kazan et al., 2015) as payments with these tokens can be cleared with high certainty after one hour when more blocks with transactions have been added to the chain (BitcoinWiki, 2017). Moreover, new cross-border payment platforms such as Ripple are offering a form of currency backed tokens, which if scaled enough could serve as a new form of settlement mechanism for cross-border payment platforms across the remittance industry (Rosner & Kang, 2016).

5.2 DLT's Coordination Improvement

From a service perspective, remittance platforms aim to build a large network and reach a high coverage across different countries. On average, each integration reviewed added 505 pay-out locations for cash payments, 158 banks to offer bank deposit payments and 47 cities where the payment was offered as home delivery. Moreover, the need of finding reachability and offering different payment methods have encouraged the creation of further intermediaries with some institutions working as a hub among the various payment platforms; similar to the correspondent banking model. This trend could be seen in one of the integrations reviewed which accounted for more than 50% of all the pay-out options in the 17 integrations compared. Even more, all of the integrations studied followed a different communication structure while repeating the same information being transmitted with a few exceptions, where additional data is required (e.g. Home delivery address for Dominic Republic).

DLT can serve as a tool to develop a standardised communication channel between cross-border payment platforms, facilitating connectivity and minimising intermediaries within the process. The current operational structures of these platforms can be juxtaposed with the way in which banks operated before SWIFT was introduced, which in the long term has allowed for a performance improvement across the banking industry (Scott & Zachariadis, 2012; Scott et al., 2017). However, the initial stages of SWIFT were not smooth as it involved an agreement from the industry to form a new non-profit organisation that wouldn't exploit the network in any competitive way (Scott & Zachariadis, 2012). With DLT these governing issues can be minimised as the technology's intrinsic assumptions are based on achieving a form of consensus between parties that do not trust one another (Nakamoto, 2008). Consequently, facilitating the creation of a new standardised communication channel while shifting the platforms structure to a distributed one where improved coordination takes place.

5.3 DLT's Data Consolidation

Importantly, cross-border payment platforms still rely on legal processes to operate where intermediaries still play a key role as these processes are lengthy and in essence rely on managing the risk of transacting with each platform. While this process cannot fully be replaced, the development of a standardised communication channel would create a data history of each platform facilitating the integration of platforms that don't trust and know each other. Moreover, the development of a standardised communication channel would require the consolidation of remittance data which currently sits within the boundaries of each platform and involves complex reconciliation processes to achieve an agreement of current balances. In the case studied this reconciliation would take place once a month where the platforms involved in the remittance transfer would agree on a common balance.

Secondly, this consolidation of data can also be client focused and facilitate Know Your Customer (KYC) processes across remittance organisations. Within the case studied this process could involve two types of identification (e.g. passport and proof of address), proof of founds (e.g. payslips), a declaration form to state the reason of the remittance and a review of previous remittances sent by the payer and received by the payee in the pay-out platform. This process is replicated across every organisation and the costs of managing and creating this data can be minimised by consolidating KYC data (Moyano & Ross, 2017). Additionally, this data consolidation would also serve as a channel to create a financial history of unbanked people in emerging economies and contribute to the needed delivery of further financial services in these markets (Agyepong & Twinomurinzi, 2016).

Lastly, in the UK this consolidation of data could shift these platforms' high-risk reputation which has led to a reduced access to the settlement payment layer highlighted in Figure 3. This was one of the main topics discussed during the conference attended where the regulator's concerns centred on the fact that cross-border payment platforms within the remittance industry were shifting their banking access to other countries where the regulator's visibility was reduced. On the other end, the platforms' concerns were the reduced access to banking services within the UK due to Banks' de-risking strategies. KYC data consolidation can be facilitated with the use of DLT to shift the industry's reputation and ease access to banking services within the same country of operation.

6 Discussion

By focusing on understanding how cross-border payment platforms operate and the ways in which DLT can be used across these platforms, this research contributes to theory and practice. Concerning theory, the case findings serve as a path for understanding the potential shapes of DLT within cross-border platforms; platforms operating for services that involve transactions across different countries. These platforms can operate by following a centralised, decentralised or distributed structure based on their architectural arrangements (Yoo et al., 2010) and the way in which the service offered is governed. Within decentralised structures, platforms follow a loosely layered modular architecture (Kazan et al., 2016) where DLT can play a part by serving as a coordination mechanism to standardise communication and as a way for consolidating data located within the boundaries of different platforms. Within centralised structures, the shapes that DLT can take are less noticeable as these platforms follow a more tightly layered modular architecture where control over data becomes a competitive advantage (Kazan et al., 2016), and where coordination within the platform does not necessarily requires DLT. Lastly, within distributed structures, DLT can play a role in consolidating data within the boundaries of each platform and potentially improve the current coordination among the platforms involved in the service.

With regards to practice, cross-border payment systems can be viewed as a hierarchical connection of platform-based systems which sit at different governing levels within the financial ecosystem of two countries. The digitalisation of value, coordination improvement and data consolidation facilitated by DLT strive for two main consequences across these platform-based businesses. An efficiency improvement which can drive costs down and the potential to promote innovative outcomes with the inclusion of new financial services driven by interoperability across institutions and the consolidation of data (Agyepong & Twinomurinzi, 2016). Further studies, however, are needed around this area to fully comprehend the way in which DLT affects payment platforms. While this research has reviewed the potential shapes of this phenomenon, future studies can review each of the implications presented in more detail to further understand how DLT changes platforms and industries. For example, the way in which improved efficiencies could allow for service integration where few organisations benefit the most or for service aggregation where more participation and services are facilitated. The DLT governance structures presented in Figure 1 can serve as an initial framework for understanding these two outcomes.

Lastly, as with any study, this one does not come without limitations. First, the focus on cross-border platforms was centred on the remittance industry from UK to Latin America, further studies can complement this research by including different perspectives on cross-border platforms supporting large payments and within different geographic locations. Second, while current literature and previous studies were considered when defining digital platforms, it is important to note that this definition is still taking shape across the literature with different views among different research fields (de Reuver et al., 2017). Thirdly, Distributed Ledger Technology is still a young technology that requires more studies and industry developments in order to thoroughly comprehend its impact.

7 Conclusion

Cross-border payment platforms supporting remittances have awakened the attention of The World Bank and the United Nations for their relevance in developing countries and current remittances costs. On the other end, Distributed Ledger Technology has been argued to play a vital role in removing cross-border payments' inefficiencies while strengthening the financial ecosystem at a global scale. By building upon literature around DLT, digital platforms and focusing on the remittance industry, this study has aimed at understanding the way in which cross-border payment platforms operate and the potential shapes that DLT can take within these platforms. Findings suggest that DLT can potentially contribute to reducing inefficiencies and promoting financial inclusion in developing countries by being used as a settlement mechanism, as a standardised communication channel and as a way for consolidating data located within the boundaries of different platforms. Future studies can further develop the implications of DLT highlighted in this study and their relevance to Digital Platforms.

References

Acosta, P., Calderón, C., Fajnzylber, P., & Lopez, H. (2008). "What is the Impact of International Remittances on Poverty and Inequality in Latin America?" *World Development*, *36*(1), 89–114.

Agyepong, S., & Twinomurinzi, H. (2016). "Facilitating Financial Inclusion Using ICT: Lessons From M-Pesa and E-Zwich." In: *Proceedings of the European Conference on Information Systems (ECIS).*

Ahituv, N., Neumann, S., & Zviran, M. (1989). "Factors Affecting the Policy for Distributing Computing Resources." *MIS Quarterly*, *13*(4), 389–401.

Baird, L. (2017). *The Swirlds Hashgraph Consensus Algorithm: Fair, Fast, Byzantine Fault Tolerance.* URL: http://www.swirlds.com/downloads/SWIRLDS-TR-2016-01.pdf (visited 11/11/2017)

Baldwin, C. Y., & Woodard, C. J. (2009). "The Architecture of Platforms: A Unified View." In *Platforms, Markets and Innovation* (pp. 19–44).

Bank of England. (2017). *A blueprint for a new RTGS service for the United Kingdom.* http://www.bankofengland.co.uk/markets/Documents/paymentsystem/rtgsblueprint.pdf (visited 11/10/2017)

Beck, R., Czepluch, J. S., Lollike, N., & Malone, S. (2016). "Blockchain - The Gateway to Trust Free Cryptographic Transactions" In: *Proceedings of the European Conference on Information Systems (ECIS).*

BitcoinWiki. (2017). *Confirmation.* URL: https://en.bitcoin.it/wiki/Confirmation (visited on 11/23/2017)

Brandon, D. (2016). "The Blockchain: The Future of Business Information Systems?" *International Journal of the Academic Business World*, *10*(2), 33–40.

Christidis, K., & Devetsikiotis, M. (2016). "Blockchains and Smart Contracts for the Internet of Things." *IEEE Access*, 4, 2292–2303.

de Reuver, M., Sørensen, C., & Basole, R. C. (2017). "The digital platform: a research agenda." *Journal of Information Technology*, DOI10.1057/s41265-016-0033-3

Dubé, L., & Paré, G. (2003). "Rigorin Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations." *MIS Quarterly*, 27(4), 597–636.

Eaton, B. D. (2012). "The Dynamics of Digital Platform Innovation: Unfolding the Paradox of Control and Generativity in Apple's iOS." PhD thesis. The London School of Economics and Political Science.

Eaton, B. D., Elaluf-Calderwood, S., Sørensen, C., & Yoo, Y. (2015). "Distributed tuning of boundary resources: the case of Apple's iOS service system." *MIS Quarterly*, *39*(1), 217–243.

ECB. (2012). *Virtual Currency Schemes.* URL: https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf (visited 10/15/2017)

Egelund-Müller, B., Elsman, M., Henglein, F., & Ross, O. (2017). "Automated Execution of Financial Contracts on Blockchains." *SSRN Electronic Journal*, DOI10.2139/ssrn.2898670

Felin, T., & Zenger, T. R. (2014). "Closed or open innovation? Problem solving and the governance choice." *Research Policy*, *43*(5), 914–925.

Ferguson, N. (2008). *The Ascent of Money: A Financial History of the World*. The Penguin Press.

Glaser, F. (2017). "Pervasive Decentralisation of Digital Infrastructures: A Framework for Blockchain enabled System and Use Case Analysis." In: *Proceedings of the Hawaii International Conference on System Sciences (HICSS).*

Glaser, F., & Bezzenberger, L. (2015). "Beyond Cryptocurrencies - A Taxonomy of Decentralized Consensus Systems." In: *Proceedings of the European Conference on Information Systems (ECIS).*

Hanseth, O., Monteiro, E., & Hatling, M. (1996). "Developing Information Infrastructure: The Tension between Standardization and Flexibility." *Science, Technology, & Human Values*, *21*(4), 407–426.

Hedman, J., & Henningsson, S. (2015). "The new normal: Market cooperation in the mobile payments ecosystem." *Electronic Commerce Research and Applications*, *14*(5), 305–318.

Jensen, T., Vatrapu, R., & Bjørn-Andersen, N. (2017). "Avocados crossing borders: The problem of

runaway objects and the solution of a shipping information pipeline for improving international trade." *Information Systems Journal*, *62*(4), 776–31.
Kazan, E., & Damsgaard, J. (2014). "An Investigation of Digital Payment Platforms Design: A Comparative Study of Four European Solutions." In: *Proceedings of the European Conference on Information Systems (ECIS).*
Kazan, E., & Damsgaard, J. (2016). "Towards a Market Entry Framework for Digital Payment Platforms." *Communications of the Association for Information Systems*, *38*, 1–24.
Kazan, E., Tan, C.-W., & Lim, E. T. K. (2015). "Value Creation in Cryptocurrency Networks: Towards A Taxonomy of Digital Business Models for Bitcoin Companies." In: *Proceedings of the Pacific Asia Conference on Information Systems (PACIS).*
Kazan, E., Tan, C.-W., & Lim, E. T. K. (2016). "Towards a Framework of Digital Platform Competition: A Comparative Study of Monopolistic & Federated Mobile Payment Platforms." *Journal of Theoretical and Applied Electronic Commerce Research*, *11*(3), 51–65.
Klein, H. K., & Myers, M. D. (1999). "A set of principles for conducting and evaluating interpretative field studies in information systems." *MIS Quarterly*, *23*(1), 67–94.
Korpela, K., Hallikas, J., & Dahlberg, T. (2017). "Digital Supply Chain Transformation toward Blockchain Integration." In: *Proceedings of the Hawaii International Conference on System Sciences (HICSS).*
Lamport, L., Shostak, R., & Pease, M. (1982). "The Byzantine Generals Problem." *ACM Transactions on Programming Languages and Systems*, *4*(3), 382–401.
Leifer, R. (1988). "Matching Computer-Based Information Systems with Organizational Structures." *MIS Quarterly*, *12*(1), 63–73.
Moyano, J. P., & Ross, O. (2017). "KYC Optimization Using Distributed Ledger Technology." *Business & Information Systems Engineering*, 1–13. DOI 10.1007/s12599-017-0504-2
Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System.* URL: https://bitcoin.org/bitcoin.pdf (visited 11/11/2017)
Notheisen, B., Hawlitschek, F., & Weinhardt, C. (2017). "Breaking Down The Blockchain Hype - Towards A Blockchain Market Engineering Approach." In: *Proceedings of the European Conference on Information Systems (ECIS).*
Popov, S. (2017). *The Tangle.* URL: https://iota.org/IOTA_Whitepaper.pdf (visited 11/11/2017)
Puschmann, T. (2017). "Fintech." *Business & Information Systems Engineering*, *59*(1), 67–74.
Rosner, M. T., & Kang, A. (2016). "Understanding and Regulating Twenty-First Century Payment Systems: The Ripple Case Study." *Michigan Law Review*, *114*(4), 649–681.
Ruckeshauser, N. (2017). "Typology of Distributed Ledger Based Business Models." In: *Proceedings of the European Conference on Information Systems (ECIS).*
Schwartz, D., Youngs, N., & Britto, A. (2014). *Ripple Protocol Consensus Algorithm*. URL: https://ripple.com/files/ripple_consensus_whitepaper.pdf (visited on 11/11/2017)
Scott, S. V., & Zachariadis, M. (2012). "Origins and development of SWIFT, 1973–2009." *Business History*, *54*(3), 462–482.
Scott, S. V., Van Reenen, J., & Zachariadis, M. (2017). "The long-term effect of digital innovation on bank performance: An empirical study of SWIFT adoption in financial services." *Research Policy*, *46*(5), 984–1004.
Staykova, K. S., & Damsgaard, J. (2015). "A Typology of Multi-sided Platforms: The Core and the Periphery." In: *Proceedings of the European Conference on Information Systems (ECIS).*
Staykova, K. S., & Damsgaard, J. (2016). "Adoption of Mobile Payment Platforms: Managing Reach and Range." *Journal of Theoretical and Applied Electronic Commerce Research*, 11(3), 65–84.
SWIFT. (2016). *gpi Nostro Proof of Concept*. URL: https://www.swift.com/news-events/press-releases/swift-tests-show-blockchain-has-potential-for-global-liquidity-optimisation (visited on 11/11/2017).
The World Bank. (2017a). *Migration and Remittances Data.* URL: http://www.worldbank.org/en/topic/migrationremittancesdiasporaissues/brief/migration-remittances-data (visited on 11/10/2017).
The World Bank. (2017b). *Remittance Prices Worldwide.* URL:

https://remittanceprices.worldbank.org/sites/default/files/rpw_report_march_2017.pdf (visited on 11/07/2017).

Thomas, S., & Schwartz, E. (2016). *A Protocol for Interledger Payments*. Retrieved November 11, 2017, from https://interledger.org/interledger.pdf (visited on 11/11/2017).

Tilson, D., Lyytinen, K., & Sørensen, C. (2010a). "Desperately Seeking the Infrastructure in IS Research: Conceptualization of "Digital Convergence" As Co-Evolution of Social and Technical Infrastructures." In: *Proceedings of the Hawaii International Conference on System Sciences.*

Tilson, D., Lyytinen, K., & Sørensen, C. (2010b). "Research Commentary—Digital Infrastructures: The Missing IS Research Agenda." *Information Systems Research*, *21*(4), 748–759.

Tilson, D., Sørensen, C., & Lyytinen, K. (2011). "The Paradoxes of Change and Control in Digital Infrastructures: The Mobile Operating Systems Case" In: *Proceedings of the International Conference on Mobile Business, (ICMB).*

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). "Research Commentary—Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics." *Information Systems Research*, *21*(4), 675–687.

Walport, M. (2016). *Distributed Ledger Technology: beyond block chain*. URL: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf (visited on 11/11/2017)

Walsh, C., Gleasure, R., Li, S., OReilly, P., Feller, J., & Cristoforo, J. (2016). "New kid on the block: a strategic archetypes approach to understanding the Blockchain" In: *Proceedings of the International Conference on Information Systems (ICIS).*

Walsham, G. (1995). "Interpretive case studies in IS research: nature and method." *European Journal of Information Systems*, *4*(2), 74–81.

Western Union. (2017). *Western Union Bank's Histor*y. URL: https://www.westernunionbank.com/en/history/ (visited on 11/10/2017).

Wikipedia. (2017). *Medici Bank*. URL: https://en.wikipedia.org/wiki/Medici_Bank#Bills_of_exchange (visited 11/20/2017).

World Economic Forum. (2016). *The future of financial infrastructure*. URL: http://www3.weforum.org/docs/WEF_The_future_of_financial_infrastructure.pdf (visited on 11/12/2017).

Worner, D., Bomhard, Von, T., Schreier, Y. P., & Bilgeri, D. (2016). "The Bitcoin Ecosystem: Disruption Beyond Financial Services?" In: *Proceedings of the European Conference on Information Systems (ECIS).*

Xu, X., Pautasso, C., Zhu, L., Gramoli, V., Ponomarev, A., & Chen, S. (2016). "The Blockchain as a Software Connector." In: *Proceedings of the Working IEEE/IFIP Conference on Software Architechture WICSA.*

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). "Research Commentary—The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research." *Information Systems Research*, *21*(4), 724–735.