



Empirical Analysis of Supply Chain Finance Innovation Model Based on Blockchain Technology

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Abstract. This paper attempts to establish a conceptual framework for the solution of blockchain-driven supply chain finance. This framework is designed to facilitate the coordination relationship between buyer and seller. Besides, it alleviates implementation inefficiency in discrete supply chain financial instruments, such as reverse factoring and dynamic discounting. In addition, this paper proposes the value drivers of blockchain technology and elaborates its unique characteristics in the application of supply chain finance. Although blockchain technology is considered a breakthrough financial technology, research on its impact on supply chain finance is scanty. Therefore, this paper contributes to the future development of supply chain finance based on the latest technological innovations.

Keywords: Blockchain technology · Supply chain finance · Reverse factoring · Dynamic discounting

1 Introduction

With the increasing application of supply chain financial instruments in various industries, working capital optimization and capital costs reduction is highly correlated. From the perspective of individual company, it is imperative to optimize the financing processes by adopting low-cost solutions (Klapper 2006). From the perspective of supply chain, supply chain finance could both benefit buyers and suppliers by facilitating the ease and capital allocation efficiency along the entire value chain (Papa 2013). Financial tools such as reverse factoring and dynamic discounting may enable companies to optimize the allocation of working capital and alleviate financial risks. Although supply chain finance possesses significant advantages in theory, the implementation of its component tools in practice is scanty. Although supply chain finance provides a wide range of technologies, blockchain technology in supply chain finance brings cutting-edge advancement for the development, deployment, and utilization of effective business applications.

In recent years, the digitization of the physical supply chain has attracted widespread interest. However, the logistics, information flow, and financial flow, more often than not, are regarded as independent flows across differential functional departments and

sections. As a result, the start of business application tends to rely on manual input and sequential confirmation (Zhang and Dhaliwal 2009). In addition, business transactions consist of numerous participants and intermediaries. The high expenditure and sophistication of complex information technology systems, security deficiencies, and lengthy processing time are typical disadvantages among others of nowadays' usual operations (Fellenz et al. 2009).

Accordingly, weak credit contract, taxes, legal enforcement, and regulations have intensified efficient interactions and standard processes among supply chain participants (Klappe 2006). In addition, the inconsistent governance structure complicates the gathering of key accounts receivables and the acquisition of archival data on default risk assessments. Pfohl and Gomm (2009) argued that buyers were not able to oversee associated account receivables. Subsequently, it would be sellers who implement the accounts receivable monitoring procedure, and buyers still could not observe this process. Therefore, in the traditional reverse factoring practice, intransigence and fraud are a major problem (Beck et al. 2003; Klapper 2006).

By adjusting all pertinent data flows utilizing digital process to build credibility and transparency, the transaction process can be significantly more functional while regulatory control can also be improved by eliminating as many unnecessary procedures as possible (Templar et al. 2016). A truly valuable digitalized, autonomous, decentralized, and distributed network will be applicable to numerous services and procedures (Raval 2016). Until now, there has been no method to show the function of supply chain finance by comprehensively examining its shortfalls and potentials. The initial concept provided a pathway to fill in the gap between opaque assumptions and actual implementation. If a foundational conceptual framework could be proposed, relevant orientation and tactics could be adopted. Additionally, it can identify plausible exploration in this field and address the scale of industry adaption and business application. Blockchain technology may offer such a technological advantage and serves as one of the most state-of-the-art technologies at the moment. In terms of the fact that operational barriers poses hurdles for key companies of widely adopting supply chain financial instruments, this paper examines the general benefits of blockchain technology and elaborates in detail its value in business practice along with supply chain finance. This paper attempts to answer the following research questions:

1. From a technical perspective, what are the inefficiencies of existing supply chain financial instruments?
2. In general, what are the potential and benefits of blockchain technology?
3. How can blockchain technology benefit supply chain financial solutions by mitigating technical deficiencies?

This paper first discusses how blockchain technology can improve the supply chain financial solution from the buyer's perspective. The concept study of Meredith (1993) is adopted. Following the design proposed in the research, the current situation of supply chain finance was studied, especially two specific methods of reverse factoring and dynamic discounting. Another goal is to determine the value drivers of blockchain technology. Based on literature review and desk research, this article highlights the main capabilities of blockchain technology to characterize its unique characteristics from a

technical perspective. In addition, this article emphasizes problem awareness by explaining the need to improve existing supply chain financial instruments. This paper develops design propositions and requirements through an iterative approach. On this basis, the conceptual framework of two practical cases is designed. Finally, it evaluates and discusses its overall benefits from a theoretical and practical perspective. The remaining part of this paper is organized as follows: Sect. 2 provides relevant theories by summarizing the most essential parts of blockchain technology and related difficulties facing supply chain finance. The third section first discusses reverse factoring and dynamic discounting use cases by adding a technical dimension to handle analysis and key findings. The fourth section is summary and prospect.

2 Stylized Facts

2.1 Block Chain Technology

Blockchain has emerged as a technology breakthrough in the last decade. It has attracted wide attention in both academia and industry. Scientists and business practitioners have been avidly following the development of blockchain. (Kelly and William 2016). To be specific, blockchain can be regarded as a new form of decentralized data management. It is considered as a synonym for a publicly accessible distributed ledger that ensures the integrity of various transactions. It is usually referred to the major making-up component of operating cryptocurrency Bitcoin, and it has attracted increasing follow-up since it was invented in 2008. Blockchain technology, as an enabling technology, is gaining more and more attention because it can build credibility between agents in a decentralized network without calling for a third party (Swan 2015). In contrast, traditional transactions are usually processed on a centralized platform and monitored by an additional party. Therefore, the competent third party testifies whether the transaction has occurred and complied with all orders. General wealth, such as all kinds of assets, have complex security signals and therefore cannot display in two spots at the same time. However, data in digital form can be easily duplicated or intercepted. Therefore, intermediaries in the form of banks are required to perform digital payments. This process can also be applied to the produce digital products, such as keys to initiate software or downloadable music pieces. The same for our daily lives, the certification of a notary public or the registration of a public authority is necessary and often unavoidable. As a result, the inconvenient correlation between the two main participants is takes a lengthy time and costs a fortune, and it is a single point of failure for centralized systems (Bertino and Sandhu 2005). Meanwhile, a shared ledger can make a record of its content on thousands of nodes, rather than an authorized ledger with evidence that the transaction took place. If most ledgers can exceed the information that has been corrupted and manipulated, trust will shift to multiple copies. Therefore, centralized authentication of the ledger is no longer required. Although data dispersion is a viable option, an overwhelming section is required to decide which information should be processed and recorded in a timely manner. In terms of technical usage, to update the entire network, one must determine which system truth to choose (Mainelli and Milne 2016). It is acknowledged that replication serves as the main function of decentralization, the shared distributed ledger as mentioned above visualizes the conceptual framework of providing functioning

prototype among equal-capacity agents. It was not until the 2008 Bitcoin white paper was released that a practical concept emerged that technically could build credibility between strangers in the trading system.

Blockchain poses one of the first innovations to achieve a completely shared, unlicensed distributed ledger. The system may function to establish credibility between strangers in the trading system basically is on one hand usually associated with the intactness of data, and is on the other hand related to the structure, generation, and distribution of information. Therefore, this technology integrates a great deal of research and consists of four major components (Antonopoulos 2015):

- Peer-to-peer network: this topography offers a data ware system for the publicly shared ledger distribution
- Transaction logic: encryption and digital signatures are utilized to protect the transaction procedures among anonymous accounts
- Data immutability: the ledger consists of continuous data blocks that are individually protected and sealed in an encrypted manner, interconnected with previous data in the chain
- Consistency mechanism: an algorithm allows participants to agree on a authentic system state of the network, consequently performing synchronization of the shared ledger

Blockchain and distributed ledger, in practice, are referred to interchangeably. However, the shared ledger method is not necessarily technically reliant on the use of blockchain. Today, the development of blockchain technology has enabled many decentralized data ware houses to keep a record of an expanding volume of transaction records. All kinds of assets, physical or digital transactions, can be recorded in cyber space. People verify that the transaction has actually been carried out because the transactions records are always checked automatically according to the design. Therefore, no intermediary is needed. Although the blockchain contains information about all occurred transactions, complete data integrity is also embedded in the blockchain framework (Swan 2015).

Due to the numerous application possibilities in different fields, this paper proposes three key features on the basis of its technical capacities. In terms of efficiency, we can improve processing in various aspects such as management, testification, approval, trading and settlement. As a matter of fact, in terms of hypervisors, blockchain technology can be applied to handle and replace any standard procedures that do not involve human thinking or accounting. This application saves tremendous time and minimizes errors, lowers expenditures, reducing waste, and optimizes resource allocation and cuts friction. The second prominent characteristic of blockchain is enhanced transparency thanks to the disclosure of complete records and the secure distributed public ledger. Due to insufficient information, regulations, cooperation, legal enforcement and disbelief of authorities, the operation of most firms are opaque. Blockchain technology improves the visibility of errors, misappropriation and misleading. Moreover, it provides information on business procedures and routines, strengthen business accountability, and facilitate more precise evaluation and enhanced monitoring. The third striking feature to mention is the realization of autonomy through decentralization and decentralization. These larger autonomous functions enable to reach anonymous consent and establish

credibility among agents involved in the system. It can set up a more compliant, fair and feasible implementation. Despite incumbent technical difficulties and deficiencies, yet the overwhelming expansion of blockchain-based applications to all kinds of industries is a promising and growing area for future exploration (Swan 2015; Burgess 2015).

2.2 Supply Chain Finance and Its Challenges in the Supply Chain

Due to globalization, intense business competition, and ever-increasing levels of supply chain risk, a large number of companies are exposed to complication and economic uncertainty (De Boer et al. 2015). A potential outcome of this complication is that to properly handle basic supply chain procedures, risks, and capital flows, the supply chain needs to be transparent. To address these problems, companies that used to work independently now need to work together to reduce redundant costs and increase efficiency (Omran et al. 2016). In reality, the majority of companies have realized that it is necessary to optimize not only logistics and information flows, but also capital flows. In addition, companies realize that optimizing the capital flow and capital allocation in the supply chain can improve the overall outcome of the supply chain and reduce financial risks. In order to meet these challenges, supply chain finance has emerged as an integration of modern innovation, and continues to evolve, providing innovative financial solutions to participants along the supply chain. Therefore, supply chain finance are defined in many different ways in extant literature. Pfohl and Gomm (2009) define supply chain finance as inter-company optimization that optimizes financing by integrating financing processes with supply chain partners. Wuttke et al. (2013) regarded the supply chain financial management as the optimization, planning and control of cash flow in the value chain and promote the optimal control of logistics. In addition, Hofmann (2005) defines supply chain finance as an embedded approach of creating value by multiple organizations in the supply chain (including third-party service providers) by designing, executing, and allocating existing financial resources at the inner-organizational level.

Supply chain finance is a leading method adopted by prominent companies to optimize the flow and distribution of resources in the supply chain. Therefore, it contributes to increased corporate profit margins and reduced costs. Supply chain finance includes a variety of financial instruments and technologies to improve capital flows. More broadly, these solutions are designed to aid transactions among supply chain partners. By providing financing and payment options, these solutions may optimize the ease and financial position of all participants in the network. Reverse factoring and dynamic discounting are two methods of supply chain finance after delivery (after invoicing), which are aimed at alleviating the tight payment situation for buyers and suppliers.

Reverse factoring is regarded as a buyer-centric approach. Large buyers are closely associated with financial institutions and provide their suppliers with short-term financing at low costs. By implementing reverse factoring, both buyers and suppliers benefit in the process. The buyer compromised with the supplier so they can extend the payment period. By doing so can the supplier benefit from the advance payment. Due to the functioning of reverse factoring, by selling their receivables to financial institutions can suppliers increase their liquidity. The supplier receives a discount payment from the finance department with a charged interest rate deducted from the invoice value. The

buyer eventually pays the bank on the due date (Seifert and Seifert 2011). Figure 1 shows the process of reverse factoring.

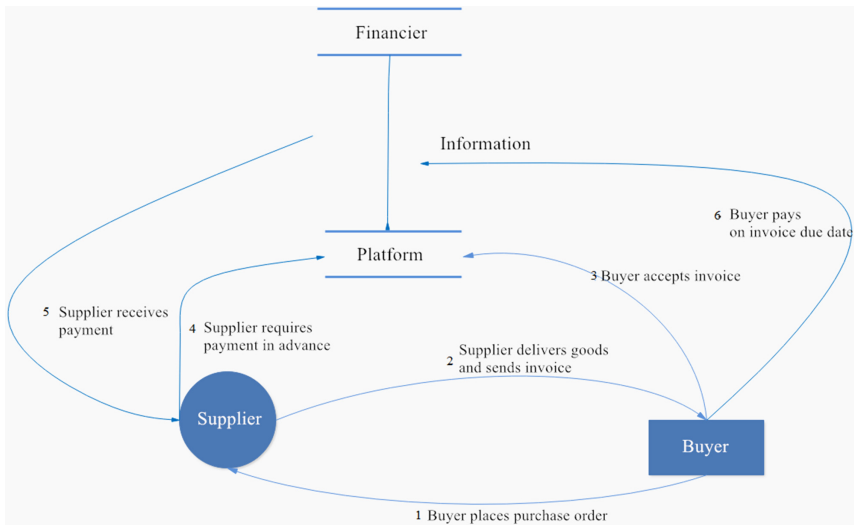


Fig. 1. Functioning of reverse factoring

During the process of reverse factoring, the buyer initiates the process and has to join the supplier one by one, which may take a lot of time and costs quite a fortune. In addition, financial institutions require “know your customers” and testify if suppliers as new participating agents. Dynamic discounting, similar to reverse factoring, is a buyer-driven approach. It enables companies to optimize cash flow by dynamically clearing invoices in a buyer-supplier relationship (Nienhuis et al. 2013). Dynamic discounting allows buyers to get discounts on dynamic payment behavior from suppliers. In addition, both suppliers and buyers are united on the same playground in dynamic discounting. Given this condition, involved parties optimize the timing of invoice payments by exchanging advance payment suggestions. The earlier the supplier receives payment, the higher the discount the buyer receives from the supplier. In addition, buyers with abundant cash started paying in advance in exchange for an agreed discount rate. As buyers and suppliers interact directly, non-financiers are also involved (Nienhuis et al. 2013). Figure 2 illustrates dynamic discounting. During the entire functioning of dynamic discounting, suppliers are able to obtain finance directly from buyers rather than borrowing from financiers. In addition, once the supplier has the funds, there is no need to “know your customer” check-in for dynamic discounting.

Reverse factoring, together with dynamic discounting, provides participants with the possibility of using supply chain finance and cooperation for efficient resource allocation and distribution (Popa 2013). As for reverse factoring, financial institutions purchase receivables from choice buyers and gather relevant information to assess the default risk of related buyers (Klapper 2006). On the contrary, dynamic discounting serves to optimize cash flow through dynamic invoices in a buying and selling relationship (Nienhuis

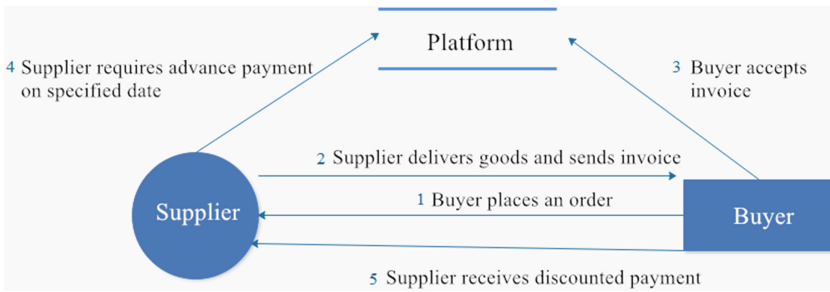


Fig. 2. Functioning of dynamic discounting

et al. 2013). Nevertheless, due to shortage of competent technical financial and material mobility platforms, high costs in many applications, like controversial invoices (Fellenz et al. 2009). Due to the fact that reverse factoring and dynamic discounting are both buyer-centric, the buyer takes the initiative to ask for an extension on the payment time and hoard cash to optimize operating capital. In addition, accounts receivable from multiple buyers are sold by the supplier to a financial institution or factoring. Therefore, it is imperative for financial institutions to assess the buyer's credit portfolio before a decision is made, which will lead to a long-term process. Despite active efforts to encourage the use of supply chain finance, a large number of SMEs are excluded and their financing options are limited. Due to the insufficiency in automation that discloses up-to-date financial information of SMEs with financing needs, banks and other types of financing institutions have always considered financing SMEs a risky business. This prevents smooth integration and cooperation. For example, conventional banking, mobile banking, and Internet-based services are not effectively delivered (Nienhuis et al. 2013). In addition, physical transactions and insufficient automation processing deteriorates total transaction costs of supply chain participants. As for now, in the supply chain financial environment, when a large buyer needs to integrate many suppliers, supplier entry is a complex activity. Implementation consists of numerous tasks and. In this stage, multiple parties can work effectively together. In the supplier entry process, there are still inefficiencies, like man-made operations, wrongful information, or lack of up-to-date data. In addition, the implementation process should be clear to all stakeholders so that they can overcome communication difficulties. Due to the fact that inefficient operations and high investments often deter companies from utilizing new supply chain financial solutions, blockchain may poses as an intangible benefit (Wuttke et al. 2016). Extant literature has found that information sharing, data distribution, credibility, transparency, and cooperation among supply chain participants are important conditions for the successful implementation of supply chain financial tools across the network. The lack of up-to-date information, like purchase information detail, order volumes, and order ID numbers, can also cause delays in cash flow evaluation and payment delivery (Gavirneni et al. 1999). Therefore, innovative technologies, like web-based cloud computing calculation, play a vital role in successful utilization. Novel hardware can to a larger extent access up-to-date data bypassing the boundaries of the physical supply chain.

As a result, transparency and automation will be key foundations of relationships and cooperation between buyers and sellers (Hofmann and Belin 2011).

Due to the nature official documents and sensitive information, digitalization stands a high chance of low authenticity. Contracts, licenses, and certificates possess the distinguished feature of security to display official identity. Digital property can be duplicated, so creditability has to be built up through centralized data management or authorized intermediaries. This consists of large information technology systems located in a single institution. Meanwhile, participants including traders, exchanges, clearing houses and other institutions responsible for legal information can conduct transactions. In particular, ledgers are major component part of business and are therefore centrally recorded and managed by credit entities. With the initiation of blockchain embedded in supply chain finance, the algorithm enables the coordinated establishment of a fully digital register. Blockchain technology has the ability to convert ledgers into tools for recording, enabling, and protecting large numbers of transactions. Working in a similar way like the Internet, blockchain is not centrally administered by a central system. Instead, it is a shared data ware house of information distributed across a large network of users (Raval 2016). Official documents in physical form are no longer the only way to build creditability among unacquainted entities. Given this set up, the fundamental blockchain function can be adapted to incorporate rules, smart contracts, digital signatures, and many more options.

3 Discussion and Main Findings

3.1 Overall Findings

Evolving technology development and increasing information accessibility in the supply chain have led to novel advancement in supply chain financial solutions. The negative impact of the economic situation has accelerated this trend, increasing the importance of liquidity and ease. In a complicated environment, obtaining financial resources might be challenging, while it gives certain advantages of full adoption among large and small companies. When each participant individually controls how supply chain finance is organized, dependence on financial institutions is reduced, such as onboarding and the “know your customer” process. This novel idea originates from digital trust infrastructure, like blockchain technology as a new form of license-free and collaborative platform. Based on the original inspiration, any participant can establish an ecosystem by providing new services. First, this paper analyzes post-shipment financing when the supplier receives financing after the invoice is approved by the buyer. However, financial institutions also face additional risks because the shipment has not been finalized yet. In addition, further development of technology on the basis of the full integration of all parties in the financial supply chain can enhance the transparency of the value chain. Building such an open platform allows financial institutions and companies to arrange supply chain finance under their own control. Therefore, it is not recommended to rely on new onboarding activities. Besides, the proposed solutions can provide active cooperation among companies, scientific institutions, and governments soon.

Blockchain technology is a destructive solution that can make the transaction process between supply chain partners more efficient, improve the relationship between buyers

and sellers during the payment process, and eliminate inefficiency in the flow of funds. Working in the same fashion like the Internet, blockchain possesses the ability of making transaction secure, transparent, and efficient. With the digitization of the process, supply chain finance still has huge development potential. Nevertheless, with the aim of creating new solutions combining the new technology, a new conceptual framework is needed. To be specific, the digitization of the entire value chain calls upon all participants together on the scale of digitization and collaboration. This integrated approach unifies material flows, and at the same time takes into account of information flows and capital flows. Following extant literature, this paper develops a supply chain financial framework with blockchain technology (Fig. 3).

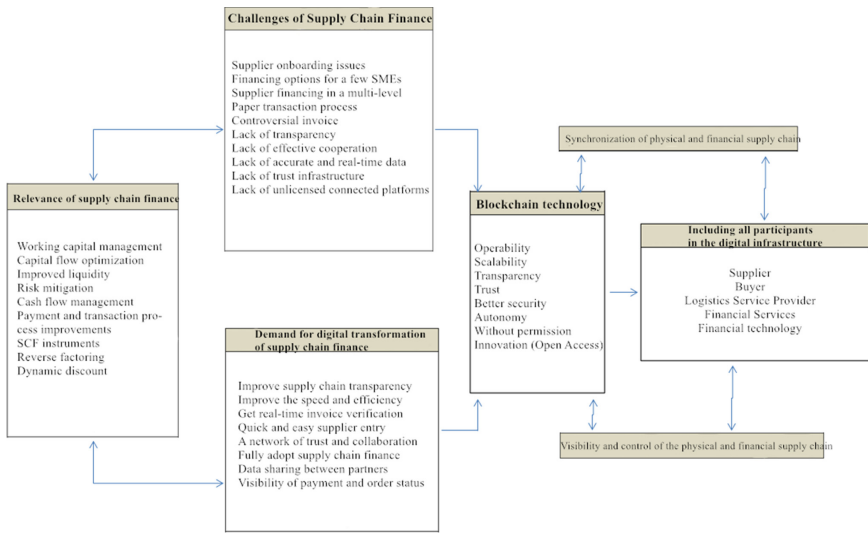


Fig. 3. Integrated supply chain finance and digitalization

Today, the supply chain finance has standardized procedures to optimize capital flows and operating capital through the supply chain. The complex process and low operating efficiency of incumbent financial services have brought significant risks to the effective management of working capital. In addition, insufficient transparency and visibility causes mistrust and certain degree of insecurity among supply chain participants. Technology is a key factor in making supply chain finance more efficient in process and information sharing. With the aid of digital technology, supply chain participants can be integrated into an ecosystem, which is fully effective and transparent. All involved parties, like suppliers, buyers, financial service providers, logistics service providers, and technology providers can benefit from it. Logistics service providers leads a vital role in the whole process, especially when they are in charge of most of the customer’s supply chain. The financial supply chain is mainly utilized in the banking sector for the time being. With the continuous advancement of supply chain finance application, such as improved invoice management, logistics service providers can provide cross-functional quotations. Logistics service providers have a lot of data on the logistics

process because they keep a close eye on the status of the goods. The risks are even more pronounced, allowing logistics service providers to work with partners (such as financial institutions) to initiate inaugural services in the field of supply chain finance. The buyer's rapid approval of the invoice is an indispensable for reverse factoring. Because of the inefficiency of logistics service providers in the process of invoicing, payment processing time may increase. Therefore, only through digitization and technology can automatically process transaction, invoice and payment status, and access to up-to-date information by all relevant participants. All participants can benefit from this comprehensive supply chain financing method in terms of transparency and reduced costs. Meanwhile, disputes and transaction costs are cut to the minimum.

The digitization of supply chain finance depends on both the technical level and the need for active collaboration. Digitalization enables to bring all participants together given the presence of an integrated supply chain financial ecosystem. As a matter of fact, a new generation of collaboration networks can facilitate companies smoothly process invoice and help supplier with onboarding and liquidity distribution. However, in an isolated and disconnected business network, these benefits cannot be realized. Blockchain technology, as an innovative revolution, has the capability of fundamentally modify business operations. By introducing this technology to incumbent networks, it can to a large extent increase supply chain financing and supply chain transparency.

3.2 The Case of Reverse Factoring

The business environment keeps changing. Supply chain finance and its practical tools still have great potential. Reverse factoring has become a short-term method for tier one supplier financing. This tool demonstrates a well-functioning advantage of unleashing cash in the supply chain and financing suppliers through advance payments. However, in the interests of suppliers, this tool still has considerable potential. In addition, regarding the upstream and downstream supply chain, supply chain finance has not been given full integration, as it is only utilized for the coordination of buyers with high credit ratings and their direct suppliers. Partner networks include a integrated end-to-end supply chain from start to finish. As a result, supply chain finance hardly affects indirect suppliers traditionally assigned to tier one supplier. When it comes to operation, for simplicity, reverse factoring does not receive timely information about accounts receivable and credit limits. For tactic usage, empowerment is an essential condition for building credibility. In order to organize the flow of funds and securely record ownership data, it will take several days to verify that the company actually received the goods. The conclusion is that there is a match between the inefficiency of supply chain financial practices and the value drivers of blockchain technology.

To elaborate on the impact on reverse factoring, this paper proposes a framework that combines supply chain finance with digitalization, as depicted in Fig. 3. This paper discusses the potential main value creation of blockchain technology to extend the reverse factoring tool and equip it with the advantages and unique characteristics of the technology. However, creating a new solution requires a perspective that involves all partners in a digital collaboration network. Therefore, Fig. 4 shows an integrated supply chain financial reverse factoring solution based on blockchain technology.

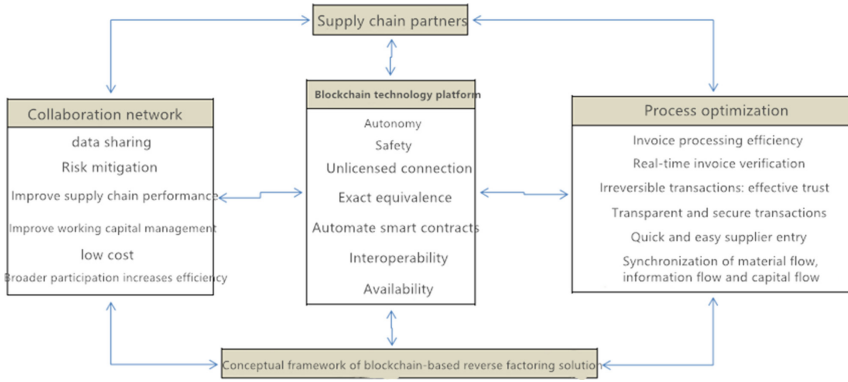


Fig. 4. Conceptual framework of a reverse factoring solution based on blockchain technology

This integrated method has to be implemented across partners’ ecosystem of supply chain. This result will enable participants to obtain up-to-date information related to supplies, data and capital flows, gain a clearer understanding of the supply chain, and reduce potential risks of supply chain failures. Blockchain technology may trigger a new perspective on innovation in the field of supply chain finance, especially in the field of reverse factoring. Compared to other information technology infrastructures, blockchain technology has the capability of enabling databases, which are directly shared between trust barriers. Each party in the blockchain independently testifies and facilitates transactions. This works well as every participant in the system can view the functioning database, access status, and real-time verification of transactions through digital signatures and private keys.

By utilizing blockchain technology as the facility of the ecosystem of supply chain, buyers and suppliers can get connected in the upstream supply chain. At the same time, suppliers of financial institutions do not rely on new onboarding activities. Information on invoice status is transmitted securely, and financiers can offer high-efficiency financing services for any transaction type regardless of the value with lower risk. Similarly, suppliers can connect with customers in this digital system. Credit ratings and supplier assessments are recorded in the blockchain and protected with encryption. If the buyer fails to honor the payment on time or the supplier does not deliver in a timely manner, dynamic adjustments and automatic evaluations are performed. Each participant involved in reverse factoring will further see this information in order to set incentives and improve reliability for all partners. Consequently, all participants can benefit from simultaneous access to data related to transactions, invoices, and payments.

Blockchain technology can also enhance transparency in the supply chain and allow trading entities to coordinate more effectively and reach a new high level of efficiency and responsiveness. Blockchain provides an innovative technology for tracking inventory, overseeing product components, and tracking global footprints. It distributes the origin of the product to all relevant personnel, like the place of production to the end user. It eliminates the need to track projects manually. Blockchain can also set up a formal

registry to identify individual products and keep a record on material ownership at different nodes in the supply chain.

Compared to other IT infrastructures, robustness is another advantage of blockchain technology. It ensures a higher availability of data, and ensures greater fault tolerance working under centralized systems. Blockchain technology enables participating entities to draft smart contracts, and it can automatically enforce contract terms. If participants in a smart contract meet a series of prerequisites, payment can be automatically initiated by the contract agreement in a transparent and efficient way. In addition, blockchain can create a listserv database that records all kinds of data that may be open to all participants in the system. Data can be accessed, shared, and added if appropriate in reverse factoring, but individuals cannot change or delete it at all. People can use a shared ledger and the only authentic information to increase transparency and creditability through a tamper-resistant and error-free system. These advantages play an essential role in blockchain technology as the preferred information technology topology in the context of supply chain finance.

3.3 Dynamic Discounting Use Cases

If effective cooperation among supply chain entities primarily relies on valuable information exchange. Effective integration of information and communication technologies is needed to automatically process business procedures and transactions (Pramatari 2007). Therefore, new financing tools in supply chain finance depend primarily on supply chain links. Blockchain utilizes electronic data interchange and integrated business solutions to optimize working capital and create financial value for relevant organizations (Gelsomino 2016). To elaborate on dynamic discount use cases, this paper proposes a broader concept framework of supply chain collaboration. This proposal can compare the generality of blockchain technology with conventional IT solutions, especially alternative supply chain financial applications.

According to the potential of supply chain cooperation, this paper defines supply chain cooperation as a business procedure in which supply chain participants undertake supply chain work together (Mentzer et al. 2001). Bowersox et al. (2003) extended this definition by incorporating information, resources, and risk sharing. By combining two concepts, this paper adds the first concept component to the conceptual framework. It is made up of six interconnected parts that achieve cooperative advantages by cutting expenditures, response time, distributing resources, and enhancing innovation (Cao and Zhang 2010). Regarding describing and evaluating the differential principles and mechanisms of blockchain technology, this paper adopts concepts of general system theory. Following Boulding (1956), the function, structure and dynamics of technology-based systems introduced a second dimension. Figure 5 shows the conceptual framework of a blockchain-based integrated solution in supply chain finance. Dynamic discounting uses the visibility of trade processes to initiate the dynamic processing of invoices in a buying and selling relation and therefore relies on available technology (Polak et al. 2012). The framework proposed in this paper is the starting point for discussing the premise of integrating blockchain technology in the practice of dynamic discounting.

According to Gelsomino et al. (2016), the procedure of dynamic discounting can be divided into four stages. To check and evaluate relevant value drivers, every stage

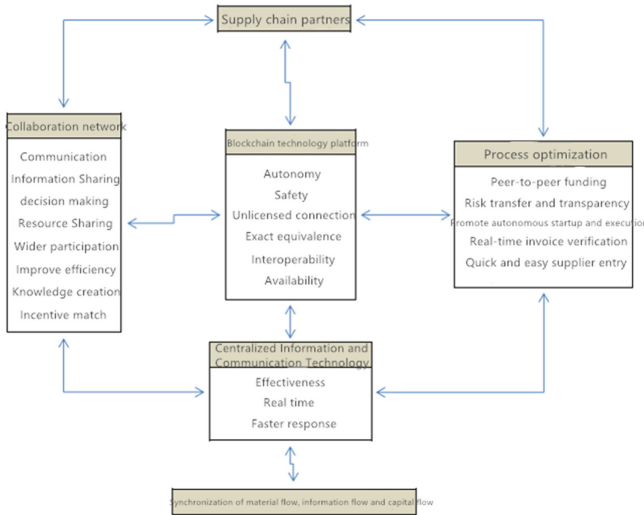


Fig. 5. Conceptual framework of a dynamic discount solution based on blockchain technology

applies elements of the conceptual framework. In this study, we further considered buyer-centric out-of-pocket payments and assumed that invoiced goods were pre-shipped. All procedures are usually performed through a single application, cloud solution, or a third-party supplement based on an incumbent enterprise resource planning system.

Generally, the buyer’s size initiates the transaction by paying suppliers in advance under discounted conditions. Under the agreement, invoice processing occurs when suppliers create, upload, and exchange related documents electronically through electronic data interchange (EDI). This stage is completed when the electronic invoice is electronically delivered to the buyer. In the second phase, the buyer’s size initiates the receipt, reconciliation, and final registration of the required payment to begin defining an repetitive approach to advance payment proposal (EPP). Therefore, the third phase aims to approve the date for payment settlement and discounting of the proposals for such advance payments. Therefore, after the buyer submits an advance payment proposal, the supplier can accept or reject it. If rejected, the buyer may modify the terms and conditions further. If an agreement is reached, this phase is finalized through archiving. With regard to the last step, the supplier and the buyer both store the invoices electronically or physically.

Compared with ordinary information and communication technology platforms, the blockchain technology exhibits valuable advantages in terms of structure. To be specific, in multi-level supply chains or supply networks, distributed databases and interoperability improve data sharing and resource distribution. Combined with its facilities, especially smart contracts, blockchain technology helps, or even speculates the launch of dynamic discount plans. Similar to the multi-standard approach in the process of supplier onboarding, the enhanced availability and auditability of trusted information automates decision making. Thanks to the interconnection of different blockchains, implementing autonomous methods through pegged sidechains becomes feasible. If the flow of funds

across the value chain is built up on the same ledger that connects all components, the risk of early default and shrinking liquidity can be automatically eliminated. For more solvency participants in the downstream supply chain, the parameters of advance payment proposal will be calculated consistently. Regarding the dynamics of blockchain technology, a solution will be applicable to consider not only vertical structures but also horizontal structures. What is decisive is no longer the buyer's current financial situation, but more likely to be the anticipated demand for customer orders in the pulling supply chain. The multi-standard method can also be applied in other cases like transforming physical objects into intelligent attributes and overseeing the material flow on the blockchain.

In general, blockchain technology always represents a more accessible, secure and inexpensive solution. This is particularly the case if the ICT service provider provides funding to the buyer. Under this circumstance, blockchain technology can provide direct funding among parties completely based on a peer-to-peer network that does not rely on intermediary. Although there is no difference in the level of transparency between different techniques, insufficient of blockchain technology remains a major hurdle in the future. In a binary configuration, centralized ICT solutions enable simultaneous data faster. Blockchain technology is still restricted to its consensus mechanism. Therefore, it takes a short while to create a block, because as the time elapses, the security of the entire chain also increases. In addition to these technical features, user cases outline the aspects of supplier-buyer relation in a quantitative way based on autonomy and key characteristics of autonomy. As complexity increases, a solution is recognized that executes decisions within a well-established set of rules based on decentralized resources and group consensus. If the entire supply chain utilizes the same visible information and protocols, the all participants can benefit from it. As for traditional buyer-initiated dynamic discounting, business exhibits significant concentration on independent participants. To make good use of the solution based on blockchain technology, a paradigm switch must be undertaken to obtain a global rather than two single local optimizations between the buyer and the supplier. Therefore, it is assumed that the main value drivers of adoption are key aspects of quality, like transparency and autonomy, rather than efficiency. Finally, the adoption of blockchain technology solutions can largely depend on the supply chain configuration and the market environment per se. Once the technical limitations are overcome and a new consensus mechanism is established, blockchain technology can ultimately have the opportunity to gain significant adoption in a highly integrated supply chain.

4 Conclusion

With digital technologies such as blockchain, the flow of funds can be increasingly streamlined, and all relevant participants can share and oversee financing-related information, including the latest invoice status, check credit limits, and payments in a transparent manner. The new era of digitalization and mobility allows all entities to easily access synchronized supply chain financial information. Participants can continuously check detailed products and transactions digitally. This inclusive infrastructure calls for

a shared ledger which provides any information related to the supply chain, while ensuring the global authenticity and security of data and information. This greatly reduces the cost and complexity of the incumbent systems.

By answering the first research problem and determining the inefficiency of existing supply chain financial instruments, this paper argues that existing challenges demand the digitization of supply chain finance. Emerging technologies can fill in the gap and achieve effective management. The flow of material, information, and funds that are considered to be independent flows can now be synchronized, and all partners can benefit from this new digital infrastructure. In addition to supply chain collaboration and traditional centralized technologies, blockchain technology is a technology that simplifies the flow of information, goods and funds on a digital platform.

By analyzing the main potential of blockchain, this paper approaches the second research question. It proposes a conceptual approach and identify value drivers. The framework revealed the unique value proposition of blockchain technology to aid the implementation of supply chain finance practices. Based on this, supply chain participants benefit significantly from three key features: efficiency, transparency, and autonomy. This paper discusses how the value drivers mentioned above can improve supply chain finance solutions by elaborating on two practices in supply chain finance, namely reverse factoring and dynamic discounting.

Therefore, based on supply chain collaboration, this paper proposes a conceptual framework and defines the technical requirements of supply chain finance practices. Therefore, this paper shows how companies can benefit from blockchain technology, manage their capital flows in their supply chain, and identify how to improve the value drivers of reverse factoring and dynamic discounting services. Blockchain-based reverse factoring and dynamic discounting aid supply chain participants in making independent decisions and smoothing the flow of funds in the supply chain. In addition, it improves the security and service quality of reverse factoring, enabling the entire process to be supervised in a visual and credible manner. This paper argues that interoperability, trust, and robustness are the key drivers of blockchain technology's superiority over traditional information technology infrastructure. The research results also show that blockchain technology provides an open organization platform of supply chain financing for all participants. Discussion on dynamic discounting compares blockchain technology with traditional information and communication technology from the level of structure, function, and dynamic capabilities. Traditional and centralized technologies show higher efficiency in terms of quantitative aspects, such as responsiveness and speed, while blockchain technology offers more qualitative advantages like dynamic discounting. Due to the blockchain-based solution, the interoperability, availability, and trustworthiness of information make it possible to automatically process within a fully peer-to-peer information system. The results show that the choice of blockchain technology over traditional solutions largely depends on the configuration of a single supply chain and the initial trade-offs between quantity and quality aspects. Supply chain technology has been proved to be more suitable for responsive and multi-level supply chains, in which the reliability and availability of information and the automation of decision-making processes lead to less expenditure. While in a stable supply chain with a higher level of

vertical integration and a focus on efficiency, centralized information and communication technology solutions may be preferred.

The research results of this paper show that, unlike other information technology architectures, blockchain technology is a technology platform that endeavors to create transparency, automation, and trust for supply chain financial tools. Based on this, a case-based practice study is proposed to investigate and provide useful applications. Although two solutions have been proposed, specific evaluations of their effectiveness are still yet to be tested. In addition to theoretical discussions, more practical research methods are necessary. Scenario analysis and even simulations can be used to measure both qualitative and quantitative aspects. This will facilitate the further development and widespread adoption of blockchain technology applications.

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