Transforming the Foundation of Supply Chain Finance

The impacts of blockchain technologies on the evolution of the supply chain finance ecosystem

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Abstract

As industrial supply chains are now spanning more countries than ever and reaching mind-boggling levels of complexity, physical supply chains are becoming increasingly efficient at delivering and streamlining value chains to secure a continuous flow of goods. However, financial and information flows within those same supply chains are often still fragmented. This has been particularly exemplified by a trend in the decade since the financial crisis for large buyers to pursue aggressive cash management strategies at the expense of their suppliers.

The recent interest in supply chain finance has in large part grown from an attempt to balance the increasing liquidity concerns and mounting pressures to optimize working capital among companies with a more sustainable approach to financial management in the supply chain. In this context, by building on the advantages of technological platforms and innovations, Supply Chain Finance (SCF) is able to offer a win-win financing alternative for suppliers and buyers, by exploiting the arbitrage opportunities in the difference between their credit ratings.

However, the growth of the SCF ecosystem has been impeded in large part, due to the high level of trust required between the supplier and the buyer to make SCF instruments function, and due to associated legal, cross-border issues and the difficulty to on-board suppliers to SCF programme.

As the quality of the information flows between participants are a determining factor for the success of a SCF programme, Blockchain technology has the potential to fundamentally alter the buyer-supplier relationship in an SCF ecosystem by facilitating trust.

Drawing on the concepts of business ecosystems, diffusion of innovations, and trust and risk, this paper attempts to examine and understand the underlying dynamics of the evolution of the SCF ecosystem with the introduction of blockchain technology innovation. As the blockchain technology is able to inject the needed degree of trust and standardization in the SCF ecosystem for it to expand in scope and scale, the maturity of the blockchain technology therefore influences the rate of adoption of SCF in organizations.

In addition, this thesis takes a particular interest in the relationship between large buyers and small suppliers and presents managerial implications for large buyers looking to develop a blockchain-enabled SCF solution to strengthen the financial strength of its smaller suppliers and ensure greater stability throughout its supply chain.

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1 Introduction

Businesses are increasingly benefitting from spreading their operations across the globe, causing labels such as "Made in Italy" or "Made in China" to become decreasingly accurate – products are now rather "Made in the World". When a customer orders a smartphone today, it might have been assembled in one place, but its components will most likely have come from all over the world. And once it's complete, the provider will able to deliver it at the customer's doorstep within a 24-hour timespan.

As technological advancements in the last couple of decades have allowed us to reach new levels of interconnectivity, industrial supply chains are now spanning more countries than ever and reaching mind-boggling levels of complexity. It has then become essential for retailers to streamline and optimize the flow of goods and avoid supply chain disruptions to service their customers, who often have great expectations as to the quality and short delivery time of their orders.

However, while physical supply chains are increasingly efficient at delivering and streamlining value chains to secure a continuous flow of goods, financial and information flows within those same supply chains are often still fragmented. This has been particularly exemplified by a trend in the decade since the financial crisis, wherein large buyers have pursued aggressive cash management strategies. This has led to several recognizable names being accused of attempting to improve their own cash flow at the expense of their suppliers. Facing public pushback in 2015, the beverage giant Diaego was compelled to reduce its commitment to pay its suppliers in 60-days instead of the initial 90 that it had envisioned (Ruddick, 2015). Yet, while companies like Diaego and Tesco are changing their supplier management practices, not all are prone to change and there are still obstacles for better financial supply chain collaboration.

Large buyers have for a long time wielded a sizeable power over (often smaller and lesser well-established) suppliers, which have had little recourse in the past, but to accept the conditions set by their larger counterparts. However, while all actors in the supply chain across are still feeling the pressure to optimize their working capital – constituting the very source of the existing buyer-supplier imbalances –, there is a growing trend to find more innovative and collaborative solutions to solve a seemingly zero-sum game and to ensure a more stable supply chain.

Yet, while innovation, to create more efficient and reliable supply chains for transporting goods, have long been the center of stakeholders' interests, doing the same for easing financial flows might prove to be more challenging. The financial crisis caused a contraction in lending practices from large multinational banks, thus pushing cash-constrained suppliers to seek financing alternatives, which are often much more expensive. Traditionally, small and medium-sized enterprises (SMEs) often required that their larger buyer counterparts invest capital into their operations in order to stay afloat, which resulted in a higher cost of goods for the buyers. In return, this has led the buyers to financially pressure suppliers, in order to reduce their costs of production, regardless of external conditions. However, in order to avoid disruptions and unstable financial supply chains, these cost reductions need to be managed and balanced across the entire supply chain, not just be passed on to the tier 1 suppliers, i.e. the first direct suppliers to the buyer.

A recent PWC (2018) study showed that working capital optimization is the most important concern for companies in supply chains. Thus, financial pressures applied by large buyers on suppliers lead ineluctably to working capital inefficiencies. These inefficiencies, complemented by other financial risks related to currency exchange volatility and high loan interest rates, resulted in an increase in the cost of the production of goods and services. It has therefore become frequent in classic supply chains to aim towards cash-to-cash cycles of less than six months so to mitigate the buyers' exposure to such risks.

In order to shorten cash-to cash cycles, and to minimize the cost of money and thus the overall supply chain costs, supply chain finance (SCF) refers to the use of short-term credits, in order to balance working capital through a bilateral buyer-seller relationship. SCF allows a simultaneous management of buyers' interests by maximizing their own payment terms and suppliers' interests by ensuring short-term liquidations of invoices.

To do so, the principles of SCF rely on an interest rate arbitrage exercised by a finance partner between a creditworthy buyer and an often less well-established seller. Essentially, SCF leverages the buyer's credit-worthiness to improve the supplier's cash flow. The cash may come from the buyer, a bank or a trade finance fintech. Compared to the classic letter of credit, SCF encompasses new trade finance instruments, including reverse factoring, payables financing, and dynamic discounting.

However, while the finance partner of the buyer is able to assess the risks associated with the buyer's direct suppliers (Tier 1), it is hardly possible with the existing supply chain management (SCM) processes to evaluate the financial risks of an extension of SCF to the buyer's Tier 2 and below suppliers, principally due to the lack of visibility and lack of trust. The access of contractual data below Tier 1 suppliers is not granted to the financial partner of the buyer, who is generally not technically capable of assessing the solvency and the performances of Tier 2 and below firms, which are often SMEs.

Visibility of processes and trust among partners are the two pillars on which blockchain technology is built. The features of blockchain have the potential to be a game changer for business interactions in a global trade context. Within the next decade, blockchain technology (BCT) is likely to implement new customized and secured IT workflows and processes between business partners. Major international companies, such as A.P. Moller Maersk and IBM, are already in the process of integrating blockchain technology in their supply chains operations (De Meijer, 2017). In doing so, they have initiated an evolution of the classic bilateral Buyer-Supplier relationship, towards a multilateral distributed process, based on real time interactions between stakeholders. The visibility and auditability of BCT will then allow financial collaboration across supply chain echelons, not just bilaterally.

As a part of the SCM, a new SCF concept based on Blockchain technology could, therefore, open new fields of financial relationship between SCF stakeholders. Blockchain-enabled SCF platforms will conceivably allow varying degrees of sophistication in terms of workflow, customizability and linkages with standard IT systems between buyers and all tiers suppliers. Consequently, BCT has the potential to fundamentally transform the business model and landscape surrounding SCF, and therefore affect all stakeholders associated. Our paper will therefore focus on answering the following research question:

How can blockchain technology impact the evolution of the supply chain finance ecosystem?

Our research question aims to understand the impacts that blockchain technology could have on the SCF ecosystem as a whole, with a particular focus on the relationship between large buyers and their SME suppliers. SCF is in itself a relatively new and innovative way to think about financial flows in supply chains and moves away from a zero-sum game in supplier-buyer relationships. In its current limited form, SCF has already proven to be a success, however, while firms are increasingly starting to recognize its value, it still lacks the scope and scale to make a profound impact on trade finance. BCT promises to change this, as its principles are maturing and could in the next decade transform the actual classic bilateral business relationship into a totally secured, trusted and transparent multilateral SCF environment.

In order to analyze how BCT may impact the evolution of the SCF ecosystem, our research paper will focus on five main themes:

Theme 1: The key characteristics of a SCF program and the main reasons to implement a SCF solution.

Theme 2: The characteristics of the blockchain technology in the perspective of the SCF environment.

Theme 3: The potential impacts of the blockchain technology on the SCF ecosystem.

Theme 4: The potential impacts of a blockchain technology-based SCF ecosystem on the process of adoption of SCF solutions.

Theme 5: The impacts of the state of the blockchain technology maturity on the evolution of the SCF ecosystem.

1.1 Motivation

Supply Chain Finance and blockchain technology are on the surface very distinct areas of research. However, combined, they have the potential to guide the discussion on how our global economy can provide better access to capital for firms globally at a more fundamental level. Both topics challenge the assumptions and status quo underlying their respective fields in trade finance, supply chain dynamics, and the use of information technologies enabling these transactions.

The novelty of both areas of research has made it up until now difficult to have a serious conversation about their combination. Supply Chain Finance emerged in the end 1990s, but really became relevant following the 2008 financial crisis, as lending for small-medium enterprises worsened. Similarly, blockchain emerged in 2009 as the technology underlying the widely speculative Bitcoin crypto-currency and is only now starting to gain traction as an enabler of trade with far more potential applications and use cases across industries that are worth looking into.

Past research has therefore focused on defining these concepts and providing a common framework of understanding. Our opinion is that both fields have a high degree of complementarity and touch upon many of the same facets of our society and global economy, albeit from different approaches. As the finance-technology dichotomy is increasingly getting blurrier, as exemplified by the continued rise of Fintech, we believe that studying their interaction and co-development will allow to cultivate a more meaningful understanding of dynamics at play in an increasingly fast-paced business world.

On a more pragmatic level, our main motivation to study the interaction of Supply Chain Finance and Blockchain is twofold:

First, advancements in technological innovation are one of the key drivers of global trade. Innovation has always been at the core of socio-economic development, and inventions such as the steam-machine or the Internet have sparked waves of industrial revolutions triggering unprecedented economic growth. The role that technology plays in our society and economy has become self-evident. In 1971, the global export volume of trade in goods stood at around USD 320 billion (UNCTAD, n.d.), and in the same year, the Transmission Control Protocol (TCP/IP) was invented and the Internet was born a couple of years later. By 2014, the global export volume of trade in goods reached a peak of USD 19 trillion (UNCTAD, n.d.). While many other factors influenced the development of global trade in the last 50 years (i.e. the geopolitics of the Cold War, the post-WW2 economic conditions in Europe, the BRICS' rise, etc.), technology advancements are what catapulted it into overdrive. Blockchain technology can be seen as a breakthrough in terms of the global relationships between business partners or stakeholders. It has, like the Internet technology at its time, the potential to create a fundamental shift in global trade worldwide.

Second, the welfare of small and medium-sized enterprises (SMEs) constitutes the fabric of our world economy's growth. SMEs account for almost 70% of the total employment and more than half of the trade value-added in the OECD area (OECD, 2018). From start-ups to mature middle-sized manufacturing businesses, SMEs are central to the well-functioning of any economy. Yet despite their evident importance, accessing capital is a challenge, as the majority of traditional financial institutions are hesitant to provide credit to riskier firms with lesser revenue potential, especially so following the 2008 financial crisis. Going forward, alternative financing solutions and technological innovations could change SMEs attractiveness to lenders and reduce the uncertainty surrounding the viability of their businesses. SMEs are often part of large buyers' supply chains and therefore subject to their financial pressure, mainly on cash flow managements. These pressures strongly hinder their day-to-day performances and their ability to grow in the long term.

Supply Chain Finance and blockchain are both innovative solutions that have the ability to create a sustainable business model for SME financing worldwide. Therefore, understanding the dynamics underpinning both concepts and the rationale for their mutual adoption would set the base for a guided discussion on the future of global trade based on SCF using blockchain technology.

1.2 Outline

In order to answer our research question, we have divided our thesis into seven key parts that detail the methodology chosen, the theoretical background and address each of the five themes of our overall research question.

Section 2 discusses our chosen methodology, research philosophy and the scope of our research.

Section 3 analyzes the relevant theories applicable to Supply Chain Finance and information technologies and creates a theoretical framework to guide our ensuing analysis.

This section introduces the concept of business ecosystems and applies it to Supply Chain Finance as a field of study. A particular emphasis is placed on the role of information technologies, such as the blockchain technology, in enabling the development of the Supply Chain Finance ecosystem. We therefore also introduce the construct of the diffusion of innovation to guide our understanding of the impacts of BCT on the evolution of the SCF ecosystem later in the research.

Section 4 is related to the first theme and provides an in-depth explanation of the concept of Supply Chain Finance and its key characteristics. Additionally, it aims to understand the rationale and the mains reasons behind the adoption and the implementation of SCF solutions for different stakeholders and argues for the soundness of its business proposition.

Section 5 is related to the second theme and presents the main characteristics of blockchain and its merits as an innovative information technology.

This section aims to answer two sub-questions:

(1) What are the main limitations of existing technologies in relation to the formation of trust in transactions and how are these issues solved by BCT?
(2) What are the main characteristics of BCT in relation to a SCF context?

Section 6 and **Section 7** are related to the third and fourth theme and constitutes the core of our analysis: it combines both the Supply Chain Finance and blockchain concepts using the frameworks laid out in Sections IV and V. It is divided into two key parts.

First, **Section 6** provides an in-depth analysis of the impacts of integrating blockchain technology into Supply Chain Finance solutions on the SCF ecosystem as a whole. Through a clearer understanding of the underlying dynamics involved in a blockchain-driven SCF ecosystem, we will therefore be able to anticipate the effects that BCT will have on the trading relationships of buyers and sellers within a given supply chain.

Secondly, **Section 7** takes an in-depth look at the criteria for adoption of SCF. Drawing on organizational innovation adoption theories, it will investigate the changes that a blockchain-driven SCF ecosystem has on firm's adoption process of SCF.

Section 8 is related to the fifth and final theme and comprises the second half our analysis. This section first situates the state of the blockchain innovation diffusion and argues for the timeframe of the blockchain evolution. It then takes a wider perspective to assess the global impacts on the SCF ecosystem as the Blockchain-SCF concept matures. This section concludes by presenting the managerial implications for firms contemplating developing a blockchain-based SCF solutions for their supply chain.

Finally, **Section 9** will conclude our paper with a discussion on the implications our research.

2 Methodology & Scope

This section will present both our chosen methodology for the paper as well as the scope of our research.

2.1 Methodology

The purpose of the following section is to define and justify the research methodology used in the thesis. This will be done by first presenting the research philosophy, process and design. Afterwards, the method for data collection and analysis will be discussed.

2.1.1 Research Philosophy

The purpose of this thesis is to uncover the impact that blockchain technologies (BCT) may have on the SCF ecosystem. In doing so, we are trying to fulfil a research gap, which exists between two separate academic studies: the interaction between BCT and SCF and their co-evolution. At the time of writing, no other academic paper that we are aware of have attempted to apply a theoretical framework or model to analyze this distinctive relationship between the two subjects. Existing literature on the subject of the link between BCT and SCF has had a predominantly "operational" focus. Our hope is then to contribute to the current literature by filling this gap with an initial conceptual approach.

The theoretical framework chosen to investigate this connection is primarily based on the Business Ecosystem framework by Moore (1993) and the Diffusion of innovation theory by Rogers (Rogers & Shoemaker, 1971). The framework and theory are combined to uncover how the adoption of innovation technologies such as BCT may affect the evolution of SCF ecosystems.

The methodologic approach applied in answering the research question is qualitative and is done through an abductive analysis. An abductive analysis is defined as: *"a cerebral process, an intellectual act, a mental leap, that brings together things which one had never associated with one another"* (Reichertz, 2009, p. 7). Abductive analysis is therefore ideal for our research question, as the purpose of this thesis is to combine two different branches of academic literature, which has scarcely been done by existing literature. The research approach is therefore based on abductive reasoning. An abductive reasoning approach entails obtaining a pre-theoretical understanding of the theories literature and the theories to be used in the analysis. This pre-theoretical knowledge thereafter forms a lens, through which the researcher can observe a phenomenon at hand. In such a way, the researcher does not implicitly try to prove a theory, but instead works towards *"discovery of an order which fits the* *surprising facts; or, more precisely, which solves the practical problems that arise from these.*" (Reichertz, 2009, p. 17). Therefore, according to Dudovskiy (2018, p. 84), a researcher using abductive reasoning can utilize multiple different methods in addressing the research question. In this way, the approach may overcome many of the weaknesses associated with deductive or inductive approaches (Dudovskiy, 2018).

The choice of data analysis approach used in the thesis is that of an abductive-themed thematic analysis to answer the research question. A thematic analysis is defined as a "*method for identifying, analysing and reporting patterens (themes) within data"* (Braun & Clarke, 2006, p. 79). This process, while simple, should follow a set of distinct steps. According to Braun & Clarke (2006), these are:

1.) Familiarizing yourself with your data
2.) Generating initial codes
3.) Searching for themes
4.) Reviewing themes
5.) Defining and naming themes
6.) Producing the report

This approach was chosen because it allowed us to find themes among a comprehensive and fragmented literature. These themes were therefore necessary, as they allowed us to find common patterns throughout the various sources of information gathered. The codes used throughout the data included terms such as: "trust", "decentralized", "interoperability" and so on. These codes helped us find common themes in data, where the intention of the data was related primarily to one area of the academic field. For example, in articles focusing on blockchain, the codes would primarily be related to the opposite field, such as: "supply chain management", "trade finance" and "trade trust", and vice versa for SCF related material. In this way, the use of such a flexible method was well suited for an under-researched topic without many specific use cases. This flexible approach, as argued by Braun & Clarke (2006), makes the thematic analysis untied to any particular epistemology or theoretical perspective.

2.1.2 Research Design

A vital part of the research lied in conducting an extensive literature review of the relevant topics. This initial literature review acted to determine possible research themes and gaps within the existing literature. This literature review was then used as the basis for a more in-depth exploration of the themes within the existing literature. By identifying and structuring the themes uncovered in the literature review, the data was applied in relevant theories to answer the research question above.

Additionally, the empirical analysis of our thesis is structured around two main thematical analyzes. The methodology and analysis approach of these is covered in detail at the beginning of Sections 6, 7, and 8, corresponding to our analysis I and II.

2.2 Scope

As the breadth of research approaches surrounding understanding the impact of BCT on the evolution of the SCF ecosystem is immense, we have decided to confine our scope of research to a couple of perspectives: first, we acknowledge the fact, that some of the potential impacts driven by the adoption of the blockchain technology on supply chain solutions are not exclusive and could be extended to other sectors, which could in turn have indirect effects on the SCF ecosystems. However, we consider it to be out of the scope of our paper as we believe that the direct impacts of BCT on the SCF ecosystem will have a greater influence on its development than the potential indirect effects of other BCT applications.

Second, to enhance the relevance of our analysis, we have decided to narrow the scope of our research on SCF to the relationship between large buyers and SME suppliers rather than discuss its implication on international sustainable development or multinational corporations' financial cooperation. The main reason for this is that SCF solutions have a much bigger potential impact on the competitiveness of SMEs, and therefore greater implications for economic growth, than established multinational corporations.

Third, while we believe that SCF has the potential to have meaningful practical implications for international sustainable development or developing economies in emerging markets, it is out of the scope of this paper given that our focus is to develop an overall understanding of how blockchain technology may improve opportunities in Supply Chain Finance processes on a conceptual level.

Given our SME focus, we will focus on the use of Supply Chain Finance Instruments for working capital optimization as will be explained later in Section 4.

2.3 Methods of data collection

In the collection of data used in the research, we chose not to include any interviews as the primary data. This decision was made, due to the difficulty in finding interviewees with insight into both Blockchain and Supply chain finance. However, the information we received from the few informal unstructured conversations we conducted helped to guide and inspire our research.

For this reason, the data of the thesis will consist of research white papers, academic journals and related publications from various academic and private organizations. This material was collected from January 2018 to December 2018. The majority of the material was collected using Google as a search engine and the CBS's online library databases, including, but not limited to, EBSCO, SpringerLink, Statistica, Cambridge Journals, Emerald Insights, JSTOR, Oxford Journals, Wiley Online Library. The most frequent keywords used in the search were those of "Blockchain technologies, Supply Chain Finance, Digital trust and Trade finance". However, although there were many hits for each search keyword, there was a very limited amount of literature, which had a combination of above keywords. Moreover, of those hits that did have a combination of these keywords, most were primarily not from academic sources, but instead from financial institutions or consulting firms, while the remaining had a strictly "operational" focus. This scarcity of academic literature on the combination of BCT and SCF helped us to identify the topic as a research gap in the supply chain management literature and further motivated the formulation of our research question.

3 Theoretical foundations

The next section will present the theoretical concept underlying Supply Chain Finance (SCF) and blockchain technologies (BCT). We will first introduce the concept of the Business Ecosystem as first introduced by Moore (1993) and apply it to the SCF context.

Then, looking upon different aspects of SCF, we have identified two main areas of literature, which complement the dynamic ecosystem model of Moore and provide more theoretical foundations with predictive characteristics for our ensuing analysis in Section 6 and 7:

(1) **Diffusion and Adoption of Innovation:** according to Moore's model, the SCF ecosystem evolves as a dynamic ecosystem instead of a static value proposition. SCF ecosystem is highly influenced by technological advancements, such as Internet or blockchain technologies. Thus, we will consider Roger's theory conceptualizing the diffusion and adoption of innovation in organizations.

(2) **Trust and Risk:** The notions of trust and risks are interrelated and represent important factors in the market structures. More precisely, trust is an important recurring theme throughout our thesis, since it is closely related to how risk is perceived for the financing instruments within SCF ecosystems. Thus, we will consider the theories conceptualizing the notion of trust and apply them to the blockchain technologies in order to understand its impacts on the essence of the trust relationship between trading partners and therefore on the nature of the risk assessments performed by the financial institutions willing to support SCF.

This section will be divided in three parts. The first part introduces Moore's (1993) concept of the Business Ecosystems. The second part presents the diffusion and adoption of innovation by Rogers (2003). Finally, the third part conceptualizes the notions of trust and risks, crucial enablers of trade finance.

3.1 Business Ecosystems

Moore (1996) defines a business ecosystem as "*an economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies.*"

At its core, a business ecosystem revolves around multiple networks of diverse organizations and institutions that are interconnected and are bound together by the shared value (or failure) of the entire ecosystem. It takes a larger conceptual scope than the organizational unit and, applied with a technological perspective, actors work together in symbiosis around a core technological innovation or platform. An example of such an ecosystem is the Microsoft Windows operating system, around which countless firms deliver services, software, hardware and other 'Microsoft Windows compatible' offerings.

As mentioned earlier, Moore (1993) introduces the idea of that a business ecosystem is dynamic and has identified four stages of its evolution: Birth, Expansion, Leadership, and Self-Renewal. Inspired by parallels to biology, Moore (1993) argues that multiple ecosystems co-exist, co-develop and compete against each other across each stage so that ultimately structures and distinct leaders rise and establish themselves. Each stage has its own distinct characteristics:

Birth is the entrepreneurial stage, wherein an ecosystem is born from the emergence of a seed innovation, and actors within it are figuring out, through trial and error, how to distinguish themselves from competition and offer a differentiated value proposition. The particularity of this stage is that through heightened cooperation, the involved actors are able to co-create and capture new value-adding solutions that are beyond the scope of any individual capabilities or resources. Therefore, at this stage, interactions between companies are primarily cooperative.

In the Expansion stage, firms have established their value proposition and offerings based on a common underlying value platform and are focusing on scaling up to gain as much market share as possible. Competition in this stage intensifies as firms race to impose themselves as leaders of their market. Here, first-mover advantages and speedy expansion play in firms' favor.

In the Leadership stage, as firms focus on growth and profitability, ensuring a certain degree of stability and standardization in a company's operations in terms of processes and supply becomes important. Actors with influence in the ecosystem are then those who can address a need that the ecosystem has. By this time a leader has established himself and focuses on retaining that position.

Finally, the Self-Renewal stage arrives when an external threat looms over the ecosystem and threatens to disrupt the existing balance of power. This usually happens through environmental changes, such as new regulations, major macroeconomic changes or shifts in customer patterns, or through innovations that have the potential to render the industry obsolete (such as with the impact of the advent of streaming services like Netflix on video-renting services like Blockbuster).

In order to stay competitive, the leaders of a given ecosystem might therefore need to undergo profound structural or cultural changes.

These stages often overlap without any clear distinct delimitation as to the end of a stage and the beginning of the next one.

	Cooperative Challenges	Competitive Challenges
Birth	Work with customers and suppliers to define the new value proposition around a seed innovation.	Protect your ideas from others who might be working toward defining similar offers. Tie up critical lead customers, key suppliers, and important channels.
Expansion	Bring the new offer to a large market by working with suppliers and partners to scale up supply and to achieve maximum market coverage	Defeat alternative implementations of similar ideas. Ensure that your approach is the market standard in its class through dominating key market segments.
Leadership	Provide a compelling vision for the future that encourages suppliers and customers to work together to continue improving the complete offer.	Maintain strong bargaining power in relation to other players in the ecosystem, including key customers and valued suppliers.
Self-Renewal	Work with innovators to bring new ideas to the existing ecosystem.	Maintain high barriers to entry to prevent innovators from building alternative ecosystems. Maintain high customer switching costs in order to buy time to incorporate new ideas into your own products and services

Table 1: The Evolutionary Stages of a Business Ecosystem (Moore, 1993)

We argue that Moore's business ecosystems describe with a high level of relevance the SCF ecosystems and its dynamic evolution in the context of the development of the Blockchain technology.

We will come back to the notion of business ecosystem stages of Moore (1993) and apply it to the SCF ecosystem and the Blockchain technology development later in Section 4 and 5.

3.2 The diffusion and adoption of innovation

The adoption of new technology by firms in a given business ecosystem is one of the fundamental driving forces that serve to change the shape of the overall ecosystem. In innovation literature, there are several theories, which describe the adoption of innovation in organizations and individuals alike. Rogers (2003) developed a Diffusion of Innovation theory, which has its roots on his seminal work in 1964 and is one of the oldest comprehensive theories in the school of social sciences. The theory has subsequently been revised several times by other academics and Rogers himself.

3.2.1 The diffusion of innovation theory of Rogers

The theory of Rogers aims to explain how an idea or product gains momentum over time and diffuses through a specific population or social system. The result of this diffusion is that people, influenced by the social system in which they belong, adopt the idea or product believing it to be better and more innovative than other alternatives (Rogers, 2003).

The adoption of innovation, however, does not occur simultaneously by all individuals in a social system, but at different points of time. The moment when an individual adopts an innovation points to certain individual characteristics, which allows them to be categorized as innovators, early adopters, early majority adopters, late majority adopters, or laggards (Rogers, 2003). For this reason, the rate of diffusion of the innovation, i.e. how quickly it is disseminated through the categories mentioned above, also reveals certain characteristics about the technology itself, such as the limits of the technology's potential or what barriers it must overcome to spread throughout the population.

The categories can be seen in the picture below and include five different groups of adopters, each of which have their own defining characteristics and are mutually exclusive.

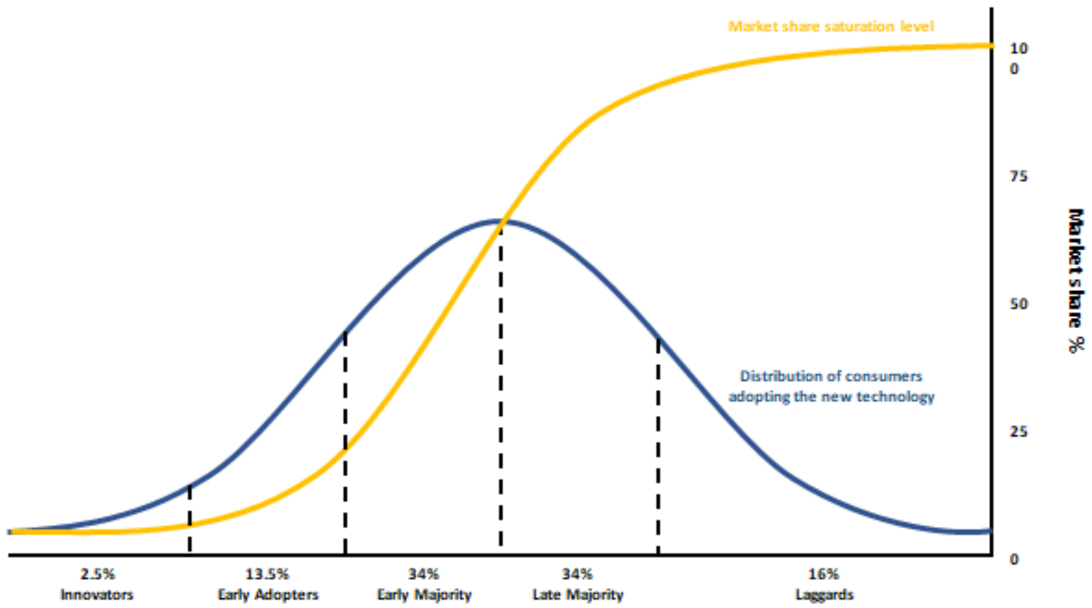


Figure 1: Diffusion of innovation model adapted from Rogers (2003)

Innovators: The first 2.5% to adopt an innovation are labelled innovators. Innovators are pioneers of innovation. They are characterized as being adventurous with new technologies and usually have significant financial backing and expertise with technology. Innovators will also be willing to accept higher probabilities of failure and levels of risk when attempting to adopt the new technology.

Early adopters: Next in line are the early adopters, which consist of the next 13.5% to adopt the innovation. These are often well established in their social systems and will often act as change agents who accelerate the technology adoption and diffusion. The early adopter aims to gain first mover advantage, by utilizing the technology early, but is often exposed to the relatively high risks and implementation issues associated with the uncertainty surrounding the technology at this early stage.

Early majority: The next 34% to adopt the innovation is the early majority. Individuals in this group will typically adopt an innovation once they have seen it successfully adopted by either "innovators" or "early adopters". They will typically wait to adopt the innovation until they are comfortable with it.

Late majority: The late majority consists of the next 34%. Late majority are characterized by being more skeptical and cautious of technology improvements. Individuals in this group are typically difficulty convinced or pressured from others to adopt.

Laggards: The last remaining 16% to adopt are the laggards. Laggards are characterized as being highly suspicious of the benefits brought about by new technologies and innovators, and will typically focus on past decisions or standards instead until they are forced by external pressures to adapt (for instance with the introduction of new standards based on these innovations). In many cases, when a laggard has adopted an innovation, the innovators will already have moved on to the next innovation.

In addition to assessing the dynamic pattern of the diffusion of innovation curve through a specific population or social system, Rogers (2003) also defines an innovation adoption stage model within an organization, wherein factors influencing the decision to adopt and the organizational implementation of an innovation can have hindering or accelerating effects on its overall diffusion.

3.2.2 Rogers' steps to organizational adoption of innovation

The decision for an organization to adopt an innovation follows a sequential process with several stages (Rogers, 2003). Analyzing innovation decisions through this stages-framework, defined by

Rogers, could help resolve complex issues with multiple structural variables. For instance, centralized organization or organizational slacks can potentially lead to various impacts on the internal capability of a firm to innovate (Rogers, 2003). Rogers's model helps to classify organizations in more details than simply in terms of adopters and non-adopters of innovation.

Moreover, Rogers' model can relevantly be applied to SCF adoption in addressing predominantly organizational innovation adoption by opposition to the downstream innovation adoption, which focuses on diffusing an innovative product or service to end-consumers.

Rogers (2003) explains that the mechanics of adopting an innovation in organization is done through five main sequential stages, each Rogers (2003) explains that the mechanics of adopting a process innovation in organization is done through five main stages. More precisely, it consists of five sequenced stages, each characterized by a particular set of timely events and decisions. Stages in the innovation process, defined by Rogers (2003), cannot be undertaken until all earlier stages have been achieved. The five stages are included in two phases, as described below (Figure 2):

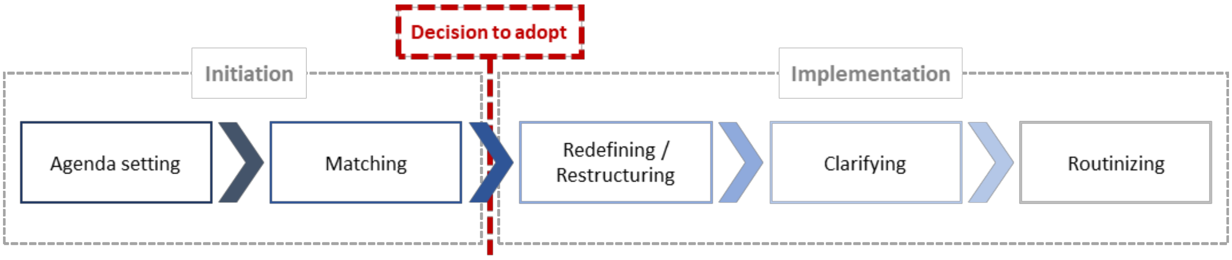


Figure 2: Innovation adoption stage model adapted from Rogers (2003)

***Initiation phase encompassing the Agenda-setting and the Matching phases*:**

This phase materializes the process leading to the decision to adopt an innovation. It consists of the gathering of all the relevant information, then conceptualizing, and planning for the results of the adoption of an innovation.

- The Agenda-setting stage deals with information concerning general organizational issues and the value-added potential of an innovation to the organization.
- The Matching stage is about planning and designing the potential match between problems from the organization's agenda with the innovation's potential to resolve them.

Implementation phase encompassing the Redefining/Restructuring, the Clarifying and the Routinizing phases:

This phase encompasses all of the events, actions, and decisions needed to implement an innovation.

- The Redefining/Restructuring stage is twofold: first, it acts to adapt and redefine a given innovation in order to fit the organization. Secondly, it acts to alter or restructure an organization if needed to accommodate the innovation.
- The Clarifying stage consists of defining clearly the relationship between the innovation and the organization as the innovation is gradually put into use within the organization.
- The Routinizing stage is about integrating the innovation in the organization and insuring that the innovation becomes eventually a regular practice in the organization's ongoing activities.

This innovation adoption stage model does not require distinguishing the degree of newness of the innovation between stakeholders. Thus, applied to SCF, the innovation might be initially perceived as early adopting for suppliers and as routinizing stage for the buyers, given timing differences in terms of the introduction of the innovation.

Eventually, when a routinizing stage is reached for all the stakeholders of a SCF, then a structure of buyer-supplier relationships is finalized. Still, in the routinizing stage, the SCF innovation may be new to late-adopting suppliers that board on to the already established SCF platform of the buying firm (see Johannessen, Olsen, & Lumpkin (2001)).

3.3 Trust and Risk

Trust is an important recurring theme throughout our thesis, since it is closely related to how risk is perceived in business transactions. Daignault et al. (2002) argues that some characteristics of trust are no longer relevant, or are transformed, when observed in an online context.

Technological innovations, as described later in Section 5, have the ability to alter the fabric of societies and foundational matters, such as the way trust is perceived. Trust has traditionally been relational and based around the rapport between a trustor and a trustee. However, through digitalization, technological innovations such as blockchain have now the technical ability to incorporate trust as a feature of their processes and build a trust economy, which as a result can mitigate financial risk in SCF solutions.

This section will first focus on outlining the interactions of the concepts of uncertainty and risks with trust. We will then study the implications of trust in trade finance.

3.3.1 Uncertainty, risk and trust

The concept of uncertainty and risk have a blurry distinction in mainstream economics. Uncertainty can be defined as "*the unpredictability of environmental or organizational variables*" (Miller, 1992) and stems from the lack of complete information or knowledge on future outcomes. Risk attempts to put an estimate on the probability or likelihood that this unpredictability will result in an undesirable consequence for a given organization. A risk analysis is then a subjective probability judgement based on the perception of its source, consequence, timing and vulnerability to negative outcomes, and is often displayed as a matrix comparing its likelihood or probability and the degree of severity of its consequences (Cox, 2008).

Calculating risk through probabilistic judgements allows actors to mitigate uncertainty (Friedman & Savage, 1948; Schoemaker, 1982). The most famous example of this is through the theory of expected utility maximization: as rational actors, people are able to mitigate uncertainty by weighing every possible outcome that reflect their own preferences with their respective probabilities and then add them together. Essentially, in mainstream economic theory, risk is the result of a subjective and rational probability calculation (Friedman & Savage, 1948; Savage, 1954). As uncertainty is fundamentally synonymous with the unknown, "*probability measures the confidence that a particular individual has in the truth of a particular proposition*" (Savage, 1954, p. 3). Therefore, according to the rational mainstream economic literature, we can always approximate the impact of uncertainty through a probabilistic risk calculation.

However, situations of ambiguity exist, where "*randomness cannot be expressed in terms of exact probabilities*" (Natarajan et al., 2011, p. 103), in which cases uncertainty cannot be mitigated by risk calculations and actors therefore need to rely on trust to push forward business interactions, cooperation and transactions. We therefore define trust as the product of social relations, in which the actors in the relationship expect positive outcomes, despite the existence of uncertainty. These positive expectations are based on the combination of factors such as the actors' good intent, their respective competencies or abilities, and their accountability to each other (Hardin, 2002). While this differs from the traditional rational calculation view of risk, it does not mean that trust is necessarily always blind, but rather it can be studied without requiring to calculations (Sabel, 1993).

This view of trust follows an economic sociology approach, which argues that trust-based decision-making rests on social networks (Das & Teng, 2004). Essentially, it simplifies the act of taking a decision, however, given its subjective nature in that it is based on individual judgements in a social relation context, it is not insurable or cannot be commoditized as is the case with rational risk calculation (Das & Teng, 2004). This is because, different stakeholders might also have differing perceptions of risk on the same situation, which points to the distinction between perceived risk and objective risk. Thus, while reaching a decision might be more complex in a rational calculation of risk, the framework in which the decision is made is based on standardized risk calculations, such as statistical models, that are widely accepted as being closer to an objective view than a trust-based judgement (Das & Teng, 2004). In that context, rational calculation of risk can therefore be traded on secondary markets, as is the case with asset-backed securities for instance. Financial institutions therefore rely heavily on this type of rational-calculation risk assessment to limit their own risk exposure when lending.

3.3.2 Trade finance and trust

As trade finance's – and by extension, supply chain finance – underlying objective is to mitigate risk, trust has therefore a significant effect on the commercial relationship between trading partners. In order for a trade transaction to be successful, the element of trust needs to be present in multiple relationships: the buyer-seller dyad, the trading partners and their respective banks, and between the banks handling the financing. This network of trust-relationships creates a trust-sphere in trade finance. As such trade finance instruments are often selected according to the degree of trust existing between each actor in these transaction-based trust-spheres, which can be seen as the product of two types of trust: reliability trust and decision trust.

Reliability trust is *"the subjective probability by which an individual, expects that another individual, performs a given action on which its welfare depends"* (Jøsang, et al., 2005, p. 2), while decision trust is "*the extent to which a given party is willing to depend on something or somebody in a given situation with a feeling of relative security, even though negative consequences are possible*" (Jøsang, et al., 2005, p. 2). These notions of trust are especially present in supply chain finance settings, which will be described in depth in the following sections: for instance, firms expect their suppliers to act in a specific way in order to ensure the continuity of the flow of goods in their supply chain, and therefore offer them SCF solutions to strengthen the reliability of their supply chain. Similarly, financial institutions provide the needed financing to these suppliers based to a certain extent on the trust they have in the supplier to perform given the external market conditions.

SCF is often perceived as a "program" wherein the supplier, the buyer and (often) the bank enter into a contractual tripartite arrangement over the long-term to secure a collaborative advantage. In this context, we can qualify an SCF program as a non-equity alliance, i.e. an inter-firm alliance that does not include equity transfers but is rather based on contractual arrangements, in which the issue of cooperation becomes central. According to Das & Teng (1996), as organizations face a 'totality of risks', which are often perceived subjectively by each stakeholder, cooperation between the trading partners is the basis for the success of an inter-firm alliance in addition to the ability of the firm to adapt to its environment. Das & Teng's (1996) focus lies in describing the risk considerations that firms need to have before entering an inter-firm alliance. Given that these forms of alliances require cooperation, a key risk dimension stems from the uncertainty surrounding the partners' future behaviors, and therefore two types of risk, that incorporate the element of trust described above, exist in inter-organizational cooperation situations (Das & Teng, 1996): relational and performance risk.

From an integrated risk perspective, relational risk refers to the possibility of a difficult cooperation between the partners, while performance risk relates to the hazards surrounding the accomplishment of the shared strategic goals (Das & Teng, 1996). These two risks are conceptually independent as relational risk is based on the internal dynamics of the cooperation, while performance risk is dependent on factors external to the alliance and related to developments in the business environment, such as political risks pertaining to new regulations or market risks as exemplified by increased competition. Ring & van de Ven (1992, p. 92-93) summarize it best: relational risk can be defined as "*uncertainty whether the parties will be able to rely on trust*" and performance risk as "*uncertainty regarding future states of nature*". Therefore, relational risk is then based on the degree of reliability trust that exists in the SCF program and performance risk is built on the degree of decision trust that each actor in the program invests in its success.

3.4 Section summary of theoretical foundations

In the preceding Section 3, the relevant theories applicable to SCF and information technologies such BCT, were highlighted, which form the theoretical framework to guide our ensuing analysis. This included the Business Ecosystems of Moore (1993) and extended it to the Supply Chain Finance ecosystem. In addition, the diffusion of innovation theories by Rogers (2003) were highlighted as a relevant tool to better understand the impact of the implementation of BCT in the SCF ecosystem. Finally, the Section 3 has studied the notions of Risk, Uncertainty and Trust and analyzed their application in the context of SCF.

The next section will provide a comprehensive explanation of the concept of SCF, its key characteristics, and its rationale for adoption.

4 Background: Supply Chain Finance

Supply Chain Finance (SCF) is an elegant solution to a seemingly difficult problem. Included in a larger supply chain context, SCF aims essentially to solve the direct conflict that exists between suppliers and buyers in terms of payment terms by offering a credit rate arbitrage to facilitate the smaller supplier's access to liquidity and allow both sides to improve their working capital by extending payment terms to the buyer and providing imminent payment to the supplier.

This section first examines, based on an overview of the market, the increased need for alternative financing in supply chains over the past decade.

Second, while there is not yet a unilateral consensus about the scope of SCF, we provide a definition that we believe is most suited to the direction in which SCF will develop.

Third, there are many different types of instruments that qualify as SCF; some are in use and others are purely conceptual. We give an overview over the key characteristics of SCF instruments available in practice and theory, and provide a more in-depth presentation of Reverse Factoring, which is currently among the most popular uses of SCF instruments, and Purchase Order Finance.

Furthermore, we also take a more pragmatic approach to this question by identifying the key players among those stakeholders which are the most relevant in the SCF context and therefore define four main types of actors: the giant buyers (often large multinational corporations that can be identified as Fortune 500 companies), the large buyers, the small suppliers generally the SMEs, and the financial intermediaries (i.e. banks).

Finally, we will examine the rationale for onboarding SCF programs, looking more closely on the question of the working capital optimization and the liquidity management, then the importance of the technology in SCF and finally the main challenges faced by SCF worldwide implementation. The analysis will be focused from the point of view of the different stakeholders potentially involved, namely the buyer, the supplier, the financial institution, the solution provider and the government.

4.1 The market case for SCF

In the last decades, global trade has boomed and has developed an ever more interconnected world economy, in which organizations and institutions are now able to share knowledge and trade goods at speeds unequalled in history in a seamless manner. Technological innovations, and in particular, the advent of the Internet, has been the catalyst of the explosion of global trade, allowing firms to operate around the world simultaneously, by breaking down transaction costs and weakening barriers to trade. Since 1980, the value of the world's exported goods has increased from USD 1.96 trillion (in current USD) to USD 17.88 trillion in 2017, with a peak of USD 19.09 trillion in 2014 (The World Bank, n.d.-a). This trend pushing forward the globalization of trade and the interconnectedness of markets have had significant implication on the level of competitiveness that firms need to achieve in order to strive. In the race for competitive advantage, global value chains have emerged and along them, an increased complexity that organizations now need to streamline through leaner logistic processes, optimized informational and material flows, and higher levels of transparency.

Research within supply chain management has therefore evolved from exclusively management and logistics concerns (including quality control and inventory management, amongst other things), to growingly more financial and economic considerations associated to a firm's supply chain. This change naturally reflects the shifting reality of the relationships between supply chain actors as new financial opportunities emerge, which promise to enhance the overall value of the supply chain.

Firms have often relied on trade credit, i.e. the elongation of payment terms toward suppliers and/or shortening of cash settlements with customers, as an important source of funding. In the UK alone, Summers and Wilson (2002) estimated that 80% of all B2B transactions are based on trade credit. Given that it helps improve working capital, trade credit is often a preferred solution in comparison to taking bank loans, even for firms with a strong credit rating (Petersen & Rajan, 1997). In the context of a supply chain, however, having suppliers with lower credit ratings, who thus pay higher interest rates, can have a value destroying effect on the chain. The most poignant example of this is the global financial crisis of 2008-2009. As the credit crunch caused banks to recede on their loans originating, which in turn also increased the associated interest rates. Ivashina & Scharfstein (2010) perceived that corporate risks increased dramatically, as a considerable number of non-financial companies suffered from a credit rating downgrade post-crisis (Chava & Purnanandam, 2011). The combination of increased perceived credit risk, stricter capital requirements under the Basel and Dodd-Frank (in the U.S.) regulations and the worsening of credit ratings following 2008, eventually led to a contraction in trade financing from growingly risk-averse banks (Asmundson et al. , 2011). As liquidity dried up, firms adopted more aggressive cash management strategies, by pressuring trade credit terms in both ends of the supply chain, increasing the risk of causing a liquidity shortage throughout the chain (L. F. Klapper & Randall, 2011). Liquidity shortages in a supply chain affect suppliers the hardest, as late payments and defaults are transferred upstream (Raddatz, 2010). According to Boissay & Gropp (2007), the recoup of one in four liquidity shocks is alleviated by suppliers along the supply chain.

Working capital management has then become an important tool to ease the tension on the supply chain and access dormant funds by lengthening the suppliers' payment terms or shortening the customers' settlement time. Companies today are still pursuing some form of aggressive cash flow management, as a way to either free up cash for dividends, share buybacks or investments (Ng, 2013), or even sometimes to ensure that the company has a safety cushion in case of any upcoming potential positive (or negative) economic opportunities. This, however, puts a tenuous stress on suppliers, especially smaller ones, which now, more than ever, need to find alternative ways to finance their operation.

Larger multinational corporations are also starting to recognize the potential detrimental effect of having an unstable supply chain and are looking for ways to help strengthen it through selected supplier. This is because, while large multinationals were able to remain fairly stable following the crisis, the small and medium-sized enterprises were the ones most troubled by the banks' risk aversion to lending, in a context of higher demand volatility, higher savings, macroeconomic instability and sovereign spreads.

Ideally, there would not be any trade-off between buying organizations' extension of payment terms and the SMEs' easy access to capital, and both would benefit from holding cash longer. Alternatively, buying firms could also benefit from early or on-time payment discounts to their suppliers, which would provide competitive enough returns, compared to other investment opportunities. Similarly, suppliers could benefit from easy and relatively inexpensive access to capital, either from their buying counterparts or through banks.

This context created the conditions for the development of new financial management solutions, such as inter-organizational working capital management. Supply chain finance (SCF) is an attempt to reach this optimum (Hofmann, 2005; Pfohl & Gomm, 2009), sometimes through the use of technology providers and/or financial institutions (Chen & Hu, 2011; Lamoureux & Evans, 2011). SCF provides a wide range of financing instruments, which will be described in further details in the subsections below and is part of wider global trade finance, which has an estimated financing gap, i.e. the quantity of financing demanded in trade finance that is unmet and cannot be accessed (especially for SMEs in emerging markets), of 1.5 trillion USD in 2017 around the world (ADB, 2017).

According to a McKinsey study (2015), the market for SCF solutions is expected to grow in the next decade up to a transactional volume of USD 4 billions. Furthermore, the Aite Group (2014) has estimated that the potential market for reverse factoring, one of the most classic supply chain finance instruments, weighs from USD 255 to USD 280 billion, worldwide.

Firms use SCF to extend days payable outstanding, while reducing days sales outstanding, therefore increasing the volumes of trade. "*The strategic relationship between supplier, buyer, and a bank would naturally prevent either party from failing to deliver on mutual contractual obligations*," according to Eugenio Cavenaghi of Banco Santander (IFC, 2017, p. 1). SCF solutions constitute attractive market opportunities for financial institutions such as banks.

As a matter of fact, the SCF sector is growing rapidly. The SCF Barometer 2017 of PWC (2017) observes that more and more businesses are coming to SCF and offering it to their suppliers for the first time. In this context, reverse factoring on a bank platform remains the most widely used SCF option. According to Çagatay Baydar, Factoring Chain International (FCI) Chairman (FCI, 2018): *"Looking back at the first statistics on factoring from 1969, FCI reported factoring volumes of about USD 22,700 million while in 2017, FCI reported EUR 2,598 billion, with a growth of 9% over 2016. FCI members account for 60% of the global factoring volume. Europe showed a 7% increase, South America 12% increase, North America 3% decrease, Africa 6% growth, Asia 18% increase and the Middle East 7% increase".* Moreover, Demica highlights in one of its research papers, that SCF associating major international banks, is growing by a rate of 30% to 40% a year (David Bannister, 2013).

4.2 SCF definition

Supply Chain Finance is a relatively new field of research within the broad operation-finance interface literature, combining elements from the supply chain management, corporate finance literature, among others. Establishing a clear and standard consensus on the definition of SCF has been a challenge over the last decade, given the lack of academic literature and clarity on the subject. Templar et al. (2010) says it plainly: *"Defining the true nature of SCF in itself appears to be difficult: model, discipline, technique, product or program?"* Today, numerous and varying definitions already exist (see Appendix 12.1).

Yet, while there are various ways to define it, it is broadly accepted that three main schools within the SCF literature exist (Templar et al., 2010): SCF as financial supply chain management, SCF as supply chain financing, and SCF as buyer-driven payables solutions.

First, SCF can be viewed as the *"optimized planning, managing, and controlling of supply chain as flows to facilitate efficient supply chain material flows"* (Wuttke et al., 2013, p. 1). A more detailed definition is provided by Blackman et al. (2013, p. 133) and defines SCF as *"the network of organization and banks that coordinate the flow of money and financial transactions via financial processes and shared information system in order to support and enable the flow of goods and services between trading partners in a product supply chain"*. SCF is then related to anything to do with finance in the supply chain broadly speaking, and goes farther than receivables and payables or working capital optimization. It covers the entire supply chain and moves in the opposite direction to the physical material flow, wherein financial flows flow from buyers to suppliers (Hofmann & Belin, 2011). Linking SCF with the physical supply chain constitutes a narrower view than Templar et al. (2010)'s financial supply chain management definition, which places SCF in the larger supply chain management literature context. In Hofmann & Belin (2011)'s definition, SCF is not exclusively made of financial flows, but also incorporate information flows, technology and data, and other supply chain processes that support the financial transactions.

Second, SCF can be seen as the ensemble of financial instruments that increase the financial flexibility of a firm and optimizes its use of monetary flows in a supply chain. The Euro Banking Association (Bryant & Camerinelli, 2014, p. 5) defines it as "*the use of financial instruments, practices, and technologies to optimize the management of working capital, liquidity, and risk tied up in supply chain processes for collaborating business partners*". Pfohl & Gomm (2009, p. 151) further define it as *"the inter-company optimization of financing as well as the integration of financing processes with customers, suppliers, and service providers in order to increase the value of all participating companies"*. It provides a narrower scope than the first definition in the sense that it focuses specifically on a couple of financial instruments rather than the whole ensemble of processes that support the financial management of the supply chain. Trade financing, working capital financing, and supplier financing constitute elements of the ensemble fitting this definition (Templar et al., 2010).

Finally, whereas the second definition takes its departure in the comprehensive set of financial instruments, that can be used throughout the supply chain, defining SCF as the buyer-driven payables (or payables finance) solutions of supplier financing narrows the scope even further to only a handful of financial instruments. Synonyms and variations include Approved Payables Finance, Confirming, Trade Payables Management, Buyer-Led Supply Chain Finance, Vendor Pre-Pay, Confirmed Payables, and Reverse Factoring, amongst other. This definition is particular and unique from the other two in the sense that it points more to a financing technique, rather than a holistic category. Payables Finance is *"provided through a buyer-led program within which sellers in the buyer's* *supply chain are able to access finance by means of Receivables Purchase"* (GSCFF, 2016, p. 9), but mainly refers to Reverse Factoring. Reverse Factoring is the most common instrument used by large companies and represents a soft variation of Payables Finance, in which "the lender purchases accounts receivables only from specific informationally transparent, high-quality buyers. The factor only needs to collect credit information and calculate the credit risk for selected buyers, such as large, intentionally accredited firms" (L. Klapper, 2006, p. 3117). Reverse Factoring has been the most researched SCF instrument to date (Hofmann et al., 2017), and various large companies, such as Volvo, Unilever and Walmart, have started to test its application in their supply chains over the last decade (Blackman et al., 2013).

Nevertheless, as the field matures, so does its definition: the Global Supply Chain Finance Forum (GSCFF, 2016, p. 8) has in 2016 attempted to provide a standardized definition of supply chain finance and defines it as *"the use of financing and risk mitigation practices and techniques to optimise the management of the working capital and liquidity invested in supply chain processes and transactions. SCF is typically applied to open account trade and is triggered by supply chain events. Visibility of underlying trade flows by the finance provider(s) is a necessary component of such financing arrangements which can be enabled by a technology platform."* A key insight worth underlying in this definition is that of the elements that compromise SCF, such as working capital optimization and visibility over supply chains, play an equally important role. However, this definition understates the importance of technology, as the reliability and viability of SCF instruments is increasingly dependent on the underlying technology platforms being used in its execution, as will be described later in the section.

Five key characteristic elements worth paying attention to emanate from this definition: Firstly, SCF is a portfolio of instruments, which aim to facilitate trade both in terms of financing and risk mitigation. It is associated with the physical supply chain, across geographies, and loosely relates to the broad set of techniques, which are both mature and in development, that will help the firm achieve the level of financial flexibility it requires (GSCFF, 2016).

Second, SCF is often used in the context of open account trading, in which an invoice needs to be paid in a pre-determined timeframe by the buyer (who is the entity responsible for completing the transaction) after the delivery of the goods or services by the supplier, contrary to paying cash in advance or utilizing trade instruments to secure the payments (GSCFF, 2016).

Third, the parties involved in SCF transactions are built around the buyer-seller relationship in a supply chain. These entities interact with finance providers in order to provide the appropriate financing to their respective transactions, either through traditional trade finance or SCF instruments. These parties often have similar, and even conflicting, agendas, among which to ensure the stability of their supply chain, increasing their liquidity, mitigating their risk, or improving their overall financial performance and balance sheet efficiency (GSCFF, 2016).

Fourth, the initiation of SCF initiative is 'event-driven', in the sense that it is connected to the timeline of the physical supply chain. Financial providers are then looking for sources of funding according to the different triggers existing along the supply chain, from pre-shipment processes to purchase orders, receivables or invoices. In this context, the more oversight and control there exists in the supply chain, the more opportunities are available to automate the SCF funding possibilities in the financial supply chain (GSCFF, 2016). Therefore, technology innovation and platforms play a crucial role in the well-functioning of SCF processes.

Finally, it is important to understand SCF as a constantly evolving set of practices, which include both established ones and more novel techniques, as well as the use of more traditional forms of trade finance. Additionally, these techniques are seldom used in isolation from one another and are often intertwined with other supply chain services.

Moving forward in line with our research objectives, this paper will follow the definition provided by the GSCFF (2016) as the master definition of Supply Chain Finance. This is mainly because the GSCFF has attempted to provide a common and comprehensive set of definitions for academia and practitioners to use. Moreover, it provides a precise definition, that closely relates seeing SCF as supply chain financing, which is not too broad, unlike defining SCF as financial supply chain management, and not too narrow as with SCF as buyer-driven payables solutions. Nevertheless, as we will show in this paper, we believe that this definition underestimates the role of technology in SCF. We therefore use this definition with a hint of criticism and use it as basis to take a more in-depth look at the relevant SCF components, based on a common frame of understanding for the ensuing analysis.

4.3 Overview over SCF instruments

There are a wide range of SCF instruments. Most of them involve a buyer, a supplier and a financier partner. We will first study the main characteristics of SCF instruments and then focus on describing one of the most widely used instruments to date: Reverse Factoring. We also show an example of a pre-shipment SCF instrument to contrast with Reverse Factoring, which is a post-shipment instrument.

4.3.1 Characteristics

In order to develop a comprehensive conceptual framework of SCF solutions, we will consider each of the four principal elements impacting the characteristics and the choice of the SCF instruments: (1) the timing of the trigger event, (2) the focal point of credit risk, (3) the availability of collateral, and (4) the financed elements in the balance sheet (Zhao & Huchzermeier, 2018).

First, SCF instruments can be typically understood as being part of three different groups in terms of the trigger event timing: (1) Pre-shipment finance, (2) In-transit finance, (3) Post-shipment finance (see figure 3 below). The trigger event timing refers to the time at which the SCF instrument is initiated and is closely related to the product's cycle across the supply chain.

- Pre-shipment finance involves financing a supplier's working capital needs, such as raw materials, inventory, personal and general costs, before the delivery of goods. The collateral is generally a purchase order rather than an invoice, which increases the overall credit risk given the higher level of uncertainty surrounding the product's delivery. In order to reduce the high interest rate associated with the high credit risk, the finance provider could then use the buyer's solid creditworthiness as collateral for advancing cash to the supplier (Zhao & Huchzermeier, 2018). As an example, this kind of SCF instrument can be used in the launch of a new product by a buyer, which requires additional capital investments on the supplier side, and therefore would increase the ease of implementation.
- With in-transit finance, financing is provided with a loan, based on the value of the product and on a certain quantity and quality of the goods, which are being transported. Here, the collateral is the product in-transit, and the credit risk is therefore less than with pre-shipment financing (Zhao & Huchzermeier, 2018).
- Finally, with post-shipment finance, a financial provider provides loans based on the accounts receivable of the supplier and uses invoices (or similarly trusted documents) on the buyer as collateral. The credit risk, and thus the interest rate on the loan, is therefore low (Zhao & Huchzermeier, 2018).

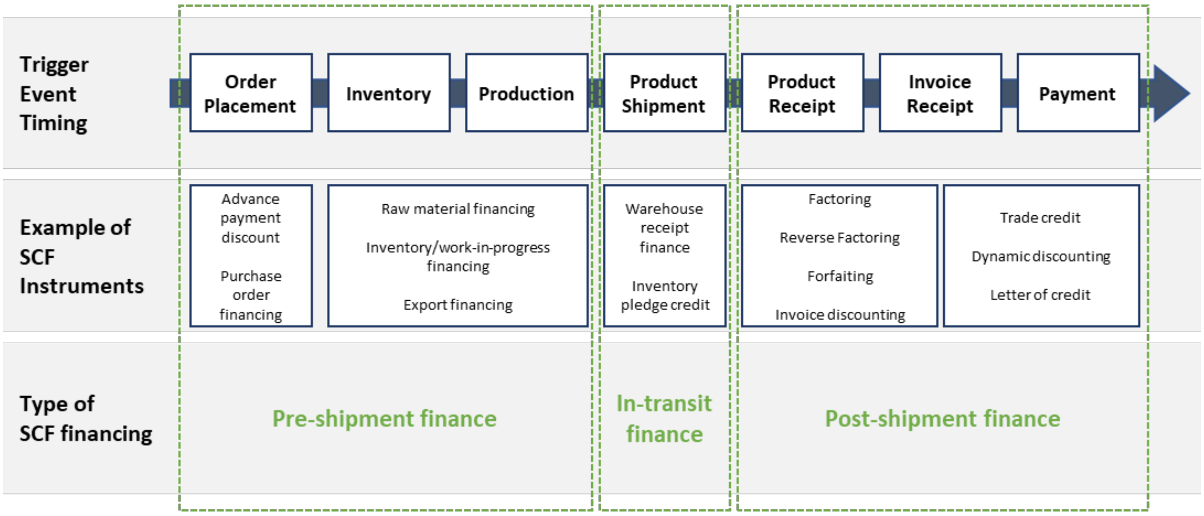


Figure 3: Timing-based classification of SCF instruments adapted from Zhao and Huchzermeier (2018)

Secondly, SCF instruments can be characterized according to their focal point of credit (Bryant & Camerinelli, 2014).The focal point of credit, that is the balance-sheet item equivalent of the cash being used for the finance provider to provide liquidity, can be based on accounts receivables for the supplier, inventory-related, or accounts payables for the buyer (see figure 4 below). With regards to account receivables finance, a financial provider transforms the supplier's account receivables into early cash payment, based on the credit rating of either the buyer or the supplier that guarantees the loan. Inventory-related finance is based on the inventory or purchase order and therefore usually has higher interest rates applicable than with collateral such as invoices and provides capital to either the buyer or the supplier. Finally, accounts payable finance, guarantees the payment by the buyer through extended payment terms, early cash discounts or a finance provider's guarantee. Here, the interest rate is entirely based on the buyer's creditworthiness.

Figure 4: focal point of credit risk-based classification of SCF instruments adapted from Zhao and Huchzermeier (2018)

Thirdly, SCF solutions can be characterized in terms of the availability of collateral, being either "arm's-length" or "relationship" financial instruments (Zhao & Huchzermeier, 2018). This type of categorization is strongly correlated with the type of relationship existing between the trading parties. Whereas "arm's-length" type instruments rely on collateral that is verifiable and tangible, such as invoices or purchase orders, and salvageable in the case of a defaulting contract, "relationship" type instruments are more dependent on mutual trust. This leads to looser forms of non-binding contracts and is often based on the history existing between the supplier and the buyer. While "arm's-length" type instruments' specific credit risk is much more accurately evaluated, knowing the overall credit risk of a lender is much easier to evaluate in the latter case. The reason is because it is based on the intimate knowledge of the supply chain parties developed through a long-standing relationship. The financial provider can then better understand the borrower's creditworthiness and do a valid evaluation and management of the associated credit risk.

Finally, the nature of the financial instrument being used has different implication on the balance sheet, its ownership and therefore on the financing opportunities for firms, depending on whether they are equity-related, fixed assets, or working capital elements (Zhao & Huchzermeier, 2018). Equity-related finance involves injecting funds through the external investors, and therefore a partial transfer of ownership of the firm. This includes, but is not limited to, selling shares to existing shareholders, mergers and acquisitions, and initial public offerings, to name a few. Given that this has the potential to change the ownership structure of a firm, it can also therefore have an impact on the competitive landscape of the supply chain indirectly. On the other hand, fixed-asset finance is based on the company's existing tangible (and often long-term) assets, such as real estate property or equipment, as collateral for a loan. Finally, working capital finance is relatively more short-term as it relates to being able to finance the day-to-day operations of the firm (rather than equity-related investments or long-term fixed assets finance) by injecting liquidity in the supply chain by using items such accounts payables as collateral (Zhao & Huchzermeier, 2018). Until now, real-life application of SCF instruments have mainly been focused on working capital finance, however, it is conceptually feasible that equity-related finance or fixed assets financing could also be used as sources of funding for the supply chain.

4.3.2 Reverse Factoring and Purchase Order Finance explained

This part provides a more in-depth look at the reverse factoring and purchase order finance instruments[1]. The reverse factoring instrument is considered a post-shipment instrument (generally classified as receivables purchase-based). This part also presents a pre-shipment instrument

[1] For a full list of all the possible SCF instruments conceptually feasible, see Appendix 12.2. Also see the in-detail description of the dynamic discounting SCF instrument, second most used amongst practitioners, in Appendix 12,.4

(generally classified as Loan/Advanced-based) as an example of the breadth of SCF instruments available.

Today, reverse factoring is the widest used type of SCF instrument and reflects at its heart the very motivation for developing SCF solutions. Therefore, having a practical understanding of how such an instrument works helps to construe a solid understanding of the benefits and risks associated to SCF instruments.

4.3.2.1 Reverse Factoring model

According to the 2016 SCF Barometer Survey by PWC (2016), 89% of the respondents use primarily reverse factoring, while pre-shipment instruments are significantly less common.

In a typical reverse factoring model, the buyer's credit rate is essentially the means by which to grant the supplier a cheaper access to liquidity than it would otherwise have had. The Global Supply Chain Finance Forum (GSCFF, 2016, p. 9) defines it as *"a buyer-led program within which sellers in the buyer's supply chain are able to access finance by means of* Receivables Purchase. *The technique provides a seller of goods or services with the option of receiving the discounted value of receivables (represented by outstanding invoices) prior to their actual due date and typically at a financing cost aligned with the credit risk of the buyer. The payable continues to be due by the buyer until its due date"*.

In this model, there are typically 3-4 parties: a buyer, a supplier(s), a finance provider, and usually a third-party technology firm who provides and manages the SCF instrument (and who can sometimes act as the finance provider, e.g. in the case of fintechs).

The steps in this reverse factoring timeline are as follows:

1. The supplier or a number of suppliers agree on a commercial contract with the buyer who then places the order. The buyer onboards these suppliers in a SCF program, which in most cases is only offered to the buyer's top suppliers, who are likely to have a relatively better than average credit rating, compared to their peers (Jeffery et al., 2017).
2. The purchase order is sent to the buyer with the relevant payment details
3. Once approved by the buyer, the finance provider or third-party technology firm, is given notice of the purchase order and offers an early payment option to the suppliers instead of leaving them waiting for the full extent of the payment terms on an open account basis. For instance, the finance provider can pay the supplier in 15 days or less instead of the 30 days that it would need to wait for with the buyer.

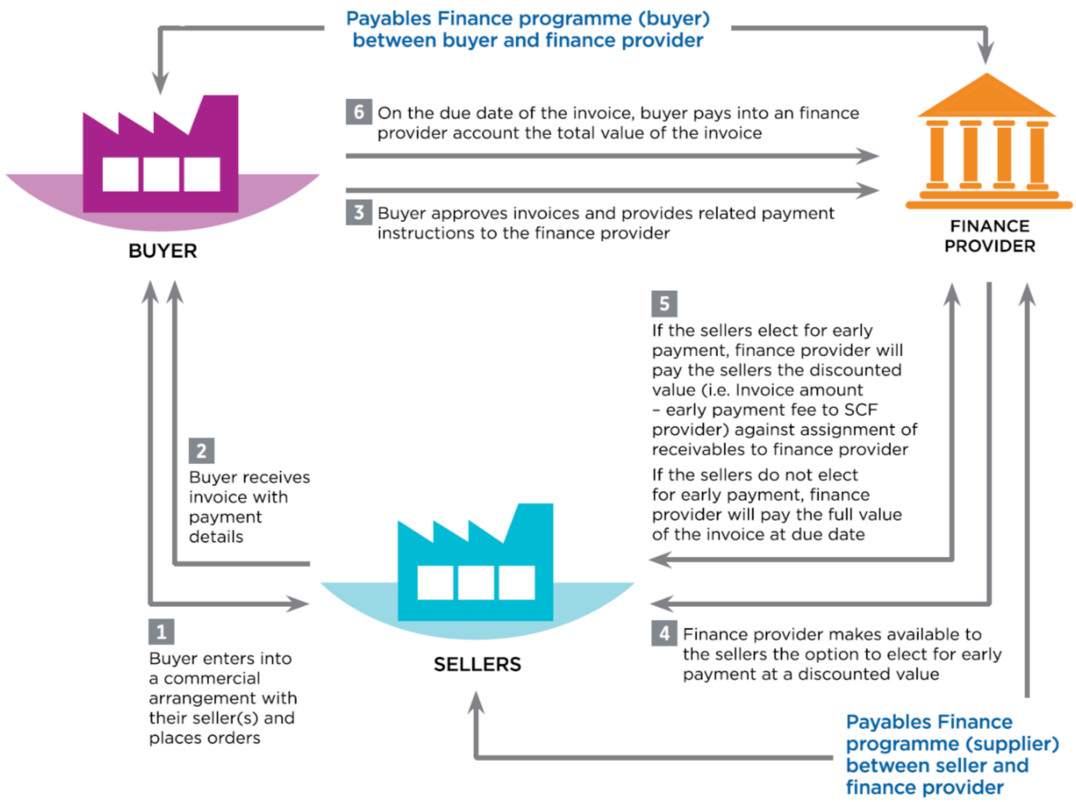


Figure 5: Reverse Factoring model (GSCFF, 2016). Here, "Payables Finance" is synonymous to "Reverse Factoring".

4. If the suppliers opt for an early payment option, the finance provider will offer to buy the supplier's account receivables associated with the invoice at a discount. The discount is generally acceptable for suppliers as it is based on the creditworthiness of the buyer, who acts as a guarantor, and will therefore not need to have recourse to a higher rate of direct financing. For example, instead of accepting a 5% interest rate in the form of a bank loan, suppliers might receive a 2-3% through SCF financing, which is translated as a discount on the total value of the goods purchased (Jeffery et al., 2017). This is possible as buyers are typically larger and more creditworthy than their smaller supplier counterparts.
5. Given its liquidity needs, the supplier therefore decides whether to accept the discount offered to receive early payment from the finance provider or wait for the full value of the invoice paid directly by the buyer at a later date. If the supplier chooses the early payment option, the buyer is then able to negotiate a new agreement with the finance provider, in order to extend their Days Payable Outstanding (DPO), which would otherwise not have been possible (Jeffery et al., 2017). For instance, instead of paying in 30 days, the buyer could negotiate with the finance provider to extend the terms to 120 days, allowing the buyer to hold on longer to its cash to use it for other purposes.

6. At the payment date, the finance provider is then able to generate a return through the discount that it provided the supplier with, as the buyer has to pay the full value of the invoice to the finance provider.

Traditional SCF is mainly viable for suppliers with lower credit ratings than buyers, given that it is based on the creditworthiness of the buyer, or sometimes the strength of the outstanding invoices. Thus, typically, these suppliers tend to be smaller than the buyers and view SCF as an attractive alternative to traditional direct financing with high interest rates from financial institutions as they are generally viewed as riskier from these same institutions.

The benefits for each party involved in using reverse factoring transactions are then evident[2]:

- **Suppliers** can be payed sooner and therefore lower their Days Receivable Outstanding (DSO) in order to satisfy their liquidity needs. Despite the discount on the payment they receive, suppliers gain from a relatively cheaper cost of financing than they would otherwise have been able to secure on their own.
- **Buyers** are able to push their payment date further out, thereby extending their Days Payable Outstanding (DPO) and benefit from a more flexible working capital. Holding on to cash allows buyers to use it in value-adding endeavors, such as with longer investment periods to generate higher returns or repay other more pressing short-term liabilities. Generally, SCF programs tend to be more successful for large corporate buyers who benefit from holding onto their cash for longer.
- **Finance providers** essentially are able to generate a return much in the same way that they do with traditional loans. By giving out early payment at a discount to the suppliers, and receiving the full amount of the invoices from the buyer at a later date, they are able to enjoy a net profit in a relatively risk-free manner, as large buyers have high credit ratings.

As is the case with most SCF instruments, multiple variations of this model exist, such as including the option of recourse, in which the factor, i.e. the finance provider, can require the supplier to pay some or all of the cost of the invoice in case of default from the buyer. This usually is rarely the case, and the most widespread use of reverse factoring can currently be found in developed economies, where buyers have high credit ratings (GSCFF, 2016).

[2] For a numerical example of the benefits of Reverse Factoring, see Appendix 12.3

4.3.2.2 Purchase Order finance (Pre-Shipment Finance)

As SCF is gaining momentum and expanding in scope, the industry is moving from a one-dimensional focus on Reverse Factoring towards an increasing number of available instruments. An example of the breadth of SCF instruments available is then at the other end of the supply chain spectrum with pre-shipment, purchase order finance.

Purchase order finance (or pre-shipment finance) is defined by the Global Supply Chain Finance Forum (GSCFF, 2016, p. 10) as "*a loan provided by a finance provider to a seller of goods and/or services for the sourcing, manufacture or conversion of raw materials or semi-finished goods into finished goods and/or services, which are then delivered to a buyer. A purchase order from an acceptable buyer, or a documentary or standby letter of credit or Bank Payment Obligation (BPO), issued on behalf of the buyer, in favor of the seller, is often a key ingredient in motivating the finance, in addition to the ability of the seller to perform under the contract with the buyer*"

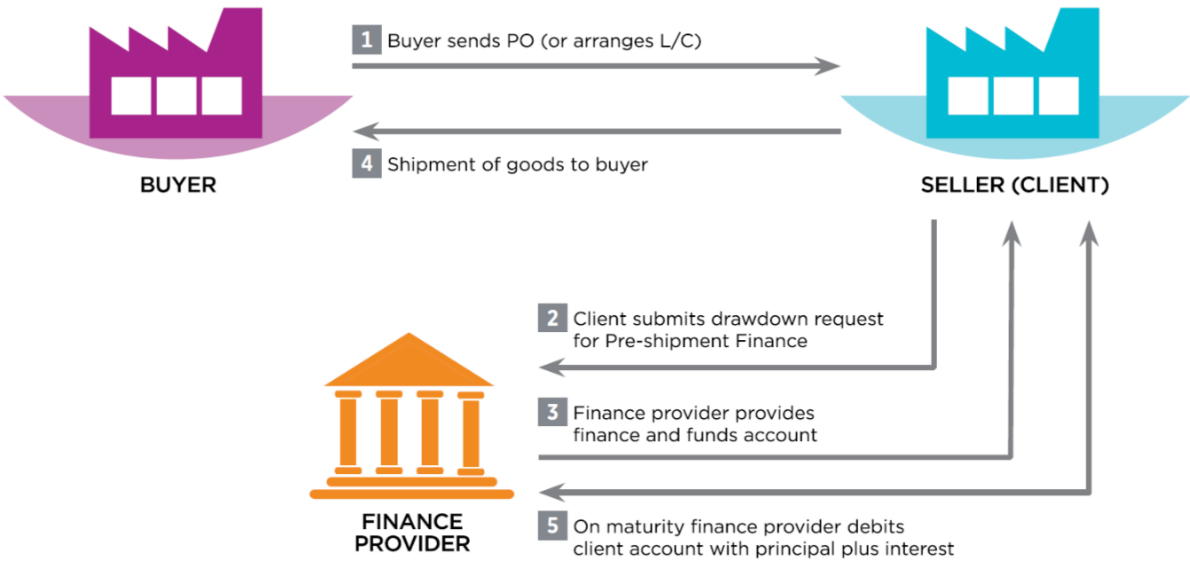


Figure 6: Purchase Order Finance (Pre-Shipment Finance) Model (GSCFF, 2016)

Until now, we have presented SCF instruments that were triggered after the delivery of products or services. Purchase order finance allows providing liquidity to the supplier at the origination of the purchase order by the buyer. It then covers the working capital needs of the supplier and allows him to finance the procurement of raw materials, the labor and packaging costs, all the way to the delivery to the buyer. There are multiple variations of this model, however it is essentially based on the purchase orders (either approved or unconfirmed by the buyer), commercial contracts or even sometimes demand forecasts (GSCFF, 2016).

The finance provider will then likely provide the financing required through a percentage of the total value of the invoice and distribute it in stages at key points of the production process. Typically, in such a transaction, the buyer is not a part of the financing solution, but might be the basis for the percentage that the finance provider is willing to give to the supplier. The percentage would then be determined, through a combination of the flow of sales proceeds by the buyer, and the commercial relationship history it has with its supplier. This form of financing can be seen most notably in Asia (GSCFF, 2016).

It is important to note that each SCF instrument has different risk profiles, depending on the nature of the instrument's characteristics as described in the subsection above. A key risk in this form of financing then comes from the performance risk of the supplier, which is dependent on his ability to perform on the purchase order, as well as the buyer's willingness and ability to pay on delivery. Here, the buyer's creditworthiness and reputation are also key elements in mitigating the associated risks (GSCFF, 2016).

The benefits are then only seen for the supplier and the finance provider, which is why a purchase order finance solution is seen as a seller-led loan/advanced-based SCF program.

- **Suppliers** benefit from early access to capital in situations in which alternative forms of finance are likely unavailable or extremely expensive.
- **Finance providers** benefit from this instrument much in the same way that it does with reverse factoring in that it is able to generate a return on a loan. However, this type of financing is riskier given that it also depends on the performance of the supplier to deliver. The finance provider therefore needs greater reassurance and control and will likely only extend this type of financing to trustworthy and reliable suppliers who enjoy a solid trading relationship with the buyer.

4.4 Stakeholders

SCF is relevant for different types of actors for varying reasons. For instance, mature multinational corporation might not need to optimize its working capital to survive. However, it would benefit from its smaller suppliers having a more solid financial foundation. We therefore take a closer look at the reasons for adopting SCF for multinationals, small-medium enterprises (SMEs), and financial institutions.

Giant firms (Fortune 500 or S&P 500) – high liquidity levels & expensive supply chains

For some of the world's largest organizations, the current business environment has resulted in the stockpiling of massive amounts of cash. While one of the root causes for this tactic, could be to avoid taxes on money being brought back to the corporation's homeland (and thus stockpiling it overseas), many also see it as a strategy for ensuring that future economic crisis do not result in a draw on cash. In either case, these firms are cash-rich, and many have begun looking for opportunities to put their cash to work. For those that are involved in a supply chain, these companies tend to be buyers with thousands of globally distributed suppliers (Jeffery et al., 2017).

Large global buyers – borrowing in greater quantities & emphasis on working capital management

As the world's largest organizations stockpile cash, the situation faced by many other large firms is one of increasing debt. For those with favorable credit ratings, low interest rates offered by banks have caused many firms to borrow in greater quantities. The result is that corporate debt skyrocketed to 51 trillion USD in 2016 and is expected to reach 75 trillion USD by 2020 (S&P Global Ratings, 2016). As debt continues to rise, these firms face increasing pressure to generate returns on their cash, which is causing them to place greater emphasis on working capital management. As many of these firms are buyers, working capital strategies often involve extending payment terms with suppliers in order to hold onto cash for longer.

Large multinational corporations have an incredible pull and power over their respective hundreds of suppliers around the world. However, as their supply chain are growing increasingly complex and globalized, mitigating the risk of any supply chain disruption is a key concern for large multinationals, which includes optimizing operational processes in the supply chain as well as taking a particular interest in managing financial flows throughout the supply chain (Protopappa-Sieke & Seifert, 2010). With thousands of suppliers across multiple geographies and going down multiple tiers, the wide network of buyers, suppliers, financial providers and logistic service providers, compose a complex web of isolated interactions and scattered financial agreements (Hurtrez & Salvadori, 2010). Aligning the interests of the different actors by sharing and communicating through these large supply chains, without information being fragmented or lost in the way, therefore presents a complex task for multinationals.

Identifying inefficiencies in inter-organizational process and streamlining them throughout the supply chain, could help unlock previously idle capital stuck in companies' working capital, as products and services are delivered but not payed for yet. Roubert (2013) highlights that as much as EUR 200 billion of excess working capital is wasted due to inefficiencies, such as delays in delivery, poor inventory management and unfavorable payment terms. Additionally, in Europe, suppliers are often short for cash, as buyers take an average of 59 days or more to pay after the delivery of products and services, given the typical 30 days payment terms. This put smaller suppliers in precarious situations, in which they often have to employ trade credits in order to receive their cash flow earlier. And as the distance from the large investment-grade buyers increases, so does the financing costs for suppliers, as their credit grade is often judged as riskier, due to their small size and dependencies on these large actors (Ng, 2013)

Practically speaking, this has a considerable impact on the welfare of small suppliers and, by extension, the well-functioning of the supply chain that large multinationals are dependent on.

Small suppliers – direct financing from banks is expensive or unobtainable & have long payment terms with buyers

The biggest challenge facing small and mid-sized enterprises (SMEs) is the difficulty to access liquidity. This is the consequence of two main trends: first, SMEs are often deemed riskier and thus have a lower creditworthiness than their larger counterparts, which hinders their ability to secure affordable financing from traditional financial institutions. Second, as mentioned earlier, the SMEs' larger buying counterparts often exercise their influence to extend the payment terms, that these suppliers face, therefore putting a strain on the SMEs' ability to cover their day-to-day operational costs of doing business. The World Bank Group (n.d.-b) estimates, that finding affordable direct financing from either banks or large corporate buyers has become increasingly difficult, as over 50% of SMEs globally lack the necessary financing that they need in order to grow.

Banks – highly regulated & risk-averse

For banks, the current landscape is one of heightened regulatory and compliance-related expectations. Many new regulations, such as Basel III, were created to address weaknesses in the banking sector, that became apparent because of the crisis. To comply with these regulations, banks have been forced to de-risk their balance sheets and become much more risk-averse (Jeffery et al., 2017). As a result, banks are now more cautious about whom they lend to and have become particularly wary of lending to smaller companies with lower credit ratings while still remaining more than willing to lend to larger companies with higher credit ratings. However, as alternative financing solutions are increasingly being offered by fintechs, these traditional financial institutions are growingly coming to realize that the SME segment represent the largest, and currently relatively untapped, revenue potential in the market. Traditional financial institutions will therefore need to adapt if they are to stay competitive (Jeffery et al., 2017).

The overall impact on supply chains points to the need for SCF solutions

The challenges outlined above for each stakeholder have a significant effect on interfirm collaboration within the supply chain. By looking to optimize their working capital and liquidity management so to retain their cash reserves longer for other business uses, large buyers have imposed lengthier payment terms onto their suppliers. This has been particularly the case in recent year, as a low-interest rate economic landscape has meant that firms have had to wait longer to generate returns. Yet, for small suppliers that depend on these large buyers, and who generally have a relatively low bargaining power, it has exacerbated the time they must wait to get paid, and therefore worsened their ability to grow.

The average Days Payable Outstanding (DPO) globally was 64.5 days in 2016, with the North America region being the lowest at 51 days, and the South America region being the highest at 75 days. Additionally, as SMEs experience greater difficulties in accessing affordable direct financing from banks, who are wary of lending to what they perceive as risky small companies with low credit ratings, many SMEs suppliers are forced to cut costs in order to cover their day-to-day operational expenses, which ultimately hinders their growth. As a point in case, 35% of SMEs stated that late payments from buyers constitute a direct threat to their survival, and 41% of SMEs viewed these same lengthy payment terms as the key factor hindering their growth, according to a survey conducted by the 2016 European Payment Report (Jeffery et al., 2017). The consequences of late payments by buyers are likely to be felt even more by SME suppliers in Asia and South America, in which the average DPO was between 70-80 days in 2016, compared to Europe's 59 days (Jeffery et al., 2017).

4.5 Rationale for SCF adoption

As already mentioned, we will examine the rationale for onboarding SCF programs looking more closely at the mechanisms behind working capital optimization and liquidity management. We will then highlight the importance of the technology in SCF. Finally, the main challenges of implementing a fully functional cross-border SCF program will be presented.

4.5.1 Working capital optimization and liquidity management

According to the PWC's SCF Barometer 2017 of (PWC, 2017, p. 12), "*working capital optimization is the most important reason for implementing a SCF program. The supplier umbrella, which includes supplier liquidity for implementing a SCF program is the second most important factor*"

Part of the renewed interest in working capital management emanate from the increasing demand for open account terms by buyers. Open account transaction allows for payment to be made after the delivery of goods to the buyer, usually in the range of 30 to 90 days. Open account agreements have been used for last couple of decades and are rapidly growing in popularity due to the increased flexibility and lower transaction costs that it offers, compared to more traditional forms of finance, such as letters of credit, i.e. a bank's guarantee of payment on the buyer's behalf. This leaves exporters/suppliers bearing more risk and therefore necessitating stronger working capital. As the competitive pressure increased following the globalization of economies and transaction costs got cheaper, supply chains have felt the push for leaner and more cost-efficient processes over the last decades, which ultimately has accelerated the exponential rise of open account transactions in the last decades (GSCFF, 2016).

SCF products provide a direct solution to mitigate this problem for suppliers and working capital has then become a key performance indicator for companies focusing on profitable growth (Aite Group, 2014). Optimizing working capital entails shortening a firm's cash-to-cash (C2C) cycle (or cash conversion cycle (CCC)), which eventually unlocks previously inaccessible free cash flow (FCF), improves the cash available for investments and ultimately increases the overall enterprise value of the firm (Hofmann & Belin, 2011). From a financial point of view, working capital is simply calculated as current assets minus current liabilities, however a more detailed calculation comes from a supply chain perspective, where working capital (WC) represents the amount of liquidity available for the company's day-to-day operations:

$$WC = Accounts\ Receivables + Inventory + Cash - Accounts\ Payables$$

,where $Inventory = Raw\ materials + Work\ in\ Progress + Finished\ Goods$

Working capital is in itself an indicator of both a company's efficiency and its short-term financial health; in most situations, if it is too low, it may indicate that the company has difficulty raising cash to meet its short-term obligation. If it is too high, it may indicate that the company is not able to use its cash efficiently and leaves large amounts of cash idle. This measure, however, gives a very static picture of working capital and therefore its performance is more accurately tracked by measuring the company's C2C cycle, which can be interpreted as *"the interval between the time cash expenditures are made to purchase inventory for use in the production process and the time that funds are received from the sale of the finished product. This time interval is measured in days and is equal to the net of the average age of the inventory plus the average collection period minus the average age of accounts payable"* (Schilling, 1996, p. 2). It can be calculated as:

C2C cycle = Days accounts receivable outstanding (DSO) + Days inventory outstanding (DIO) – Days payables outstanding (DPO)

, where:

*DSO = (Accounts receivable * 365)/Revenue*

, which measures the time it takes the firm to recoup cash after a sale (accounts receivables can be seen as credit given to customers). Typically, the lower the better, unless its low customer credit is causing missed opportunities in sales.

*DIO = (Inventory * 365)/Cost of sales*

, which measures how long it takes to convert inventory into sales. Generally speaking, the lower the better, unless a low inventory is causing missed opportunities in sales.

*DPO = (Accounts payable * 365)/Total cash operating expenses*

, which measures the time a firm takes to pay its suppliers. As a rule of thumb, the higher the better as long as it does not affect its relationship with the supplier (and by extension its performance by pushing payments to a later date).

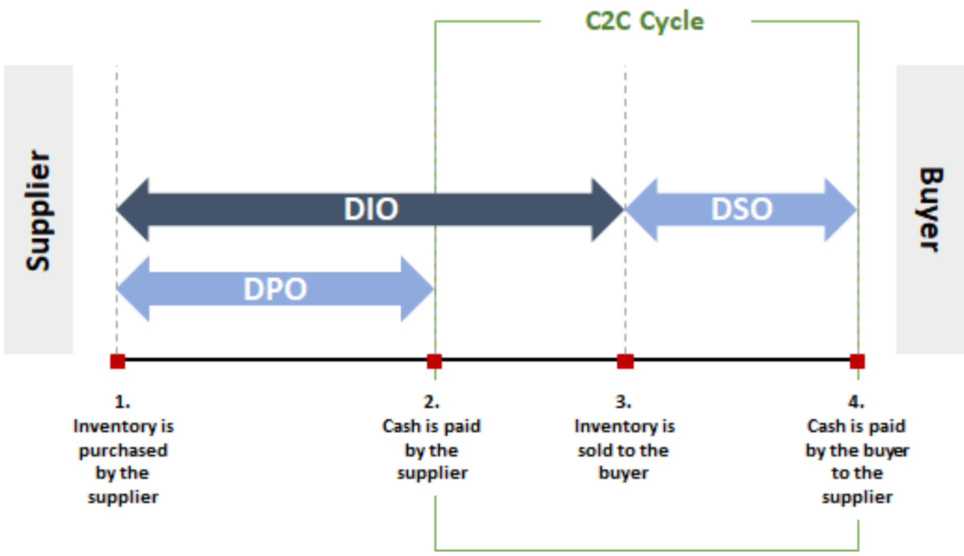


Figure 7: C2C cycle from the supplier's point of view, adapted from Hofmann and Belin (2011)

In essence, the C2C cycle measures how much cash is captured in the company's operations for how long. A short C2C cycle generally points to a healthy company, as the firm is able to collect its receivables quickly, predict accurately its inventory needs and can extend its payment on its expenses. A longer C2C cycle by contrast might indicate that the firm takes longer to collect cash, which might lead to insolvency for smaller companies. Whether the C2C cycle is positive or negative depends on the nature of the firm's operations: C2C cycles are usually negative when the firm first collects payments from its customers and then pays its suppliers.

The incentive to shorten the C2C cycle comes from the inverse relationship existing between a firm's C2C value and its profitability. Several indicators of profitability exist, among which the most common are the economic value added (EVA) and return on capital employed (ROCE). Hofmann & Belin (2011) show the impact that managing the working capital (i.e. shortening the C2C cycle) has on the firm's EVA, both directly and indirectly (see Appendix 12.5). EVA is calculated as the net operating profit after taxes (NOPAT) minus the cost of capital from its operating profit, which can be calculated as invested capital (or total assets minus current liabilities) multiplied by the weighted average cost of capital (WACC), which incorporates both the equity and debt costs of capital. As the company improves its working capital by shortening its C2C cycle, it reduces its accounts receivables (A/R) and/or increases its accounts payables (A/P), and/or decreases its inventories. This reduces its fixed and current assets and therefore leads to a higher credit rating, which in turn lowers the company's WACC. Better working capital also implies that it can release the cash that was tied up in operations, and therefore production costs decrease indirectly, and lead to a subsequent increase in its operating income (Hofmann & Belin, 2011).

However, shortening the C2C cycle for both trading parties involved simultaneously might be difficult given that in order for the suppliers to reduce their DSO, the buyers would have to reduce their DPO and therefore lengthen their own C2C cycle. Without the help of an intermediary, there's a clear conflict in the supplier-buyer relationship to gain the liquidity tied up in a zero-sum game-like environment. Smaller companies are therefore often at risk of being power-pressured by larger multinationals into lengthening their payment terms (DSO, or DPO for the buyers).

As reports the PWC's SCF Barometer 2017- 2018 (PWC, 2017a), working capital optimization is the key common implementation driver. More than 50% of the firms of large sectors such as Manufacturing, Consumer Goods or Communication & IT have already a SCF program in place. SCF as a solution offers clearly the possibility of a win-win situation, in which the suppliers can receive their cash relatively early and the buyers can still extend their payment to a later date, therefore improving both companies' working capital (Hofmann & Zumsteg, 2015).

4.5.2 The importance of technology

Technology platforms, and the development and improvement of software solutions, are one of the most important factors for the success of a SCF program. Automating processes allows businesses to fasten the speed of their monetary flow through their supply chain and improves their ability to enter into mutually beneficial partnerships (Bryant & Camerinelli, 2014). Fintechs are now increasingly paving the way in terms of innovations in software and technological platforms to help facilitate trade amongst all parties, representing an estimated 10 – 15% of the SCF market and taking over services traditionally offered by banks (McKinsey, 2015). These technological platforms have the potential to improve and automate processes from invoicing, credit notes, purchase orders, to payments, thereby improving the information flow between all parties involved in the supply chain (Hofmann & Belin, 2011).

Additionally, the level of technological resources needed to handle SCF programs varies according to the size of the company: larger ones require a seamless integration with the existing enterprise resource planning (ERP) system of the client, as well as added services such as accounting packages, while an Internet-based platform would suffice for SMEs (Wyman, 2016). Furthermore, cooperation between technology providers and banks is often crucial for the well-functioning of an IT system that can service the clients' needs. Banks, both mid-sized and large, have realized that outsourcing the technological capabilities needed to an external and experienced third-party is more efficient than building those capabilities in-house (Leonard, 2013).

Recently, growth in the SCF industry has mainly been derived from the increased accessibility of SCF platforms for SMEs and middle-market actors. Until now, banks who originally offered SCF solutions have tended to focus exclusively on large mature companies with a solid credit rating and their most reliable suppliers, since they represented the most obvious source of profit. In contrast, the SME segment, despite having the largest revenue potential, was left out as they were perceived as being too risky or financially unviable to be onboarded by financial institutions. The technological innovation brought about by fintechs have made it possible to increasingly onboard a larger number of suppliers at lower costs, regardless of their size. New solutions and technological firm third-party providers have therefore had a heavy hand in developing a large part of the previously overlooked corporate world (Jeffery et al., 2017).

The addition and application of Software-as-a-Service (Saas) to the SCF landscape in recent years, has in this regard been a pivotal technology, that has allowed the spread of SCF to smaller SMEs. SaaS will allow SCF to transition, from a proprietary service held by financial institutions and aimed at unique clusters of buyer-supplier dyads, to an online marketplace where buyers, suppliers, and finance providers can all participate. Through these networks, interactions and communications throughout the supply chain are more efficient, and implementation and onboarding costs are significantly lower (Jeffery et al., 2017).

As the interest for and the need for SCF solutions keep mounting, with the market growing rapidly, fintech firms are increasingly becoming more popular than the services offered by bank platforms. In this context, traditional financial institutions, despite still being able to enjoy a dominant position in developed and emerging markets segments (PWC, 2016a), are being forced to adapt in order to stay competitive. Large global banks still retain a competitive advantage due to their significant capital reserves and their first-mover advantage, as they have been offering SCF services for decades and have thus secured deep client relationships. These institutions are able to cross-sell their SCF offerings across a global network of existing clients and lean on this advantage in regions where SCF has yet to mature to onboard clients before their competitors do. Additionally, clients also prefer to rely on their existing relationship with their banks to provide the support they need to launch a full blown SCF program, rather than trust an untested third-party fintech solution (Jeffery et al., 2017).

For regional and domestic banks with fewer assets, it has been more difficult to keep pace with the rapid expansion of fintech firms. These banks tend to have strong relationships with clients in certain regions but are not able to expand their scope of influence as effectively as their larger counterparts. In many cases, smaller banks do not have the resources to build or manage their own

SCF program. For these institutions, it makes more sense to partner with fintechs or larger banks and provide 3rd party funding through their program.

4.5.3 Main challenges to supply chain finance implementation

While there seems to be many benefits to adopt SCF solutions, which is reinforced by the fact that existing SCF programs are generally viewed as a success (PWC, 2017a), there are nevertheless some issues and challenges blocking a full worldwide SCF implementation. The PwC's annual Working Capital Study 2018/2019 (PWC, 2018) emphasizes the fact that many sectors are still leaning on their suppliers to improve their working capital. Moreover, a key observation by PWC's 2017 SCF Barometer Survey (PWC, 2017b) shows, that the main bottlenecks for onboarding a SCF program are the commercial offering to the suppliers, the supplier appetite for cash, and the onboarding-process of suppliers.

We therefore identify two main challenges to global adoption arise: (1) legal, cross-border and jurisdictional issues, which relate to an organization's ability to implement an SCF program globally, and (2) the organization's ability to onboard its suppliers on an SCF program.

4.5.3.1 Legal & Jurisdictional Issues across Global Supply Chains

One of the biggest challenges in achieving a global international SCF program for companies is the inconsistency in legal and regulatory norms across regions. In most developed countries, such as in Europe and North America, standards and guidelines exist in legal and regulatory matters, that provides an understandable framework for firms to interact beyond national borders. However, in emerging markets regions such as Latin American and large parts of Asia, laws and regulations vary widely over the different jurisdictions, which often have certainly diverse cultures, languages and customs procedures that complicate the establishment of a unified regulatory framework. Implementing a cross-border SCF program in these regions is therefore complex (Jeffery et al., 2017).

In addition to the inconsistent regulation, many regions in developing countries lack the regulation and institutions necessary to provide verifiable financial information and trustworthy credit ratings, such as in Latin and South America, which muddles the task of mitigating risk for financial institutions and organizations. Moreover, much needed Asset Liability Management (ALM) practices, which help manage a firm's liquidity in order to reduce the risk of loss from unmet financial obligations, sometimes lack in regions where economic instability further worsens the risk of lending and doing business with domestic firms. Know Your Customer (KYC) conformity therefore becomes laborious when critical information on a firm's credit rating, risk tolerance or financial strength is limited (Jeffery et al., 2017).

Adopting a global cross-border SCF program requires a comprehensive understanding of the regulatory and legal systems of the jurisdictions in which suppliers reside. The successful implementation of a SCF program is contingent on the existence of a unified standard that allows cross-border transactions. Regions where these structures are under-developed therefore pose a challenge for a widespread and global adoption of SCF programs.

4.5.3.2 On boarding process of suppliers in a SCF program

The onboarding of suppliers is ranked among the key most important steps in ensuring a successful SCF program (PWC, 2017a). However, onboarding suppliers is not always an easy task, as the implementation costs, the suppliers' eligibility to access the program and the lack of trust between some partners can constitute heavy constraints for implementing a SCF program.

Cost of Onboarding

Onboarding suppliers requires legal checks and requirements to be carried out, such as KYC, as the set-up of the particular SCF program tailored to fit both the supplier's and the buyer's needs. Some suppliers, if large enough, might also ask for an integration of SCF solutions into their own IT systems. All of these onboarding steps can therefore have heavy costs for the suppliers, which in turn might decide that the costs of participating in a SCF program outweigh their benefits. In order to cope with this issue, some buyers choose to offer free onboarding for suppliers, dedicating hotlines or support portals for onboarding assistance. In this case, the assistance has to be relatively inexpensive for a buyer, compared to the value of maximizing supplier participations.

Depth of supplier Tiers onboarded:

SCF solutions are often limited in scope to the tier 1 suppliers, i.e. the suppliers with which the buyer has a direct relationship to, as they are well known by buyers. As seen in Section II, unbeknownst small suppliers with low credit ratings have great difficulties in access capital from banks as they are deemed to have to high of a performance risk, and must therefore often rely on relation trust to access financing. This is another obstacle for buyers seeking to establish a wider SCF network than their tier 1 suppliers.

Transparency:

The lack of transparency makes trust difficult in SCF cooperation. Banks are generally not capable of implementing reverse factoring solutions between buyer and any given suppliers. Without the necessary access to a supplier's operations details, a financial institution can hardly assess the financial capability of a small supplier unknown to them.

4.6 Section summary of supply chain finance

We have demonstrated that SCF aims to solve the direct conflict that exists between suppliers and buyers in terms of payment terms. The analysis shows that the markets case for SCF is growing steadily and that the needs for alternative financing in supply chains increase.

Adopting the definition of the Global Supply Chain Finance Forum (GSCFF, 2016) relevant for modern SCF, we have detailed the key characteristics of SCF instruments considering the four principal elements impacting the choice of the SCF instruments: (1) the timing of the trigger event, (2) the focal point of credit risk, (3) the availability of collateral, and (4) the financed elements in the balance sheet.

We have, then, provided a detailed presentation of Reverse Factoring and Purchase Order Finance, which are both aiming to cover the working capital needs of the supplier and to allow the buyer to delay its payments. We took therefore a pragmatic approach by identifying the key players among SCF stakeholders: the giant buyers (often large multinational corporations that can be identified as Fortune 500 companies), the large buyers, the small suppliers generally the SMEs, and the financial intermediaries (i.e. banks).

Finally, we have highlighted the main incentives for onboarding SCF programs, namely the working capital optimization and the liquidity management. We have furthermore demonstrated the huge importance of technology in SCF. Technology has the potential to improve and automate processes from invoicing, credit notes, purchase orders, to payments, thereby improving the information flow between all parties involved in the supply chain. However, we have pointed out some limitations and challenges. They are mostly inherent to legal issue aspects, such as aligning regulations or cross boarding flows and to on boarding processes, such as implementation costs, suppliers' eligibility and transparent and trusted relationship.

The next Section will focus on the Blockchain technology in the context of a SCF environment.

5 Blockchain technology and its technological concepts in an SCF environment

As was discussed in the previous section, Supply Chain Finance and its instruments are closely intertwined with the underlying technology platforms on which it is built and the concept of trust. However, without a suitable technological platform, there is very little opportunity for the advancement and use of SCF instrument. Therefore, the following section will focus on addressing the innovation of blockchain: a technology which facilitates trust in transactions between participants in a network. The section will start with a presentation of blockchain as a in the context of techno-economic paradigms and argue for its relevance as a similar technological innovation that has the potential to transform business foundations. It will then explain the core technological concepts behind blockchain technology, as well as the augmented features, which have been added to the technology over time. These will then be compared with existing technologies to highlight the uniqueness of blockchain in its ability to facilitate trust in transactions. The section will then be concluded with a summary of the key characteristics of the technology, which will be used in the subsequent analysis.

5.1 Techno-economic paradigms and technological revolutions

In the modern setting, wherein new technological innovations and products are issued almost daily, techno-economic paradigms are a useful framework for estimating an innovation's real-world significance. The construct of techno-economic paradigms, developed by Freeman and Perez, are at the core of general, innovation-based theories of economic and societal development. They seek to understand and explain the notion of technological revolutions by analyzing the economic impacts of innovations and by identifying regularities, continuities and discontinuities in the process of innovation (Perez, 2009). The term, techno-economic, therefore refers to the impact that the technology has on the economy and institutions, and their relevance for economic analysis (Perez, 2009).

According to Perez (2009), there have been five distinct technological revolutions, which have played a very significant role in shaping society as we know it. The earliest of these technological revolutions was the industrial revolution, which originated in 1700's century England, and the latest was the information technology revolution of information and telecommunications, which originated in the 1970's in the USA and later spread to Europe and Asia (Perez, 2009). Once the technological revolution has reached a certain degree of maturity, the resulting applications and innovations of the revolution will have permeated to almost every aspect of daily life. For example, many modern-day innovations, such as computers, smart phones and even the internet, can be attributed to the most recent technological revolution of information and telecommunications. Although these innovations are considerably different in nature, they share a common root, which can be traced all the way back to the introduction of a single individual radical innovation.

A radical (or disruptive) innovation, as explained by Perez (2009), is one in which a new technology is used or introduced to a market for the first time and which is capable to disrupt the existing paradigm. At the time of its release, the technology will be in a relatively primitive version. However, once the potential for the technology has been recognized and accepted by the market, it will be subjected to a series of incremental innovations that improves the existing radical innovation and whose maturity degree follows an s-shaped curve (Perez, 2009). This is illustrated in the image below:

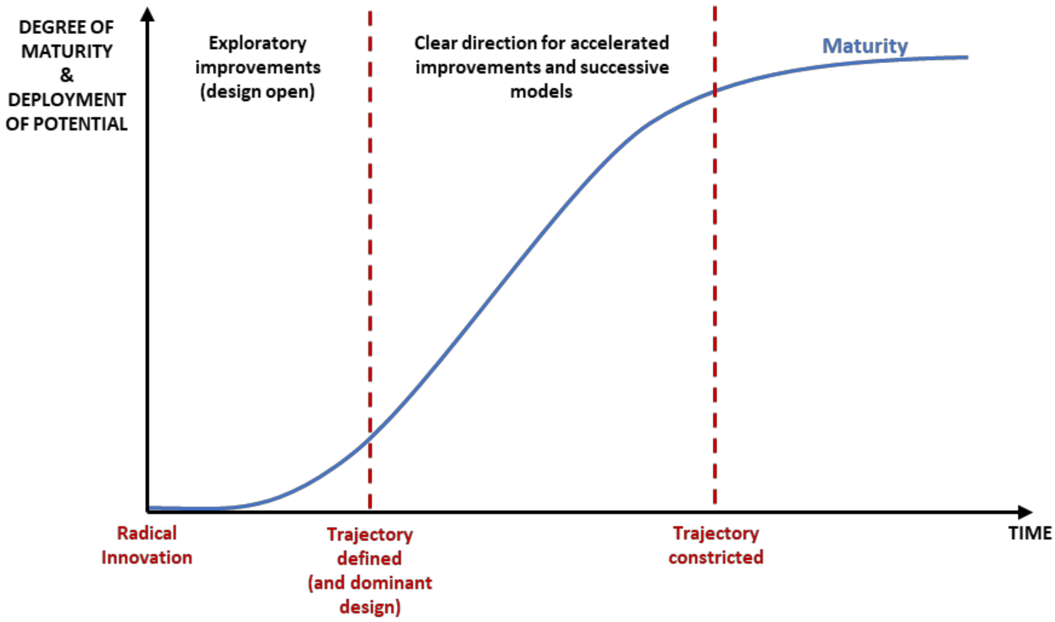


Figure 8: Evolution of the maturity of an innovation, adapted from Perez (2009)

In the image above, the time to maturity for a techno-economic paradigm is shown, which begins at the introduction of the initial radical innovation, to the point where the innovation has reached its final form and maturity. As such, the graph is reminiscent, and almost identical to that of the original diffusion of innovation curve from Rogers (2003). At the time of the introduction, the improvements will occur slowly, while producers, designers and consumers begin to engage in a feedback/learning process. However, improvements will rapidly emerge once a dominant design is established in the market and add to it (Perez, 2009). What is important, is that it is usually not the first iteration of the technology, which eventually becomes subject to incremental innovations, but the concepts of technology behind the innovation. Notable examples of such radical innovations and their subsequent technological revolution include, as according to Perez (2009):

- The Arkwright's steel mill that opened in Cromford in 1771, which was at the origin of the "Industrial Revolution" and seen as the first technological revolution. The introduction of this technology sparked a manufacturing transition from handcrafting to machine production and factory systems.
- The first Model-T car from the Ford Plant in Detroit Michigan in 1908 was the radical innovation that started the technological revolution of Automobiles and Mass production.
- The announcement of Intel microprocessors in 1971 indicated the start of the most recent technological revolutions of Information and Telecommunications.

The radical innovations therefore form a form of milestone, being the first applications from which a long list of new technologies, redefined industries and infrastructures can emerge. This point is shown in the image above, where the radical innovation represents the beginning of the curve, with incremental innovations to the underlying technology driving its maturity and moving it up along the curve. Incremental innovations, in this context, being entirely new successive products, services or even whole industries, build upon the innovative space created by the initial radical innovation (Perez, 2009). In this way, the innovation is framed as a technological paradigm, in the sense that it represents a tacit agreement amongst the agents evolved in what is considered an improvement or a superior version of a service, product or technology, which originates from said innovation (Perez, 2009). For example, microprocessors are expected to become faster, smaller and more powerful and are therefore superior versions of the technology.

Blockchain and techno-economic paradigms

When charting the evolution of an innovation, it is important to understand that reaching maturity for an innovation is a collective process, involving many agents of change and taking place across complex dynamic networks (Perez, 2009). The evolution of the innovation should therefore never be seen in isolation, as it interconnects with other technologies and innovations, forming new paradigms on their own. According to Swan (2015), the most recent technological revolution of information and telecommunications has given rise to what she refers to as 'disruptive computing paradigms'. These disruptive computer paradigms have emerged almost religiously in each decade, the first being the advent of mainframes in the 1970's, then the PCs in the 1980's, followed by the

Internet in the 1990's and social media in the 2000's. These have paved way for what she believes will be the fifth computing paradigm, blockchain.

Swan (2015) believes that blockchain technology could enable a connected world of computing to emerge. In such a world of connected computing, blockchain could be seen as a "seamless economic layer of the web", wherein blockchain cryptography could support the transfer of money as well as information (Swan, 2015). Interaction across digital platforms may then be fundamentally different from what exists today, allowing for new applications possibilities that were previously unimaginable or thought to be impossible.

A defining characteristic of blockchain as an innovation, and what distinguishes it as a techno-economic paradigm, is its role in facilitating the establishment of a "trust economy". After thoroughly examining the amount of resources that would be required to create institutionalized trust in the digital space through the existing (non-blockchain) procedural, organizational and technological infrastructure, a report by Deloitte (2018) found that to uphold such a system would be too expensive, time-consuming or inefficient to provide a real substitute to trust. Nevertheless, these traditional trust mechanisms, which include elements such as banking systems, credit ratings, and legal instruments, are today necessary to facilitate trust in transactions. However, in a trust economy, trust is directly established through person-to-person (P2P) transactions (Piscini, 2018). Facilitating trust in such a setting relies on each transacting party's digital reputation and identity, which are elements that may soon be stored on a blockchain. For individuals, these elements may include information such as the financial or tax history of the individual, consumer preference and other useful information. Likewise, with companies, the ability to maintain their reputational identities, as well as establishing themselves as trustworthy business partners and vendors, would be reliant on their history of transactions with other actors across the network.

5.2 The concept of blockchain technology

As with any technological innovation, the technologies surrounding blockchain have undergone substantial developments since its inception as a radical innovation. For this reason, many of the following versions of blockchain technologies bear very little resemblance to the blockchain originally envisioned by Nakamoto, both in terms of function and purpose. In fact, the term blockchain may in many cases not be appropriate, as many associate it with Bitcoin, leading some academics to prefer the term "Distributed-ledger technologies" instead of blockchain technologies (Hofmann et al., 2017). However, despite the progress and dissemblance of subsequent blockchain technologies to that of the original Bitcoin, most still share the same fundamental technological concepts, which characterize them as "blockchain technologies" (the terminology and definitions, as with SCF, are still evolving and are constantly changing, yet the term "blockchain technologies (BCT)" will be used throughout this paper).

This section will start with a description of the original intentions of Nakamoto, the issue of digital assets, which lead to the creation of Bitcoin. It will then explain the technological concepts behind Blockchain technologies, the distributed ledger systems, the crypto hashing principles and the Group consensus mechanism. We will demonstrate the relevance of these concepts compared to existing technologies in a supply chain and how they facilitate trust in transactions.

5.2.1 The issue of digital assets

The initial radical innovation, which started the innovation of BCT, was the release of a paper in 2009, by the Japanese programmer and author, Satoshi Nakamoto, who conceptualized a new type of peer-to-peer electronic currency: the Bitcoin. In his paper, Nakamoto agued that the internet commerce depends too heavily on financial institutions to act as trusted third parties in processing electronic payments. Nakamoto then endeavored to solve the principal difficulty of digital assets, called "the double-spending problem", in order to eliminate the need for third parties (Nakamoto, 2009). This issue stems from the fact that digital assets are simply strings of code with no physical form, which can be easily duplicated. Therefore, anyone could easily transfer a digital asset while simultaneously retaining a copy of the same asset. To overcome this issue, each transaction must be checked against a central ledger when spent, to make sure that the same person cannot spend it more than once (Cham, 1992). In addition, there also must be proof that each party in the transaction consented to the transaction.

Traditionally, banks have fulfilled this role and serve as a trusted and central third party with an authoritative record of all transactions. However, for peer-to-peer transactions to be feasible without central intermediary, the necessity of an authoritative record of transactions constitutes a paradox, as it should be both accessible to all participants and impervious to any kind of tampering and forging. Nakamoto solved this issue by creating a constantly updated and distributed ledger system, which relies on a unique key cryptography protection and a tamperproof consensus mechanism.

5.2.2 Distributed ledger systems

At the core of Blockchain technologies lies the distributed network architecture (see illustration below). However, to understand how distributed networks function and what purpose they serve, it is necessary to compare it with the traditionally more common centralized and decentralized networks.

A centralized network can be characterized by a single entity handling all resources and calculations on a network (typically a server or computer) and to which all participants must connect and communicate to through a terminal (Hofmann et al., 2017). To give an example: if a user wants to use Facebook or a bank account, the service is accessed through a web-app, which communicates directly with a central server. Activity on the web is sent to the server, where it is processed, stored and sent back to the user. However, as all communication goes through the central server, the owners of the server hold complete authority and control over the entire network. If the central server were to break down, the entire network would collapse.

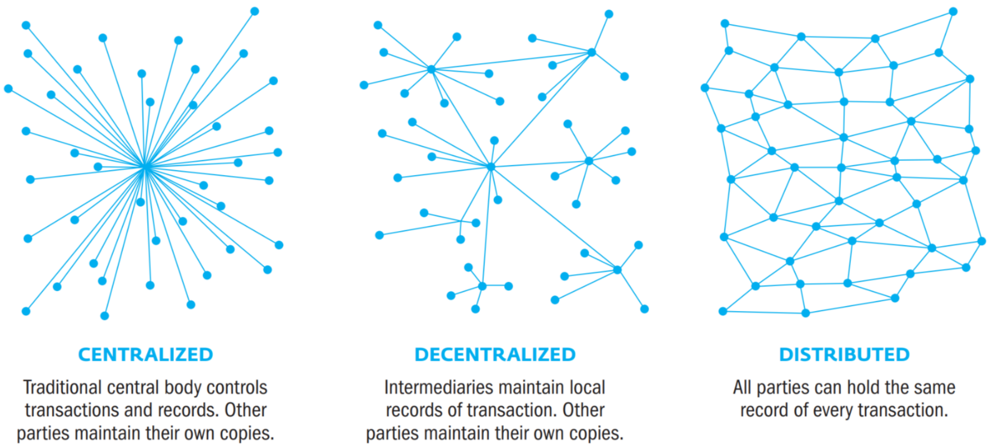


Figure 9: Distributed Network Architecture, adapted from Swanson (2015)

This centralized network structure is in itself not without its merits, and for most everyday uses, it may be preferable. The reason for this being that they have a traditionally simpler structure and that the authority controlling the central node can be held responsible for its malfunctioning and any misuse of data (Nandi & Kumar, 2016). However, in the modern setting, centralized networks rarely exist entirely detached from other networks.

Organizations working within some form of supply chain typically use some form of localized information systems, ERP systems or custom solutions. With the ever-increasing complexity of supply chains, the demand for interoperability between these systems and the need for a heightened level of collaboration between relevant stakeholders has increased dramatically. However, given the current state of supply chain data management, most systems are characterized as "data silos", being centralized systems, lacking a common technological environment, and security and exchange protocols to facilitate data sharing (Rakic et al., 2017). This lack of interoperability, as well as other technical hurdles, reduce the real-time availability of supply chain data to stakeholders involved (e.g. consumers, financial institutions, and trading companies in the supply chain).

In addition, the complexity and low interoperability in turn creates information asymmetries, which means that information is unevenly distributed throughout the supply chain. As explained by Rakic et al. (2017, p. 4): *"When participating stakeholders have misaligned incentives, such as the case in which participating stakeholders are different companies, there is no incentive to provide complete information which contributes further to information asymmetry."*

This impediment of centralized systems on the formation of trust in supply chains can be explained through the "three sins of centralized ledgers and databases" model by Sams (2015). The model highlights the three main ways centralized systems can manipulate information data, which acts as deterrent for trust:

1) **Sin of Commission – forgery of transaction:** Centralized systems can purposefully forge false information, as outside parties may have difficulty in assessing the definitiveness of this information.
2) **Sin of Omission – censorship of transaction:** A centralized system may choose to omit certain details or information in a data transaction, as there is no way for an outside party to make certain that all relevant data has been included.
3) **Sin of Deletion – reversal of transaction:** A centralized system may delete sensitive information contained in their network, as there is no way to ensure the integrity of the records.

As there are considerable consequences in committing any of the abovementioned "sins", actors will for the most part be dissuaded from these activities fearing repercussions in the long-term. However, the fact that they are still able to do so, due to information asymmetries, in turn creates uncertainty amongst stakeholders as to the likelihood of moral hazard and fraudulent behavior (Rakic et al., 2017). This in turn stands as a barrier for building trust.

The solution in overcoming the shortcomings of a centralized network, according to Nakamoto (2009), is to switch to a distributed network model. A distributed network architecture (illustrated in the picture above), as defined by Schollmeier (2001), *"…is one wherein participants in the network share resources, such as processing power or storage capacity. These shared resources are necessary to provide the service and content offered by the network (e.g. file sharing or shared workspaces for collaboration). They are accessible by other peers directly, without passing intermediary entities."* In this way, no single central entity has control over the entire network. The combined resources of all participants on the network make it sustainable, without any one participant being indispensable for its well-functioning. The most outstanding example of such an architecture is Bitcoin itself, wherein all transactions are broadcast, recorded and stored by the participants of the network and not in any central server (Hofmann et al., 2017).

However, with no single entity or central authority to be held accountable for the validity of transactions, participants on the network cannot be sure that transactions are immune to counterfeiting and tampering. In addition, doubts as to whether digital assets are replicated or altered is an enormous concern for trading parties. These two issues can then be resolved through cryptographic hashing and the Group Consensus Mechanism.

5.2.3 Cryptographic hashing and Group consensus mechanism

5.2.3.1 Cryptographic hashing[3]

As mentioned, for a system to handle digital assets, there needs to exist a form of authoritative record of all transactions. For Bitcoin, this authoritative record is the blockchain; a shared database of all transactions, which are registered in blocks of data by an architecturally distributed peer-to-peer network (Hofmann et al., 2017). Any transaction on the network is time-stamped to prove that the data existed at a given time and to give a chronological order to the blocks of transactions. All transactions are bundled together in blocks of data (hence the name "blockchain"), and each additional new block of data are cryptographically chained with the block before, securing the preservation of a unique history of transactions. The chain of data blocks therefore gives a complete history of ownership of the digital assets, and all the activities on the network, which are impossible to replicate. In, addition it is theoretically impossible for participants to alter or redo parts of the chain after a certain amount of transactions (Nakamoto, 2009).

The core function, which enables the blocks of data to be linked together, is the technical process of cryptographic hashing. In simple terms, cryptographic hashing is a process, which converts any input into a digital string of unique and irreversible code. For a transaction to be recorded, all information regarding the transaction must be bundled together and converted into a hash code, which is then cryptographically linked, to the end of the chain.

The result of this cryptographic process is a long chain of immutable transaction data, which is impervious to any kind of tampering and accessible to any node in the distributed network. This

[3] For a more detailed explanation of the intricacies of the cryptographic hashing process, see Appendix 12.6

leads the blockchain to overcome the three sins of the centralized ledger, namely forgery, censorship and reversal of data, as described above.

5.2.3.2 Group Consensus Mechanism

The process of cryptographically chaining Blocks together is completed throughout the distributed network of computer nodes with each node contributing processing power to the process. However, as the network is comprised of many different nodes, a method must be in place to make sure that all are in consensus of the order with which Blocks are added to the chain. If not, the different nodes may attempt to simultaneous place Blocks to the chain and would create information conflicts and inconsistencies throughout the chain. Therefore, to ensure that Blocks are added in an orderly fashion, and that only one single global truth exist between all the different actors, a Group Consensus Mechanism needs to be in put into place (Hofmann et al., 2017). The method utilized by the Bitcoin Blockchain is called the 'Proof-of-work' (POW) consensus mechanism. The mechanism consists of solving a hard-computational problem (a hash problem, see subsection above) at the time of creating a new Block of transactions. This problem requires a substantial amount of processing power to solve, however, once solved, it is very easy for others to verify (Hofmann et al., 2017). Once the computational problem is verified, the new block is added to the existing chain of blocks. The procedure of offering processing power to solve these hard-computational problems are what is referred to as "mining". The miner, who has contributed processing power to facilitate the process, is in turn compensated with Bitcoins, which he may spend in the Blockchain. However, while the enormous scale of Bitcoin requires it to have such a POW consensus mechanism to support its functioning, establishing a blockchain platform in supply chains will likely not necessitate the same level of computational processing power and therefore the same consensus mechanism, as will be explained in the next subsection.

5.3 Evolution of the Blockchain

Although the section above describes the fundamental concepts of blockchain technologies, the technology has undergone considerable transformation since. This section aims on explaining the two major developments, which have influenced the technology underlying Bitcoin and brought about new potential applications of the technology.

5.3.1 Permissioned versus permissionless blockchain networks

Although Bitcoin has become a worldwide phenomenon, there are several issues with the technology. The first of these is a purely practical issue. In 2014, a study conducted by the National

University of Ireland, concluded that the energy consumption used to maintain the Bitcoin Blockchain, was on par with the total energy consumption for the entirety of Ireland (Malone & O'Dwyer, 2014). In addition, the study concluded that the "industry" was theoretically deficient, as the cost for supplying processing power (in terms of electricity and hardware abrasion) for a participant without access to specialized equipment, would far exceed the reward in terms of bitcoins (Malone & O'Dwyer, 2014). This has led to the majority of the processing power supplied to the network originating from a few large mining pools, such as Bitfury or F2Pool (Malone & O'Dwyer, 2014). This conflicts with the principles of distributed networks, as the nodes contributing to the network have become increasingly concentrated to these few actors.

The second issue is related to the security of the network, and potential tampering from malicious third parties. Should a third-party control over 51% of the processing power available to the network, it would theoretically be possible for them to rewrite and change information in newly created blocks. All though this is considered an extremely unlikely scenario by many Bitcoin practitioners, the possibility still exists, which could potentially undermine the regulatory requirements of irrevocability and finality of financial transactions required in the capital market (Swanson, 2015).

The third issue relates to the anonymity of participants on the network. On the Bitcoin blockchain, the participants whom hold currency, as well as the miners who supply the processing power, are anonymous by design. However, the anonymity of participants is a particular concern for regulatory authorities, which is illustrated in a report given by the European Banking Authority (EBA, 2014, p. 5): *"…that payer and payee can remain anonymous; that [Virtual Currency] schemes do not respect jurisdictional boundaries and may therefore undermine financial sanctions and seizure of assets; and that market participants lack sound corporate governance arrangements."*

This concern is especially increased, if the application of the technology should be extended to other types of digital assets. As blockchain has the ability to include assets such as contracts, the legal enforceability of these digital assets would be difficult to establish as they require a full identity disclosure (Swanson, 2015).

In response to this critique, some financial institutions began to envision their own private blockchain networks that included only trusted and preselected validation nodes, i.e. permissioned blockchains (Hofmann et al., 2017). A permissioned Blockchain, is one in which the identity of the participants is whitelisted through some type of KYB (Know Your Business) or KYC (Know Your Customer) procedure (Swanson, 2015). In contrast, a permissionless blockchain is one, such as Bitcoin, wherein the participants are anonymous. According to Swanson (2015), the benefits of a permissioned network include:

- **Legally accountable validators:** As all validators and participants are known, they can be held legally accountable for their activities.
- **No reversals – settlement finality:** As only trusted validators can insert Blocks into the Blockchain, the network is immune against malicious third parties, who attempt to control a majority of processing power.
- **Suitable for off-chain assets such as securities, fiat currency, titles:** As all participants are known, the concept of digital assets, which are tied to elements external to the Blockchain, becomes a possibility. Because participants are known, the issue of legal enforceability mentioned above is greatly mitigated and the asset itself would be easier to administer by legal authorities (explained in further detail in the next sub-section)

In addition to the advantages above, a permissioned blockchain would not have to utilize a proof-of-work group consensus mechanism, as is the case with Bitcoin, given that the validation nodes are known (Greenspan, 2016). This means that the network does not need to rely on a large number of distributed miners (as is the case with permissionless networks) to supply processing power to solve hard computational problems before a block can be added. Without having to go through an extensive proof-of-work process, the network could achieve significantly increased efficiency in the validation process, which in turn would increase its scalability, its capacity for higher transaction volumes and its ease of use for regulators and legislators (IFF, 2015).

Broadly speaking, there are two different types of permissioned blockchain networks. These, as explained by Buterin (2015), are: (1) Fully Private Blockchains, and (2) Consortium Blockchains.

Fully Private Blockchains

In a fully private architecture, the blockchain platform is built around a single organization. This means that the company's ERP-system is fully or partly based on a blockchain platform, and that the only participants are internal members of the organization. Implementing such a blockchain solution uniquely for internal use is advantageous, as it can facilitate an internal alignment between the different functions, extenuate the threat of malicious actions, and limit the potential hazard of human error, among other. Some examples of applications include, database management, auditing or other internal controlling functions. Additionally, the flexibility of a blockchain-based IT intra-firm solution allows the creation of added features, which could be providing viewing permissions to outside participants, such as regulators or stakeholders (Buterin, 2015).

Consortium Blockchains

In a Consortium Blockchain architecture, the consensus process of the distributed ledger system is controlled by a preselected set of nodes. To give an example, if a group of financial institutions decided to initiate a Consortium Blockchain, they would first agree on which of them would be controlling nodes. From this point onwards, additional participants may be onboarded to the blockchain, and may add information to it. However, the information added by these participants will not be added into a block, unless it is authorized and verified by every controlling node. In this way, activity is verified, authenticated by the controlling nodes, and accepted only if every node accepts the transaction. This means that should a single node try to manipulate information in any way, a dispute would arise between the other nodes, thereby bringing the malicious node to light. In addition, the right to read the blockchain may be opened up to the public, so that external parties, such as regulators, legal institutions and stakeholders, may view it (Buterin, 2015).

5.3.2 Smart contracts

In addition to permissioned ledgers, another pivotal innovation for BCT was the introduction of the Ethereum project. In the time preceding the Ethereum project, BCT primarily had the capability to store immutable information through cryptographic hashing and allow new information to be added by distributed network nodes through a consensus mechanism (Lewis, 2016). In the case of the Bitcoin Blockchain, participants were limited to the action of: "PublicUserID(Y) sends X amount of Bitcoins to PublicUserID(Z)". However, although the technology was considered groundbreaking in itself, very few applications of the technology existed outside of cryptocurrencies.

Ethereum was founded on the principals of a white paper written by Buterin in 2013 and is an open source Blockchain, which has a built-in Turing-complete programing language (Buterin, 2013). The Turing-complete programming language allows participants on the Blockchain to write code or applications on the Blockchain so to create their own arbitrary rules for ownership, transaction formats and state transition functions (Buterin, 2013). The purpose of these are to function as small computer programs located on the blockchain, which can dictate ownership and transfer of assets, according to the rules of the programming (Buterin, 2013). The ability to create these computer programs therefore allowed for the creation of smart contracts.

The concept of smart contracts were first described in the 1990's by Szabo (Hofmann et al., 2017) and refers to a computer protocol, which facilitates, verifies, and enforces the terms of a commercial agreement (Swanson, 2015). They can also be characterized, as Brown (2015) explains, as; "…*an event-driven program, with state, which runs on a replicated, shared ledger and which can take custody over assets on that ledger"*. A simple way to think about a smart contract is to envision it as a programmable calculator that can receive inputs – execute code – then provide an output (Swanson, 2015). An example of a simple smart contract could be:

- Two participants on a blockchain wish to engage in a smart contract
- The participants set the terms of the smart contract, which state that participant (A) transfers digital asset (X) to participant (B), if Event (AB) transpires. If Event (AB) does not occur, no amount of value will be sent.
- Both participants agree to the contract and the smart contract is initialized. The smart contracts takes custody of the digital asset (X) belonging to participant A.
- The smart contract hereby awaits the specified input, i.e. if the event (AB) happens, which trigger the contract execution.
- If event AB occurs, the program self-executes and initializes a transfer from participant A to participant B without the need for oversight from either participants.

The above is a very simplified use case, but the variations of use cases are endless. According to Swanson (2015), the most important aspects of a smart contract lies in its ability to react to external events (i.e. information not located on the Blockchain) and its application to off-chain assets (i.e. digital representation of assets which are not located entirely on the Blockchain, such as securities, stocks, etc.). When the participants commit themselves to the smart contract, the program itself will take custody of the digital assets in question. With on-chain (i.e. internal to the blockchain) digital assets (such as Bitcoin), the accounts will be automatically settled, as the smart contract automatically dictate the movement of assets based on the conditions met. However, for off-chain digital assets, the accounts can be considered settled when the off-chain accounts match the settlement instructions (Swanson, 2015).

The abovementioned characteristics give smart contracts three distinct key elements, which distinguish them from ordinary contracts (Swan, 2015):

- **Autonomy:** Once the participants have committed to a smart contract, it does not need any intermediary or contact with its initiating agent. It acts in its own rights without the need for any outside assistance.
- **Self-sufficiency:** A smart contract can independently marshal any kind of resource necessary for its function. For example, a smart contract can raise funds by issuing equity or providing services, which could be spend on necessary resources such as processing power.

- **Decentralization:** As the smart contract is registered on the blockchain, it can distribute and self-execute across a wide network of nodes.

However, although smart contracts provide a great deal of utility to blockchain, there are some drawbacks to the technology. The first of these has to do with the input of information. As smart contracts can react to external events, the information emanating from these events may be difficult to account for in the programming of the smart contract. Smart contracts process information according to the cold logic of their programming, which, if given distorted inputs, will always produce distorted outputs. This concern is raised in the paper written by Gendal (2015), who concludes that successful smart contract execution greatly relies on the quality of the input data. Another drawback of smart contracts is the legal enforceability of smart contracts. Because there is limited coding expertise in existing legal frameworks (Flood & Goodenough, 2017), several authors, including Swanson (2015) and Gendal (2015), have raised the concern that smart contracts may not be viewed as actual and valid legal contracts.

5.4 The key features of Blockchain Technologies

Up until now, the purpose of the preceding sections has been to explain the key concepts and mechanisms behind any blockchain system. This section will therefore now present the main technical features of blockchain, which are relevant for its application in the SCF ecosystem context. The section starts with describing the two primary purposes of any application of the technology. Thereafter, the section evaluates the possible applications of the technology, which are derived from the technical aspects analyzed in the previous sections.

5.4.1 The primary purposes of Blockchain Technology

Although the technology and concepts behind blockchain seem to offer many benefits, the use of BCT has some limits. Albeit the inflated excitement surrounding the potential of blockchain, it is not a "miracle technology" that will replace every other network technology currently in use. In fact, BCT can essentially only perform 2 distinct tasks, and it is from the completion of these two tasks, that the various applications for the technology are possible. These tasks, according to Lewis (2016), are to act as a digital token ledger and an activity register. These are illustrated in the graphic below:

	Emerging uses for blockchains	
	Asset ownership tracking	**Activity registers**
What is being tracked?	▪ Changes of ownership of digital tokens ▪ Tokens can be actual assets (e.g. Bitcoin) ▪ Or tokens can represent claims (e.g. tokens on Ripple)	▪ Immutable timestamped data records ▪ Underlying data can be anything, such as ➢ A newspaper headline ➢ A picture ➢ Trade fact ➢ Identity information
What does "Consensus" mean?	▪ The network agrees that the ownership changes are valid according to the network rules ▪ The network stores the changes in ownership	Two categories of consensus: **1. Relevant-party consensus**, i.e. one or more parties agreeing about the content of some data, for instance: ▪ A newspaper asserting a headline ▪ Two parties agreeing on trade facts ▪ Multiple parties signing a document **2. Network consensus**, i.e. validating parties agree that the existence of data has been legitimately uploaded ▪ The data itself could be uploaded (privacy health warning) ▪ A 'hash' or fingerprint of the data could be uploaded

Figure 10: The emergence of blockchains as activity registers, adapted from Lewis (2016) - Bitsonblocks.net

Digital token ledgers

The key characteristic of digital token ledgers, as explained by Lewis (2016) are that they record the ownership and the changes to ownership of digital tokens. The two distinct types of tokens are digital assets and digital claims.

In the case of digital assets, the token itself is the asset that is being tracked. The classic example of this is Bitcoin. In this case, the ownership of the asset is tracked on the Blockchain and ownership is registered and validated by the network (either private or public). The other case is when the digital token is a digital claim for something against someone else. The token in this case represents an IOU, which is an asset to the holder, for a claim against someone else. These tokens can be passed around to different owners, where changes in ownership is recorded on the Blockchain. The owners will eventually ultimately have to come back to the issuer to claim the underlying. As an example, the token could represent the receivable of an invoice, which could be freely traded on the Blockchain.

Activity registers

The second purpose is to securely store data, usually under the form of hashes, which as explained before, are digital fingerprints of information (Lewis, 2016). By storing these hashes, the

Blockchain can prove, that the given facts existed at a time-stamped time and that both parties agreed to the facts at hand. For example, if two participants on the Blockchain agreed to trade, they would first agree on the carious trade facts and details (dates, price, amounts, etc.). This trade data would then be converted to a hash, which both parties would have to verify, before entering it unto the Blockchain. If any participant thereafter were to try to alter details of the trade, a dispute would arise with two different versions of the truth. These two different versions could then be compared to the initial hash on the Blockchain, wherein the one that matches would be accepted as the truth while the other be discarded. In addition, as the hash is simply the fingerprint of the trade details, no sensitive data would be exposed to competitors. The Blockchain therefore acts to give "proof of satisfaction", i.e. giving evidence or assertion that something happened to the satisfaction of parties involved (Lewis, 2016).

5.4.2 The five key features of Blockchains technology

To analyze the impact of BCT on the SCF ecosystem, this section will list the key features of BCT relevant for SCF, which are derived from the technical aspects analyzed in the preceding sections. These five key features, as suggested by Hofmann et al. (2017), include the capacity for BCT: (1) to act as a notary, (2) perform clearing and settlement of transactions, (3) automate contractual relations, (4) provide an immutable (public) data storage and (5) provide transparent real-time data.

Notarization

The first primary capacity of blockchain is its potential to function as a notary. On the blockchain, all data is entered and chained together through the process of cryptographic hashing as explained above, which is then validated through a consensus mechanism. In this way, all information is automatically authenticated and time-stamped, without the need for any outside intermediary (i.e. a notary). Any party can know for certain, that any given information existed at a particular time. The safety of the cryptographic hashing process also guarantees authenticity and that no data can be tampered with.

Clearing and settlement

The second capacity for Blockchain is its potential for efficiently clearing and settling transactions. On the Blockchain, any kind of asset (in a tokenized form) can be transferred without the need of trusted third parties, through private/public key cryptography. These transactions can thereafter be efficiently settled and processed through use of the distributed ledger. This could potentially eliminate the need for post-trade affirmation or confirmation and central clearing during the settlement cycle. In addition, it could also potentially reduce the amount of data errors, disputes and reconciliation lags, leading to faster end-to-end processes (Wyman, 2016).

Trusted automation of contractual relations (smart contracts)

The third capacity for Blockchain is its potential for automatically processing the terms of a contract with smart contracts. Smart contracts have the ability to automatically change the state of an asset on a distributed ledger, according to the programming logic placed into it. This opens up the possibility for programs, which react to external inputs (e.g. goods received) and thereafter change the state of a given digital asset. For example, a smart contract could be; "***if*** goods are received ***then*** transfer X amount of asset to supplier". Smart contracts may help Blockchain business networks to evolve and may better support end-to-end business processes and a wider range of activities. In addition, smart contracts could substantially reduce or eliminate counterparty risk in trading relationships (Hofmann et al., 2017).

Immutable data storage

The fourth capacity of Blockchain is its potential to function as an immutable data storage. The cryptographic process of hashing any kind of data together in chains of data, and thereafter distribute them throughout the network, provides the possibility of an immutable data storage capacity. Once the conditions of a transaction have been agreed to, the data is available for all participants and is immune to any kind of tampering. This immutable transaction history allows for clear indication of ownership and the tracking of tokens (i.e. chain of possession).

Transparent real-time data

The fifth and final capacity of the Blockchain is its potential to provide transparent and real-time data. This distinctive trait, as explained by Oliver Wymann and Euroclear (Wyman, 2016), could eliminate the need for any type of data enrichment (such as aligning trade data with settlement data), disputes among counterparties and reconciliations. Participants on the Blockchain could selectively reveal data to one another ahead of trading time to provide a greater degree of certainty of their own reliability, and therefore reduce the risk and/or credit exposure.

These 5 key features are the primary features which we will use in our analysis on the impact on the SCF ecosystem.

5.5 Section summary of blockchain technology and its technological concepts

BCT has arguably evolved significantly since its inception as a radical innovation. Although initially intended for use as a revolutionary new currency, BCT has evolved into being a facilitator for the establishment of a trust economy. Even though blockchain shares the spotlight with many other technological innovations, such as machine learning, artificial and new innovative business intelligence systems, none of these systems have a viable solution in overcoming the issue of trust in centralized systems.

With the addition of permissioned ledgers, BCT has gained the opportunity to overcome many of the commercial limitation of the original Bitcoin. In addition, with smart contracts, BCT have been given the opportunity for applications, which are increasingly autonomous and decentralized.

These result in 5 distinct key features of BCT, namely, notarization, clearing and settlement, smart contracts, immutable data storage and transparent real-time data. These key features, and their impact upon the SCF-ecosystem will the focus of the ensuing analysis.

6 Analysis I part I: Impacts of Blockchain Technology on SCF ecosystem

As discussed in section 4, SCF is included in a larger supply chain context and essentially aims at solving the direct conflict that exists between suppliers and buyers, notably by facilitating smaller suppliers' access to liquidity and allowing both sides to improve their working capital management. The market case for SCF is growing steadily, offering more alternative financing solutions in supply chains such as Reverse Factoring, currently one of the most popular uses of SCF instruments, or Purchase Order Financing, which facilitates access to credit for suppliers at an early stage in the production process.

Although the strategic decision for a firm to onboard SCF program is facing some challenges, as described in Section 4, SCF solutions are highly dependent on the performances of underlying technological innovations and the degree of trust existent between the involved stakeholders. In this context, Section 5 has highlighted that blockchain technologies (BCT) are based on a common technological innovation facilitating trust in transactions between participants within a network. The five key features defining BCT capabilities are its ability to (1) act as a notary, (2) perform clearing and settlement of transactions, (3) automate contractual agreements, through the use of Smart Contracts, (4) provide an immutable data storage and (5) provide transparent real-time data. Together, these features enable the establishment of a trust economy between the involved stakeholders.

In this section, we will focus on analyzing the potential impacts of BCT on the SCF ecosystem.

In this perspective, we will first describe the SCF ecosystem framework as developed by Bals (2018). We will then analyze the impacts of the five key features of BCT on the SCF ecosystem framework's dimensions.

6.1 Analysis Method

To find the potential impacts of BCT on the SCF ecosystem, the analysis will use Bals' SCF ecosystem framework as the structure to guide our analysis. The analysis process was done by first reviewing the theoretical concepts of the framework, and the related relevant literature. Thereafter, the themes and findings of the theoretical background were inserted into the framework, as well as relevant secondary literature. The secondary literature was reviewed through a thematic process, in which relevant themes were selected, such as "supply chain finance" and "Financial supply chain", in order to filter the data for application in the relevant context.

In addition to Bals' framework (2018), the analysis is supplemented by the empirical findings of other related academic literature, so as to support the accuracy of our analysis and bring additional insights to the framework.

6.2 The framework of SCF ecosystems

As seen in section 4, since the global financial crises of 2007-2008, companies encountered heavy restrictions in terms of capital access. SCF offers innovative financial solutions to liquidity and working capital needs of companies bridled by this lack of access to capital.

Based on the concept of a business ecosystem, defined by Moore (1993) and detailed in Section 3, Bals (2018) argues that greater connectivity and information flow are the drivers of the SCF ecosystem, which lead to lower information asymmetry between actors.

The SCF ecosystem framework proposed by Bals (2018) identifies seven dimensions and a perspective. Figure 11 below, shows an illustration of these six dimensions, encompassed by a stakeholder perspective (e.g. Buyer, Supplier Government, and Financial Institution), which in turn is encircled by a Life-Cycle Dimension.

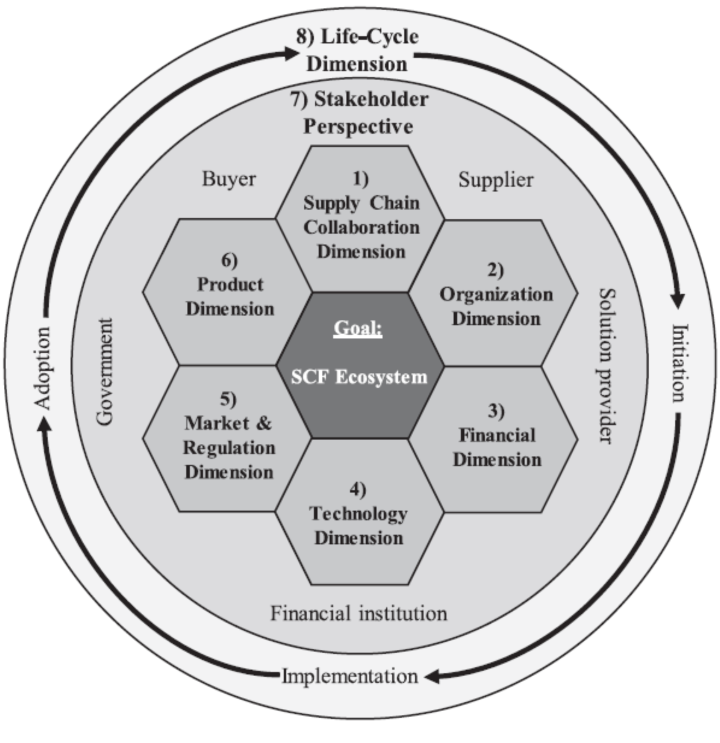


Figure 11: SCF Framework by Bals (2018)

In his working paper, Bals (2018) pointed out the absence of a comprehensive framework or theory in the literature, which could adequately explain and predict the evolution of the complex network of actors involved in SCF. For this reason, by using the principles underpinning Moore's business ecosystem framework (1993) and applying them in a SCF context, Bals identified 6 interrelated dimensions, which he argues are essential for the evolution of the SCF ecosystem. These six dimensions include:

The *Supply Chain Collaboration dimension* covers the dynamics of the interaction amongst supply chain stakeholders. Key themes of this dimension are trust and power distribution in buyer-supplier relationship.

The *Organization dimension* covers managerial and internal structural aspects within a single participant of a SCF, such as knowledge transfer and incentives. According to Wandfluh et al. (2016), financial buyer–supplier collaboration may require aligning financial strategies and structural adaptations in the cross-department collaborations, especially with regard to management decision making.

The *Financial dimension* is dealing with the optimization of financial flows among stakeholders, including working capital management, liquidity needs, credit risks assessments, cash-to-cash cycle, and financial solutions.

The *Technology dimension* is dealing with information flows across stakeholders using information technology (IT), including automation, technology innovation and IT platforms.

The *Market and regulation dimension* cover SCF market factors issues and the jurisdictional governance environment of the SCF, such as legal aspects, regulations, taxes, standards.

The *Product dimension* is centered on the ensemble of SCF solutions, such as reverse factoring, dynamic discounting, and financial institutions providers.

The six previous dimensions can be analyzed all or part through different *stakeholder perspectives*. In particular, motivations and benefits can differ largely from a buyer, a supplier or a bank perspective.

Moreover, the motivations and benefits can equally differ over time between the stakeholders of a SCF. This dynamic evolution is covered by the *Life-cycle dimension* of the Framework proposed by Bals (2018). In this perspective, Iacono et al (2015, p.287) have identified that there is a need of life-cycle dimension analysis as they observed that in some cases "the benefits of reverse factoring arrangements have been assessed purely in terms of the market state prior to implementation".

6.3 The impacts of the five key features of BCT on the dimensions of the SCF ecosystem

We will first sum up the five key features of Blockchain technology, detailed in Section 5 and then analyze their impacts on the dimensions of the SCF ecosystem framework as defined above.

6.3.1 The five key features of the Blockchain technology summarized

As seen above in section 5, the term "Blockchain technologies" (BCT) is a general term, which refers to a type of technology called "distributed ledger technology", utilizing distributed network architecture, that can either be permissionless, meaning participants have free access to the network or permissioned, wherein all participants are known and have been allowed access through a selection process.

BCT solutions allow a high level of processed interactions between participants, using a broad range of secure encrypted application utilities, potentially featuring financial securities and instruments without reference to a central database. Their purposes are, principally, recording the ownerships and registering the activity, allowing thus immutable storage and securely traced data.

Therefore, as described in section 5, the five key features of the Blockchain technology can be summarized as follow:

- *Notarization*: The first primary feature of Blockchain is its capability to function as a notary. Any party can know for certain, that any given information existed at a particular time. The safety of the cryptographic hashing process guarantees the authenticity of the data.
- *Clearing and settlement of transactions*: The second feature for Blockchain is its capacity for efficiently clearing and settling transactions through use of the distributed ledger, reducing the amount of data errors, disputes leading to faster end-to-end processes.
- *Trusted automation of contractual relations*: The third feature for Blockchain is its capacity for automatically processing using smart contracts, reducing or eliminating counterparty risk in trading relationships.
- *Immutable data storage provider*: The fourth feature of Blockchain is its capacity to function as distributed and robust immutable data storage, allowing clear indications of ownership.
- *Transparent real-time data provider*: The fifth feature of the Blockchain is its capability to provide transparent and real-time data, eliminating disputes among counterparties and therefore reducing the risk and/or credit exposure.

The combination of these five features allows the mitigation of trade risks between stakeholders and therefore, as seen in Section II, may significantly increase the trust-relationship within a SCF. The full implications of the five key features of BCT on SCF ecosystems are analyzed in the next section.

6.3.2 Impacts of BCT on the dimensions of the SCF ecosystem framework

The impacts of the five key features of BCT will be analyzed through six of the dimensions of the framework of a SCF ecosystem as defined by Bals (2018) and detailed above. This section will cover the supply chain collaboration, product, organization, financial, technology, and market and regulation dimensions. Section 7 will in turn take a more in-depth look at the seventh dimension, namely the life-cycle dimension.

Moreover, given that we have restricted our scope to analyze in particular the dynamics underlying the large buyer–small supplier relationship, the stakeholder perspective is considered to be out of the scope of this paper. However, we believe that it is possible to extend our findings to some extent by considering the point of view of the different stakeholders in the SCF context, as described in Section 4.

6.3.2.1 The Supply Chain Collaboration dimension

As indicated previously, SCF is a collaborative entity primarily encompassing three types of participants: buyers, suppliers and finance providers. These three parties have their own interests and incentives for onboarding a BCT enabled SCF-program. According to Liu (2015, p. 14696), "*the successful SCF implementation is contingent on better cooperation and collaboration in the same language between these partners*". We therefore argue that BCT's trusted automation of contractual relations along with its transparent real time flow of robust data represent a powerful vector enabling the alignment of interests and trust between stakeholders of a same SCF program, by fostering collaboration in the same language.

Moreover, several papers have already explored the intersection between the "finance" and "supply chain collaboration" dimensions of the framework of Bals (2018) as described above, identifying scenarios where trust and power issues are hindering adoption of supply chain collaborative solutions (Bals, 2018). The absence of trust reduces the supplier's willingness to adopt SCF.

The impact of BCT on trust

As seen in section 3, trust and risk are interrelated and always emerge in contexts wherein a decision needs to be reached under uncertainty and ambiguity. Aljazzaf et al. (2010: p. 1) point out that *"in human communities, there is uncertainty in the behavior of strangers. People who do not trust others avoid interacting with them."* This is especially so in supply chains between suppliers and buyers, which is furthered by the limitations of centralized systems, as pointed out in Section 5. However, mistrust between trading parties is often present and the ability to develop large and complex supply chains globally stems from mitigating relational and performance risks and finding a mutually beneficial equilibrium, in which each party trusts, that the incentives given to the other side are enough to ensure collaboration. Therefore, it is understandable, that the need for third parties to act as brokers of trust, who facilitate and maintain the contracts, transactions, and the records, have been among the defining structures upon which our legal, political and economic systems are built.

Global trade has therefore continued to rely on financial institutions to act as a trusted intermediary to carry out complex business transactions. Yet up until now, trust has always been built on a social dimension. Whether it is manifested by direct relationships, on a reputational basis or in that the incentives framework would induce a certain type of behavior, which are often the issue of an active attempt to mitigate risk. However, the advent and development of the distributed ledger technologies upon which blockchain is based, has the potential to radically transform these foundations, primarily due to the way it impacts our perception of trust as a society (Iansiti & Lakhani, 2017).

Through its unique technological prowess, blockchain is able to transform trust as a relationship-based mechanism to a process-based one through its digitization (Jarvenpaa & Teigland, 2017). This results in situations in which trust between parties in a business transaction is enhanced or in which it is not needed anymore (Mattila & Seppälä, 2016). As blockchain's underlying distributed ledger technology allows to capture verifiable and immutable information, third parties and financial institutions will no longer be as relevant when it comes to acting as trusted intermediary, but still remain pertinent in SCF program as finance providers, as seen in Section 4. According to Leibowitz (2016), the distributed nature of this technology allows it to be truly trust-free, which will allow it to act as a trust medium between parties in a transaction: "*if each participant in the transaction trusts the blockchain itself then they do not need to directly trust each other*" (Leibowitz, 2016). Blockchain would then be able to solve the reliability trust factor and mitigate to a large extent the relational risk problem in an SCF program. In essence, worthy of a Reagan-like nuclear disarmament philosophy, blockchain will give the means for firms to "trust but verify".

Therefore, it stands to reason that supply chain collaboration will be considerably impacted by the introduction of BCT in the SCF ecosystem. Trust will be guaranteed in between supply chain partners and collaboration will therefore be greatly facilitated.

6.3.2.2 The Product dimension

Closely linked with the supply chain collaboration dimension, the Product dimension of a 'BCT-enabled SCF will be improved twofold: This includes more efficiency for managing the financial flows by simplifying the risk perception in the SCF ecosystem and allowing access to a larger spectrum of approved payables solutions.

First, the adoption of BCT for implementing SCF solutions is an important enabler of trust and efficient collaborations in a supply chain as seen in the supply chain collaboration dimension. We will therefore focus on the impact of BCT on specific timing trigger events of SCF solutions described as being a key characteristic of SCF instruments in Section 4: order processing, shipping, invoicing and payment phases.

Order processing

The buyer initiates the order-processing workflow with the issuance of a Purchase Order (PO). The problem in a classic SCF is that perceived risk differs from the real risk profile because of the inability to precisely track the steps of the PO fulfilment process (see Fig. below). The real risk profile is actually the composition of credit risk corresponding at the credit rating of the buyer and the performance risk of the supplier in fulfilling the PO (Bryant & Camerinelli, 2014, p. 82).

Within a BCT-enabled SCF, the PO is immediately time-stamped and becomes, as such, an official document executed according to the terms and conditions of a smart contract (Bryant & Camerinelli, 2014, p. 9). POs therefore become valid contractual references, in which adaptions will be tracked by the embedded time-stamp mechanism registered in the Blockchain. Moreover, POs and invoices can be matched and settled automatically, due to the smart contract terms and conditions, which formalizes consistency between prices and quantities, allowing thus automated invoice approvals. The traceability of the transactions, provided by the immutability of the data stored in a Blockchain, offers clear audibility and trust between stakeholders of a Supply Chain.

Shipping and material flow

Keeping track of the material flow during the shipping traditionally requires a great deal of manual processes, usually subject to human errors, losses, damages, thefts or fraud (Harris, 2016).

In this perspective, BCT-enabled SCF offers the end customers access to robust information flow in real time, to prove the authenticity against counterfeits, through smart contracts and cryptographic multi-signatures, as the product is constantly tracked all the way through the supply chain. Moreover, during a shipping phase, trade documents (programmed as smart contracts) embedded in a BCT-system can automatically execute the payments when the products have been received (EBA, 2015).

Thus, a BCT-enabled SCF solution is based on a fully integrated and automated trade network, where documents and goods are transparently identified, tracked and registered on a distributed database. This fosters greater trust between all the stakeholders of a SCF.

Billing and invoicing

According to Harris (2016) and Lawlor (2016), the 'tokenizing' invoices using BCT is an efficient mean to avoid fraud and double-financing issues.

As explained above, the key characteristics of a BCT allow each invoice to be distributed across the network of the stakeholders, hashing and time-stamping them in order to create a unique identifier. In the eventuality of a supplier selling the same invoice twice through the network, that invoice will indicate its previous track records to all the stakeholders, and thus automatically avoiding a double financing issue.

Moreover, according to Oliver Wyman and Euroclear (2016), this notarizing capability creates a reliable source of value, that could be used as collateral in a SCF product. Because the invoices are uniquely identified in a BCT enabled SCF, and then approved and cryptographically signed by the buyer, financial institutions can be certain that the financed invoices are not previously sold or fake, reducing risk and therefore the overall cost of financing. Such a BCT-driven platform would achieve faster and safer systems.

Payment

Developed initially to create a peer-to-peer version of electronic cash to allow online payments (Nakamoto, 2009), payments were the first applications of BCT.

BCT, applied to SCF, presents high potentials in the banking industry for improving the payment services (Accenture, 2015). In particular, for cross-border payments and high transaction costs, the use of smart contracts combined with distributed ledger enable real-time transfers of funds with minimal fees and guaranteed delivery without the need for direct intervention from banks (WEF, 2016).

Wave Inc, an Israeli-based start-up, is developing a solution for SCF, using the Bitcoin Blockchain and aiming to replace printed documents with stored electronic data able to manage both invoicing activity and ownership of each document (Deloitte, 2016b).

Therefore, BCT-enabled SCF will create more efficient payment processes between the different stakeholders of a SCF, eliminating the need for each institution to maintain their own ledger. Moreover, using Cryptocurrencies could radically improve the actual payment concept within a SCF ecosystem. Moreover, financial institutions will be able to reduce considerably their perceived risk in supply chains as relevant SCF instruments are utilized (see figure below).

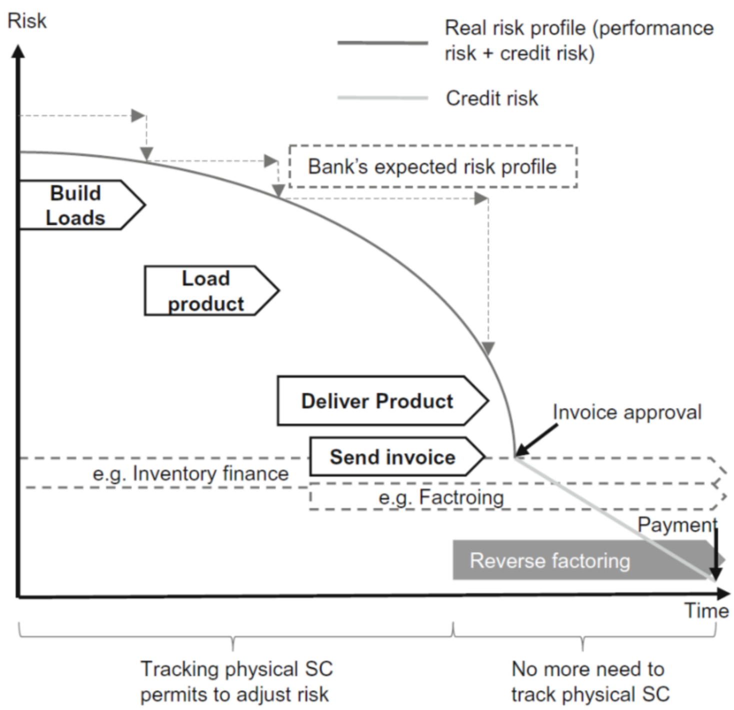


Figure 12: Risk perception in the supply chain, adapted from Camerinelli and Bryant (2014)

Additionally, if the entire supply chain uses a common BCT-solution, then the five key features of BTC could allow additional supplies access to more financial instruments, which will not be limited to tier 1 Suppliers as is in a classic SCF, but extended safely to all tier suppliers, allowing them to reach higher degree of competitiveness, transparency and flexibility. For instance, through a BCT-enabled SCF, the spectrum of possibilities of instruments concerning approved payables financing is can be widened to include instruments such as reverse securitization, in which the supplier's receivables are packaged and sold on capital markets directly to investors (see Appendix 12.7).

6.3.2.3 The Organization dimension

The Organization dimension as described by Bals framework covers managerial and internal structural aspects within a single participant of a SCF, such as knowledge transfer and incentives.

As seen above, BCT solution will foster the alignment of interests and trust between stakeholders of a same SCF program. As direct consequences, the internal organization of each firm of the same SCF will evolve towards more interoperability and more structural alignments.

Moreover, according to Wandfluh et al. (2016), financial buyer–supplier collaboration may require aligning financial strategies and structural adaptations in the cross-department collaborations, especially with regard to management decision making.

An obvious example of the cross departmental collaborations is the corporate accounting. As it was initially intended to serve a distributed system for digital cash, distributed ledger technology enabled by BCT could potentially be used for corporate accounting. The key characteristics of BCT allow new ways of managing ledger entries in a network of companies and thus changing the auditing processes in a SME registered in a BCT enabled SCF ecosystems. In a disruptive scenario, key features of immutability and transparent real-time data could potentially replace auditors if all business transactions of a SCF take place on a Blockchain (Lazanis, 2015). As all transactions can be registered and validated, performing an audit could be automated and eliminate related high audit costs. A more conservative scenario, detailed by Deloitte (2016a).

Deloitte (2016a), sees the BCT key characteristics allowing auditors to automatically verify large portions of financial data. The cost and time necessary to conduct an audit will therefore be strongly reduced. The application of BCT based SCF in corporate accounting could therefore represent an opportunity.

6.3.2.4 The Financial dimension

"Financial objectives make generally all companies want to become "late payers" and "early collectors". This situation, however, can increase transaction costs in the form of credit risk and rating, with capital costs being transferred from certain levels to others in the supply chain." (Vázquez et al., 2016, p. 324). BCT-enabled SCF has clear potential to benefit supply chain stakeholders, by including more visibility for the

financial institutions regarding the flow of goods, cash, working capital information, leading to more efficient and faster processes for the approval of orders.

"Failing to recognize the role of banks in synchronising the flow of goods with financial and information flows, and in managing supply chain collaboration, information sharing and visibility, is to miss significant opportunities for improved supply chain performance." (Silvestro & Lustrato, 2014, p. 317). As such, BCT will enable a higher level of collaboration between Banks willing to invest in SCF solutions and therefore easing the cash cycle in a SCF.

According to Randall and Farris (2009), Cash-to-cash cycle management and supply chain-optimized capital financing provides value that has previously been left on the table (Randall & Farris, 2009). The key characteristics of BCT enable more visibility and more trust among the stakeholders of the same SCF-program, thus mitigating the risks for the investment of the banks. This will allow an easier management of the Cash to cash cycle in SCF.

As a result, the adoption of a BCT-enabled SCF will potentially reduce the overall cost of the supply chain while maximizing the satisfaction level of the end customer. For instance, the rigid structure of invoice discounting can be eliminated using BCT platforms for SCF solutions. In the classical SCF model, the funding is provided by a financial institution, usually the buyer's commercial bank, which finances the early payments at the supplier's request. In a BCT enabled SCF, the distributed ledger along with the key characteristics of BCT, described above, could allow greater flexibility for a pool of banks working together within the same supply chain and offering new possibilities for the stakeholders. Banks could reach higher scalability by using BCT. Clients and suppliers could then benefit of lower costs for financing SCF solutions.

6.3.2.5 The Technology dimension

As seen, in Section 5 about the techno-economic of the BCT, it is important to understand that reaching maturity for an innovation is a collective process, as it interconnects with other technologies and innovations, forming new paradigms on their own. Technology is seen as an integral part of a modern supply chain (Walton and Gupta, 1999). Banks have been reluctant to respond to the request of companies to help them improve supply chain performances due to technology and system integration issues (Silvestro & Lustrato, 2014). According to Silvestro and Lustrato (2014), technological challenges hinder SCF adoptions.

With BCT, a growing role of the technological dimension is available in SCF. For instance, IBM's autonomous decentralized peer-to-peer telemetry (ADEPT), combines internet of things (IoT) technologies with BCTs. A product is registered into a Blockchain, so that the product remains a unique entity within that Blockchain throughout its life, even when it changes ownership (Sanjay Panikkar et al., 2015) In such a Blockchain-based IoT, the possibility of maintaining product information, its history, and warranty details transforms the Blockchain into a trusted database.

The BCT is therefore a disruptive technology as the technology dimension of a SCF ecosystem is likely to become a primary concern for all the stakeholders of a SCF, as they will all be compelled to adapt their IT systems in order to interoperate in a BCT network.

6.3.2.6 The Market and regulation dimension

Legal regulations vary strongly in different countries. However, Wu (2011) found that, with the introduction of property legislation, movable assets could be treated as either pledge or mortgage. As a result of an inadequate legal system, this could lead to many security rights being tied with the same movable assets, resulting in banks losing property rights. Liu (2015, p. 14697) suggests that it is imperative to "improve the judicial interpretation of property law and establish a registration and inquiry system for movable assets." In this context, BCT has the capacity to standardize the notarial processes of the property. Therefore, the judicial interpretation of property law for movable assets is achievable through BCT-enabled SCF. Equally, according to More and Basu (2013), the cross-border transactions are complex within various legal jurisdictions. These cross-border transactions are "often slow and inefficient and lead to challenges for the global Supply Chain." (More & Basu, 2013, p. 629).

BCT could achieve this imperative through its key characteristics, as it could potentially impose standardization in terms of interpretation of legal regulations between the stakeholders of the same SCF. Moreover, in order to protect financial systems from illegal activities, such as money laundering, 'know your customer' (KYC) checks are mandatory prior to any financial business with a new supplier, and are usually costly processes. If a bank wants to take part in a program with numerous suppliers, the costs could rapidly represent an important issue. A survey from ICC Global Trade Finance (2014) points out that compliance requirement is one of the principal barriers for onboarding SCF.

The key features of BCT concerning a decentralized database in which information is immutably recorded and available in real time allow financial entities to access secure and trusted sources of information about suppliers in a SCF.

Therefore, BCT enabled SCF represents a useful use for KYC and anti-money laundering (AML) purposes, as it offers cost-effective KYC checks when a newcomer is onboarded in a SCF ecosystem (usually smaller SME suppliers) (Nassr & Wehinger, 2014). Deloitte (2016a) sees BCT as particularly useful for this purpose. They underline the fact that it is possible to avoid duplication of KYC checks by sharing and registering previous checks on a Blockchain.

A BCT enabled SCF could therefore provide a trusted registry for which access to information could be restricted only to interested stakeholders, and therefore greatly facilitate the handling and organizing of identities for KYC requirements. A cost-effective onboarding process could be simplified in a BCT enabled SCF, particularly for buyers with a network of suppliers coming from different jurisdictions. Moreover, a shared and trusted KYC registry could encourage financial institutions to participate in BCT enabled SCF ecosystem.

Furthermore, SCF represents an opportunity to deal with Basel III regulatory framework. The low risk profile and the inherent liquidity of trade credit solutions has made SCF solutions an attractive asset class for dealing with the restricted capital ratio calculation directives imposed by regulators (Bryant & Camerinelli, 2014).

6.3.3 Limitations of Bals framework

While the framework presented by Bals (2018) is very comprehensive, there are a couple of flaws to it. First, it considers all of these dimensions to be of equal weight in describing the SCF ecosystem dynamics. However, as we have seen, the technology dimension has relatively more pull than the market & regulation dimension for example. This is because advancements in technology have a universal reach into all aspects of SCF and is at the base for its development, whereas market & regulations are geographically based and more static in their nature. In themselves, resolving market differences and regional regulatory challenges only add to the complexity of providing SCF solutions globally – something which could potentially be solved through technological innovation. Secondly, the framework presented has a very limited predicting power over the SCF ecosystem dynamics. While the main objective of the author was to provide an ecosystem perspective to SCF, it shows a very static picture of SCF as is and fails to provide tools by which to anticipate.

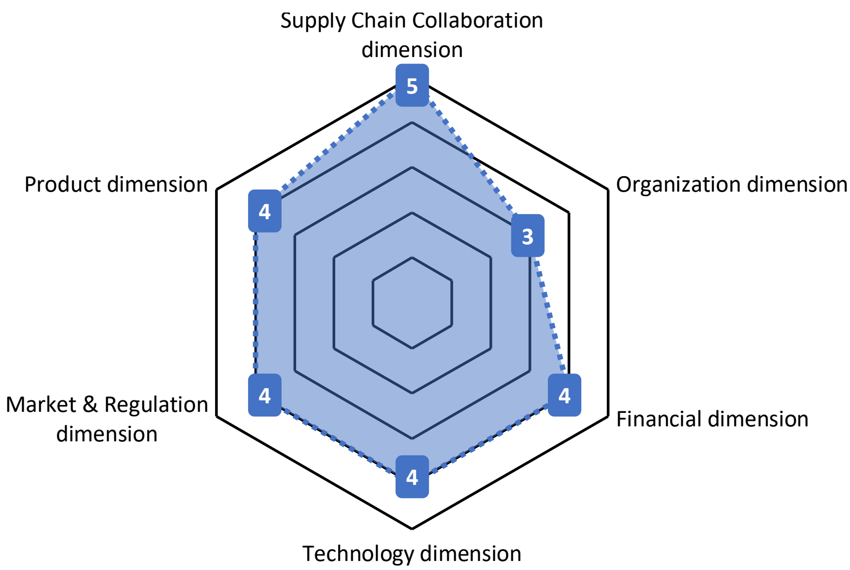
As seen in Section 2, Moore (1993) is the first to introduce the idea of a business ecosystem drawing on concepts from biology. His argument is that business environments are not static but instead its various elements interact and co-develop together to create a dynamic business ecosystem. Technology plays a big part in shaping a business ecosystem: *"in a business ecosystem, companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the new round of innovations."* (Moore, 1993, p. 76). Ultimately, the only true sustainable competitive advantage is to innovate more than the competition.

6.3.4 Conclusion of BCT impact on SCF

6.3.4.1 Review of impact

As seen in each section above, BCT impacts significantly the dimensions of the SCF ecosystem described by Bals (2018) (see figure below). Greater connectivity and information flows constitute the innovation at the center of the SCF ecosystem, leading to lower information asymmetry between stakeholders and implying thus a mutation of the classic model, based on a dyad relationship between a buyer and a Tier 1 supplier, to a distributed secured trusted multi-actor relationship.

Looking more in depth at the impact of BCT on each of the dimensions of a SCF ecosystem as defined by Bals (2018), we can argue the following using a rating system with 5 points, ranging from 5/5, full impact, to 0/5, no impact:



Supply chain collaboration dimension is the most impacted by BCT. Added transparency and trust between stakeholders will lead to a natural alignment of incentives and interests working towards common objectives. The trust-based relationship enabled by BCT among stakeholders of a SCF ecosystems lead to minimal risk perceptions, and better overall performances, as highlighted in the Trust and Risks theories detailed in Section II.

Organizational dimension is in contrast the less impacted dimension, as BCT is not likely to change dramatically corporate cultures and internal structures, although improving processes and allowing internal clarifying and transparent interactions in a SCF. Although, with the addition of a fully private ERP blockchain solution, this could very well change how information is handled internally.

Financial, technology, product, market and regulation dimensions all stand to impact the SCF ecosystem more or less similarly. The key characteristics of BCT will enable participants to perform KYC more efficiently, perform transactions autonomously due to smart contracts, as well as create the potential for new and underutilized types of SCF instruments.

Overall, BCT will allow SCF, greater transparency, better credit risk assessment, trust-based relationship, more available financial instruments which are more suited to all tier suppliers, optimized management of Working Capital through automated and cheaper processes. Due to its capability to standardize securely processes, BCT could potentially become the main operating technology solution for SCF, but also for Supply Chain Management.

BCT will help with legal standardization of SCF instruments through notably its smart invoices. For instance, POs will be able to be considered legal contracts, which can be insured or traded. Additionally, it will ease considerably the process of undergoing KYC and AML checks when onboarding suppliers.

The increased transparency and verifiable authenticity of the flow of goods in supply chains through BCT will allow expansion of the current portfolio of products: not just limited to approvable receivables finance (Reverse factoring, dynamic discounting) but also to pre and post shipment finances;

However, market dynamics and regulatory changes remain unforeseen and it is not evident today that Blockchain will be adopted by all the jurisdictions to its full SCF application extend. Firms will possibly still rely on classic communication and technological platforms for other business functions. Without Blockchain, SCF still disposes of a handful of reliable instruments, evident from its current success.

6.3.4.2 Implications for SCF

In the context of SCF in the 21st century, innovation draws largely from greater information and connectivity flows, which are enabled by the growth of the information technology sector over the last decades. This in turn continues to challenge the existing business models as information is more readily available to all actors involved. Therefore, BCT enabled SCF solutions are inevitably centered around information and financial flows between multiple stakeholders, where as seen in Section II, classic SCF relationship are shaped around a dual relationship between a Buyer and a Supplier Tier 1.

On a broader scale, BCT enabled SCF will allow a higher level of inter-firm collaboration and can change the existing relationship between companies in the supply chain. We therefore argue, that BCT enabled SCF ecosystems, are radically changing the nature of the relationship between the stakeholders of a same SCF, mutating from a duality Buyer-Supplier to a multi-actor real time distributed flow of information, between the buyer, all tier Suppliers and the financial institutions.

SCF has traditionally been driven by international banks that are more focused on cross border trade, but its adoption has been slow due to weak recourse environments, as well as scalability and origination costs. However, BCT initiates a shift toward digitization and automation of SCF transactional flows and SCF solutions.

We argue that the key characteristics in BCT enabled SCF are potentially its ability to transition from paper-based transactions to trusted electronic flow data including invoicing, to move from a buyer-centric model dealing bilaterally with tier 1 suppliers to a trans-border distributed network of buyers and suppliers with no defined central node and to use dataflow to assess the credit of many financial institutions.

BCT enabled SCF could not only prevents disruptions, but also helps stakeholders to better manage their financial risks. André Casterman, a member of the ICC Banking Committee states that "a big innovation in the market would be using transactional data for risk assessment and mitigation. The data collected through technology providers can be used to enhance the knowledge of the credit-worthiness of a particular enterprise, industry, or region." (IFC, 2017, p. 1).

Historically, the issue represented a major problem for organizations and was addressed by either using multiple SCF programs or by only allowing participation in the SCF program to a specific subgroup of suppliers. However, as this dilemma has persisted within the industry, fintech providers have begun developing hybrid SCF solutions that allow companies to self-fund as little or as much of their program as they see fit and rely on 3rd party funding to service the rest of the program. This may mean that one segment of a buyer's supply chain is serviced through a traditional SCF program that uses 3rd party funding, while another segment is serviced through a dynamic discounting program that uses the buyer's own cash. However, both programs are run centrally over the same platform and use the same interfaces. In this way, a buyer can manage supplier financing operations for their entire supply chain through a single solution, even if different financing programs are used for different groups of suppliers.

The availability of hybrid SCF solutions allows buyers to benefit from a supply chain finance program without having to overcommit on funding or rely too exclusively on 3rd party funders.

6.4 Section summary of the impacts of Blockchain Technology on SCF ecosystem

We have demonstrated in previous sections that SCF essentially aims at solving the direct conflict that exists between suppliers and buyers, notably by facilitating smaller suppliers' access to liquidity and allowing both sides to improve their working capital management. Analyzing then blockchain technologies (BCT), we have highlighted that BCT is facilitating trust in transactions between participants within a network.

In this section, we have argued that BCT impacts significantly the dimensions of the SCF ecosystem described by Bals (2018). Greater connectivity and information flows constitute the innovation at the center of the SCF ecosystem, leading to a mutation of the classic model, based on a dyad relationship between a buyer and a Tier 1 supplier, to a distributed secured trusted multi-actor relationship. In this perspective, BCT enabled SCF could not only prevents disruptions, but also helps stakeholders to better manage their financial risks, allowing therefore new financial instruments such as hybrid SCF solutions where companies are able to self-fund part of their program and to rely on 3rd party funding the rest of the program.

Having analyzed the impacts of BCT on SCF ecosystem, we will now investigate the potential impacts of Blockchain technology-based SCF ecosystem on the process of adoption of SCF solutions

7 Analysis I part II: The potential impacts of Blockchain technology-based SCF ecosystem on the process of adoption of SCF solutions

Having analyzed how BCT stands to impact the SCF ecosystem, we now take a more practical approach for managers to effectively make decisions regarding the adoption of BCT enabled-SCF.

As described in section 4, SCF is an effective way to deal with short-term liquidity concerns for both buying firms and suppliers. It can also provide a longer-term financial advantage to the supply chain by eventually reducing the overall extent of liquidity needed to sustain a supply chain: when the financial flow is coordinated throughout a supply chain, it requires lesser amounts of liquidity than in an uncoordinated one (Protopappa-Sieke & Seifert, 2010), which in fine leads to greater savings for buyers and suppliers especially when their credit ratings differ significantly (Pfohl & Gomm, 2009). However, despite the clear financial gains for all parties involved, adopting and implementing SCF remains organizationally challenging and complex (Protopappa-Sieke & Seifert, 2010).

Up until now we have looked at SCF from a business ecosystem perspective as presented by Bals (2018) based on Moore (1993). However, in order to fully grasp its criteria for widespread adoption amongst firms, we can also view SCF in a narrower context as an innovation. By building on an extension of Rogers (2003) diffusion of innovation theory, we present SCF as the process innovation underlying the SCF ecosystem. This part looks at how organizations adopt SCF, more specifically at on buying firms influence suppliers to on-board SCF programs. We therefore first present SCF as a process innovation, and then building on Rogers' (2003) extension of his diffusion of innovation theory on the organizational innovation adoption, we present the key factors affecting the adoption of SCF in an organization. Finally, using our findings from Section 6, we analyze the impact that BCT has on this process of SCF innovation adoption.

This analysis will help us guide our understanding of how the introduction of BCT will impact the evolution of the SCF ecosystem, which will be described in more detail in section 8, by looking under the hood at the means by which BCT facilitate the adoption and implementation of SCF programs across organizations.

7.1 SCF as a process innovation versus SCF ecosystem

While literature on SCF has mainly focused on researching the mechanisms surrounding SCF instruments and programs as well as pointing out their benefits and limitations, it seems to have very little to say about adopting SCF within organizations and its implementation processes.

Scholars are increasingly recognizing this gap and some have already attempted to provide insights into the SCF adoption process, and as we will see in the next subsection, Wuttke et al. (2013) offer an empirical approach to understanding the SCF adoption factors in organizations.

While the construct of innovation has many definitions, the existing innovation literature seems to agree that novelty is at the center of it. We therefore define innovation as "*any idea, practice, or material artefact perceived to be new by the relevant unit of adoption*" (Zaltman et al., 1973, p. 10). It should be noted that this does not mean that any new thing is necessarily considered as an innovation, as it needs to be relevant to the entity adopting the innovation.

Johannessen et al. (2001) categorize innovation as being either a product or a process innovation. Given that SCF does not influence the end physical product of either the buyers or the sellers, SCF is then a process innovation, as it provides a new alternative means to manage financial flows in a supply chain. Additionally, as will be described below in further details, SCF processes are significantly redesigned throughout the innovation adoption process, which therefore impacts the buyers and their suppliers, i.e. the unit of adoption, considerably.

This innovation process view of SCF contrasts with an ecosystem perspective of SCF in terms of the significant difference in scope. SCF as a process innovation focuses on the mechanisms and instruments developed to solve specific organizational hurdles by creating new processes such as with the optimization of working capital (see Section 4, rationale for SCF adoption). In comparison, an SCF ecosystem takes a much broader view of the business environment surrounding this innovation and includes all kinds of stakeholders which contribute to the environment. In this sense, SCF as a process innovation is the basis on which the SCF ecosystem is built.

7.2 Innovation adoption of SCF solutions

Wuttke et al. (2013), based on an empirical case study of 6 European firms, analyze the conditions for the adoption of SCF as a process innovation. The authors draw on the five stages of organizational innovation adoption, an extension of Rogers' (2003) diffusion of innovation theory and adapt it to the SCF context:

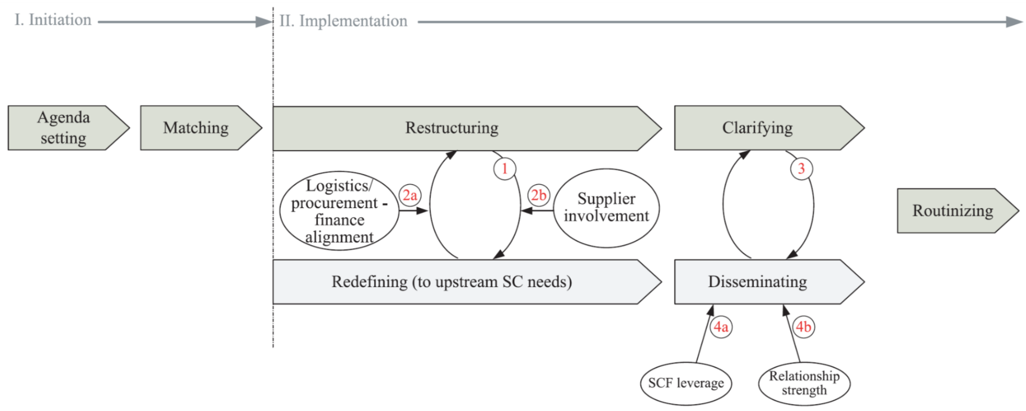


Figure 13: Organizational innovation in the SCF context according to Wuttke (2013)

7.2.1 Initiation of and decision on SCF adoption

According to Rogers' (2003) model, which we described in section 3, the initiation phase comprises of agenda setting, i.e. information gathering concerning general organizational issues and the potential for added-values of the integration of an innovation in the organization, and matching, i.e. planning and designing the potential match between problems from the organization's agenda with an innovation. Essentially it involves all of the considerations, actions and decisions that need to be made by the firm interested in the value of an innovation to reach a decision on whether to adopt it.

Wuttke et al. (2013) found that there were three main organizationally intrinsic factors determining the success of this stage:

(1) Organizational culture – the extent to which an organization's culture is open to change and can incorporate new innovations.
(2) Uncertainty avoidance – the degree with which an organization's risk aversion impacts its willingness to innovate.
(3) Lack of top management commitment – top management's commitment to innovate.

Firms are then more likely to adopt an SCF program if their corporate culture is open to innovative business models, if their organization has a low risk aversion, and if top management is strongly committed to actively pursue innovations. By contrast, corporate cultures shaped by tradition and continuation, high risk aversions and priorities for top management that do not include innovation, they will be less likely to adopt an SCF program (Wuttke et al., 2013).

Several other factors also play a role in the decision to adopt by firms. For instance, according to Rogers (2003), firms need to be able to see that the potential value that an innovation brings is in line with their strategic priorities. With SCF this is the case as the firms involved, i.e. the buyers and suppliers, are both looking to optimise their working capital and improve the overall stability of the supply chain at the same time. Moreover, the competition's attitude towards SCF adoption is also a way for companies to glimpse at the opportunities available, and to foster imitation among other firms. Still, this decision to adopt at this stage remains internal to each organization and there is not yet any intercommunication between buyers and suppliers.

Nevertheless, it is important to note that compared to mainstream innovation literature, SCF distinguishes itself in two main ways: first, SCF is an upstream innovation whereas most of the existing innovation literature focuses on diffusing innovation downstream to end-customer as a result of competitive pressures or demand patterns (Wuttke et al., 2013). In the case studies conducted by Wuttke et al. (2013), only a handful of suppliers demanded explicitly SCF solutions from their buying partners, meaning that buyers are at the origination point of the SCF innovation. SCF could therefore be seen as a push innovation rather than a pull innovation, wherein buying firms have to persuade suppliers to onboard an SCF program. Second, as opposed to being able to test for the instant success of a downstream innovation, which is often linked to a profitability lifecycle, SCF focuses on longer-term efficiencies in order to optimize the management of working capital through structural changes, and therefore the success of SCF program might take some time to truly materialize.

7.2.2 Implementation of SCF

According to Van de Ven (1986), the success of the adoption of an innovation is contingent on its ability to accustom the needs of the organization implementing it. This can be done in three main ways: either by redefining the innovation to fit the needs of the organization, by restructuring the organization so to accommodate the innovation, or a combination of both (Rogers, 2003). Additionally, after having successfully redefined the innovation and restructured the organizational structure accordingly, a firm must then be able to clarify internally the relationship that exists between the organization and the innovation, as the latter is gradually put into regular use. Finally, in the context of SCF, the added step of upstream dissemination is required as buyers need to convince their suppliers to adopt the SCF innovation.

Redefining

As described in section 3 in Rogers' (2003) stages of organizational innovation adoption, redefining is the process in which innovations need to adapt to the specific needs of the firm but also take into account the contextual factors surrounding it. In this sense, the interests of suppliers play a significant role in the adoption process for buyers as SCF needs to be configured to address both buyer and supplier needs. For instance, an SCF program might be adjusted to provide cashflow and invoicing visibility to the supplier, because the supplier might value increased flexibility concerning its payments to be able to plan (Wuttke et al., 2013). Similarly, the SCF program might be implemented through a supplier's own existing IT platform rather than having recourse to a third party (Wuttke et al., 2013). Before defining a SCF solution, companies therefore need to comprehensively understand the requirements needed for the implementation of a SCF innovation.

According to Wuttke et al. (2003), three main patterns of redefining SCF can be distinguished: (1) benefits allocation mechanisms, (2) degree of automation of transactions, and (3) scope of suppliers using SCF.

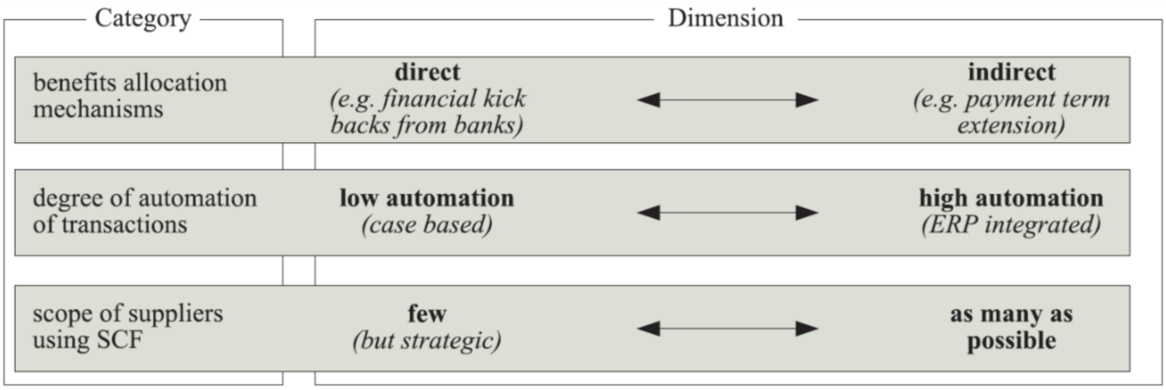


Figure 14: Categories of redefining the SCF innovation (Wuttke et al., 2013)

Restructuring

Compared to most organizational innovations, redefining SCF needs to consider the needs of upstream supply chain partners and is therefore closely intertwined with the restructuring stage (Wuttke et al., 2013). Therefore, in an SCF context, the redefining and restructuring stage have to be envisaged together, making the adoption of SCF more intricate compared to generic innovations.

Moreover, Wuttke et al. (2013) argue that the strategic alignment of logistics and procurement/finance functions, and not just mere project-based collaborations, is a key indicator of the success of this stage. Overall, SCF requires a significant internal alignment between different departments whose operations relate to SCF, which need to be persuaded to use SCF and which can create management issues, and onboarding suppliers early in an SCF innovation project can therefore prove to be challenging as the buying firm has not yet fully delineated and incorporated SCF.

Clarifying and disseminating

Clarifying within the organization is one of the most important tasks in the process of adopting an innovation (Van de Ven, 1986). As seen in section 3, clarifying consists of defining clearly the relationship between the innovation and the organization as the innovation is gradually put into use. Wuttke et al. (2013) find that, in the context of SCF, there is an added dimension to this stage: upstream dissemination, which relates to spreading the use of SCF among suppliers.

Both clarifying and dissemination are closely interrelated, as suppliers upstream will be less incentivized to explore the SCF innovation without a clear clarification. Conversely, as more suppliers onboard the SCF program, dissemination helps clarify the value and practicability of SCF.

As such, external organizations then play a much bigger role in the innovation process than in the downstream diffusion of innovation case (Rogers, 2003; Van de Ven, 1986). Whereas the downstream innovation dissemination process focuses on developing new products by investing, maintaining and improving in long-term supplier relationships (Kim, 2000), the case of upstream dissemination concentrates on persuading the key players to adopt the innovation.

Effectiveness of the upstream dissemination process

In order to convince their suppliers to onboard SCF, buyers have two main tools at their disposal: SCF leverage, and the relationship strength that exists between the buyer and each of its suppliers (Wuttke et al., 2013). These factors help to predict whether the buying firm will be able to effectively disseminate the SCF innovation.

The SCF leverage that a buying firm has over their suppliers represents the ensemble of benefits that they can provide the suppliers through an SCF program. These benefits need not be only financially based: while the core principle of SCF is to use the buyer's credit rating to provide cheaper financing to suppliers, Wuttke et al. (2013) found that the qualitative qualities that come with an SCF offering could also be of equal importance to the supplier. For instance, a supplier might value the increased flexibility from full transparency on SCF payment and automatization processes in order to better anticipate payment schedules. Sometimes even these qualitative benefits can be perceived as being more valuable than the cheaper access to financing itself: a supplier might instead prioritize the diversification that an additional financing source brings rather than the difference in financing costs (Wuttke et al., 2013). In that sense, the buyer's SCF leverage over suppliers is dependent on the way that the SCF is structured to fit the supplier's needs and the scale and scope of the financial advantages it can provide through a SCF instrument. Therefore, developing an SCF leverage stems from the organization's capacity to provide these benefits to its supplier rather than from its relationship with the supplier.

The relationship strength that exists between the buyer and the sellers is another factor that determines the effectiveness with which buyers can disseminate upstream SCF to its suppliers. It is based on three key levers: (1) trust, (2) buyer-power, and (3) communication obtrusiveness (Wuttke et al., 2013).

(1) The more relational trust there is in between the buyer and the seller, the more willing the supplier will be to adopt SCF. Wuttke et al. (2013) take the example of a supplier which only came onboard the SCF program after its buyer directly introduced it to instead of trusting the buyer's bank, which acted on the buyer's behalf and which attempted to do the same beforehand.

(2) The more power a buyer yields over its supplier, the more likely it is that the supplier will adopt SCF at the buyer's request. A quote from a buying firm's financial manager from Wuttke et al.'s (2013, p. 158) research describes it best: "*We would say to our supplier, 'We will extend payment terms anyway. It is up to you—take our SCF offer or leave it.*". And as is often the case for smaller suppliers, which are heavily dependent on their larger counterparts (sometimes upwards of 50% of their revenues), suppliers are then in no position to refuse. Interestingly, this kind of coercive power is used to further strengthen the supplier's financial strength instead of as tool to take advantage of the supplier's relative weakness.

(3) The more sophisticated the communication channels are between the buyer and the supplier, the easier will it be for the buyer to persuade the supplier to onboard to adopt SCF. For instance, workshops and meetings between the firms' respective finance professionals, often seen in practice with the buyer's important suppliers, will be easier to onboard than the ones with which communication is limited to simple e-mails and phone calls (Wuttke et al., 2013).

These four levers available to buyers to convince suppliers of the merits of SCF – SCF leverage, trust, power, and communication obtrusiveness – differ in the degree of influence that they hold over suppliers (Wuttke et al., 2013). For instance, using buyer power on smaller suppliers is much more effective than merely communicating the potential benefits of SCF. However, they also differ in the consequences that their respective use has on the quality long-term buyer-supplier relationship. Compared to SCF leverage that presents real benefits for the supplier, using coercive force, mainly in cases where the buyer might meet resistance from their suppliers, might result in a weakening of the buyer-supplier relationship's strength (Wuttke et al., 2013). Ultimately, the reciprocity between the effectiveness of the buyer's persuasion levers and the quality of the buyer-supplier relationship adds further complexity to the diffusion of the SCF innovation.

Overall, the successful upstream innovation dissemination of SCF can only be achieved if certain conditions are met. First, the redesign of SCF to suit the needs of both buyers and suppliers as well as the internal organizational restructuring needed to accommodate these financing changes need first to be successful. Second, the buyer has to be able to have enough SCF leverage and relational strength with its suppliers to persuade them to onboard their SCF program.

We will now apply our findings on the analyze of the impacts of Blockchain technology on the innovation adoption of SCF.

7.3 The impacts of Blockchain on the innovation adoption of SCF

As our findings in section 6 showed, the introduction of BCT in the SCF ecosystem will allow for greater transparency, better credit risk assessment, higher trust in buyer-supplier relationships, more available financial instruments which are more suited to all tier suppliers, optimized management of Working Capital through automated and cheaper processes.

Therefore, BCT affects the innovation diffusion of SCF as described above in a couple of ways:

First, the subsection above explained that the redefining and restructuring stages are closely linked and that its success is dependent on the degree to which a buyer accounts for the needs of the upstream suppliers and is able to achieve a logistics-procurement/finance alignment within its organization. The needs of the upstream suppliers in turn depend on their unique preferences with regards to the way that SCF is set up through, (1) the benefits allocation mechanisms, (2) the degree of automation of transactions, and (3) the scope of suppliers using SCF (Wuttke et al., 2013).

Introducing BCT to the SCF ecosystem, has therefore several implications for its adoption on this stage:

- Provided that blockchain technologies will eventually become an integrated part of each organizational structure in the supply chain, alignment between the logistics function and the procurement/finance departments will become more manageable and straight-forward as BCT will improve processes, allow internal clarifying, and transparent interactions in a SCF
- As BCT will be able to provide a high level of standardization and visibility throughout the supply chain, buyers will no longer need to adapt their SCF program to suit the needs of the suppliers as options that suit all of its suppliers' benefits allocation preferences will

most likely already be incorporated. It is imaginable to anticipate that a combination of SCF configuration options will be able on the buyer's respective BCT platform to provide a tailored solution for each supplier.

- Similarly, consideration regarding the scope of the suppliers onboarded will also be altered: buying firms will no longer be limited to onboarding only a few select suppliers of high strategic importance but will able to onboard suppliers across many more tiers of the supply chain.
- The degree of automation of transactions will also inevitably become automated and integrated into each supplier's IT systems, as the BCT platform will already be implemented throughout the supply chain. This will then, in addition to smart contracts and invoicing available through BCT, allow the buyer to forego the need to set up SCF transactions on a case-by-case basis.

Second, the subsection above outlined that clarifying and dissemination are closely interrelated, and that upstream dissemination is dependent on the buyer's ability to persuade its suppliers to adopt SCF. This ability is the product of four main levers: (1) SCF leverage, (2) relational trust, (3) buyer-power, and (4) ease of communications.

Introducing BCT to the SCF ecosystem, has therefore several implications on the buyer's upstream dissemination process:

- The SCF leverage that buyers are able to offer to their suppliers will increase dramatically as more products will be readily available as finance providers will be able to better assess the credit risk, buyers will have more visibility into their supplier's operations to best service their needs, and the legal standardization of SCF instruments through notably BCT's smart contracts will allow financing solutions to be created earlier in the supply chain process.
- BCT-driven SCF will also strengthen the quality of the buyer-supplier relationship:
  - As actors will rely on BCT to act as a broker of trust, the importance of relational trust between the suppliers and buyers will be greatly reduced in the process of SCF adoption.
  - Through its key characteristics and given the structural changes and IT adaptation that BCT will bring about in organizations, communication will be facilitated between the suppliers and buyers and the need to coordinate transactions and processes between organizations will also be lowered

- Additionally, while the buyer-power element is likely to remain relatively unaffected by a BCT implementation, the developments of the SCF ecosystem as described in section 6 in terms of the increased availability of financing solutions, the alignment of the buyers-suppliers interests and the elevated level of transparency throughout the supply chain, will mitigate the need for a buyer's coerciveness to convince suppliers to onboard SCF.

Finally, while the need for internal clarifying is still essential regardless of the impacts of the BCT, BCT will allow a smoother upstream dissemination by resolving a number of obstacles and therefore, as more suppliers and buyers onboard SCF, the clarifying process will become less challenging.

Overall, most of the obstacles currently hindering the adoption and implementation of SCF will likely be solved through the implementation of BCT in organizations. As blockchain standards emerge, implementation costs will be lowered. The balance of power will change, trust will be almost completely guaranteed, and communication greatly facilitated. SCF leverage will become greater as more financial instruments will become readily available, finance provider will be able to better assess risk, and BCT will engender lower transaction costs. Therefore, we argue that the implementation of BCT in supply chains will accelerate the adoption of SCF amongst suppliers and buyers.

However, it might be the case that the implementation of BCT in a given organization will require a considerable effort to internally clarify its role. Therefore, the real challenge for buying firms will not be in disseminating the SCF amongst its supplier base but rather onboarding them to a common BCT platform.

7.4 Section summary of the potential impacts of Blockchain technology-based SCF ecosystem on the process of adoption of SCF solutions

The introduction of BCT in the SCF ecosystem will allow for greater transparency, better credit risk assessment, higher trust in buyer-supplier relationships, more available financial instruments which are more suited to all tier suppliers. Therefore, BCT will affect the innovation diffusion of SCF and thus its adoption. BCT will improve processes, to provide a high level of standardization of the SCF.

Similarly, consideration regarding the scope of the suppliers onboarded will also be altered. Buying firms will able to onboard suppliers across many more tiers of the supply chain, which in turn will have an increased availability of financing solutions. In addition, BCT enabled SCF will allow a smoother upstream dissemination by resolving a number of obstacles and therefore, as more suppliers and buyers onboard SCF, the clarifying process will become less challenging.

Overall, most of the obstacles currently hindering the adoption and implementation of SCF will likely be solved through the implementation of BCT in organizations. Therefore, we argue that the implementation of BCT in supply chains will accelerate the adoption of SCF amongst suppliers and buyers.

The next section therefore seeks to understand the impacts of the state of Blockchain. technology maturity on the overall evolution of the SCF ecosystem.

8 Analysis II: The impacts of the state of Blockchain technology maturity on the evolution of the SCF ecosystem

In the previous section, we highlighted the key features of BCT and argued that it has distinct potential to impact SCF ecosystems. However, in attempting to prove this possibility, we have imposed a contradiction on our research. If there are convincing opportunities for BCT enabled SCF business applications, why are there next to none use-cases of this present today? An apparent and obvious answer to this question is that the technology still needs to evolve for it to progress along the diffusion of innovation curve, so that more use cases can emerge. However, this is a somewhat inadequate answer and reveals only a partial truth. Blockchain has existed for almost 10 years, but the large-scale disruption which many BCT supporters envisioned, have still not come to bear.

Blockchain is a network technology, and for any network technology to be feasible, it requires active participants. These participants are organizations, whom expose their activities to the Blockchain for the other participants to see. However, committing the organization to partake in such networks often takes a considerable amount of time and resources. In addition, although Blockchain technologies may create very noticeable opportunities within SCF, there are also very reasonable limitations to the technology, which are holding the technology back from achieving wider adoption. In addition to the limitations, that have to do with the technology itself and the factors surrounding it, there are also limitations caused by the mangers responsible for implementing these new technologies, in existing legacy organizations.

For this reason, to be able to address the research question of how BCT may impact the evolution of the SCF ecosystem, the following section's focus is the impact, which the current state of BCT as an innovation, may have on the evolution of the SCF ecosystem.

We will therefore study the state of maturity of Blockchain technologies using Rogers' diffusion of innovation theory (2003), by finding its placement on the curve of innovation. In addition, the analysis will focus on the impact of Blockchain technology adoption on SCF adoption, i.e. the factors that either progress or impede the innovation on the innovation diffusion curve. We will then analyze the implications for SCF and International Sustainable Development. Finally, we will elaborate on the managerial implications for buyers looking to develop a Blockchain-driven SCF solution for SMEs in their supply chain.

(Point of analysis criticism: Although the purpose of this thesis is to investigate the adoption of Blockchain in a supply chain setting, it is nearly impossible to separate the adoption of Blockchain in this setting, from the overall adoption of Blockchain technologies as techno-economic paradigm. Although this analysis excludes many factors of adoption primarily irrelevant for Supply chain organizations (such as cryptocurrencies), the analysis focuses on the whole of Blockchain technologies as a techno-economic paradigm).

8.1 Blockchain technology maturity

Rogers diffusion of Innovation (2003) highlighted how an innovation must travel along a curve of adoption, passing through different categories of adopters. These range from the risk-willing innovators in the beginning of the diffusion, all the way to the tradition bound and change adverse laggards, as the end of the curve. Each adopter category has their own distinct characteristics and implications for the innovation.

In a BCT context it is very easy to envision the organizations, that could be labelled as innovators. These include the organizations, who immediately embraced BCT, such as the technology giant IBM, the R3 Blockchain consortium, or other blockchain focused start-ups such as Openledger. However, these companies have centered their entire business model around blockchain technologies and as such fit well into Rogers definition of the innovator category. Innovators, as explained by Rogers (2003), are by nature risk takers, and are excited by the possibilities of new ideas and new ways of doing things. However, how far the innovation has spread beyond this initial group is not immediately clear.

The next in line on the diffusion of innovation are the Early adopters. As according to Rogers (2003), this group tends to have a reasonable approach to risk and are the most influential group within their market space, often considered to have "thought leadership" for other potential adopters. For this reason, they play a decisive part in the adoption of the innovation. In the BCT context, early adopters are existing legacy companies, which business model is not entirely focused on BCT, but are tempted by the prospects of the technology. Examples include, financial institutions, tech companies and industry leaders, who are exploring the potential of the technology. However, although some companies matching this description, may advertise their commitment to BCT solutions, it does not necessarily entail that the technology has transitioned completely to the early adopter category. It is therefore necessary to conduct a thorough analysis, to determine the state of adoption for BCT.

8.1.1 Analysis Method

To determine the point of adoption of Blockchain technologies, as well as the factors that lead to adoption, the analysis adopts a triangulation approach. The purpose of the triangulation method is to combine several methodologies, such as qualitative and quantitative methods, as complementary methods for improving the overall research study accuracy (Bryman & Bell, 2007). By allowing a researcher to examine a phenomenon from different standpoints, the overall conclusion tends to be sounder, even though one perspective suggests a different conclusion than the other. This is an important characteristic of our analysis, as the analysis is based on secondary data, which can be argued, may contain a certain degree of bias. For this reason, triangulation may limit the potential for data (and researcher) bias, which increases the reliability of the findings, as well as adding to the methodological rigor of the research project (O'Gorman & MacIntosh, 2015).

The triangulation methods chosen for this analysis include:

1. Environment analysis (PEST-framework)
2. Sentiment analysis
3. Financial analysis

The choice of these three methods for the triangulation approach are inspired by the previous work of (Bradford, 2003), which used a similar approach in their analysis on the diffusion of innovation within Enterprise Resource Planning (ERP). The results of each approach will be used to pinpoint the point of adoption of Blockchain technologies. Thereafter, the implications of this placement will be discussed.

8.1.2 Environmental analysis

To uncover the point of adoption of Blockchain technologies on the diffusion of innovation curve, it is important to understand the key environmental factors that surround the technology. Many of these environmental factors regarding the technological aspects of Blockchain have been were presented section 2, and will be expanded upon in this analysis in regards to how they influence the diffusion of the innovation along the adoption curve. These key factors are explained through the classical PEST-framework, which focuses on Political (combined with regulatory and legal factors), Economic, Social and Technical factors.

8.1.2.1 Political

One of the primary opportunities of Blockchain technologies is the possibility to remove the need for any intermediary or third party. However, this distinct attribute of the technology is also one of the primary impeding factors of adoption. As Blockchain technologies significantly redesign the way in which transactions take place, it also significantly changes the interaction of financial institutions and regulators in this new structure. This creates a significant barrier, as the new structure creates a need for entirely new regulatory frameworks, legislation and industry standards (Deloitte, 2018). Although removing intermediaries was one of the predominant principals behind the creation of the technology, these institutions and their functions are still a necessity for a functioning modern economy. This particular barrier was highlighted in a survey from Deloitte (2018), in which the respondents' chose "Regulatory issues" as the primary barrier to further investment in Blockchain. This barrier is further complicated by the general week knowledge of coding language in legal frameworks, and the concerns of enforceability of smart contracts as valid legal contracts (discussed in section 5). In addition, because information on the Blockchain can never be deleted (only corrected through new transactions), concerns have been raised if Blockchains are in contradiction of the European GDBR-guidelines, and the right for people to remove sensitive personal data (WE-forum, 2018).

Although the factors above represent considerable barriers to the adoption of Blockchain, there is reason for optimism in regards to overcoming these barriers in the near future. In many countries across North America, Europe and Asia, central banks have begun to recognize the benefits that Blockchain are able to provide. By having a complete record of all transactions, Blockchain would enable financial authorities to have full read, which in turn would significantly reduce the resources previously spent on collecting transaction data, managing the central registers and having supervision on market participants (Hofmann et al., 2017). However, the commitment to adapt the existing legal frameworks and the progress towards achieving it varies for each country. In London, for example, The Bank of England proactively assisted fin-tech startups in researching how their regulatory frameworks could exist within their current standards (Giancarlo, 2017). However, the most important commitment to date comes from the signing of a declaration in early 2018 between 23 countries in the European Commission, to establish the European Blockchain Partnership. The purpose of this partnership is to share experience in technical and regulatory fields and prepare for the launch of EU-wide Blockchain applications (European Commission, 2018).

Although there are considerable barriers to Blockchain adoption, due to regulatory and legal frameworks, there are also significant indications that legal institutions are willing to work towards bridging these shortcomings. However, the results of this commitment may take several years to come to bear, as the process of changing regulatory frameworks are extensive and cumbersome, meaning that changes are rarely applied rapidly (Giancarlo, 2017).

8.1.2.2 Economic

One point that continually raised regarding Blockchain technologies is its potential to disrupt many different types of industries and services. For example, in a large survey from Deloitte (2018), including over 1000 tech-savvy managers of large multinational corporations, the participants were asked if they agreed with the statement that Blockchain could disrupt their industry. In the Automotive, Oil & Gas and the Life Sciences (Including Biotech, Medical Devices and Pharma) industries, over 70% of the mangers agreed that Blockchain could disrupt their industry (74%, 72% and 72% respectively). In comparison, 64% of managers in Financial Services agreed. The largest part of this disruption comes from the automation of different tasks, which were previously seen as essential for the business (Woodside et al., 2017). The tasks affected would include those of accountants, auditors, notaries and many other manual desk functions, as these would be made redundant by the automation brought by Blockchain applications. For example, in an analysis made for implementing Blockchain in the retail banking, the report forecasted that upwards of 30% of banking related jobs could be cut over the next decade if Blockchain was implemented (Giancarlo, 2017). For this reason, it is very understandable that workers employed in these functions (as well as their associated unions) share animosity against implementing such Blockchain initiatives. This could potentially go as far, as to make these employees directly oppose and actively hinder the implementation of such initiatives. However, although Blockchain may make some functions obsolete, it may also create new jobs. In an interview by Pete Rizzo with PwC FinTech director, Jeremy Drane, the latter explained that many organizations were experiencing an extreme shortage of Blockchain talent and were subsequently hiring and training new employees in this area at a high rate (Rizzo, 2015).

For this reason, it is to be expected that implementing Blockchain initiatives may be met with resistance from organizational employees in threatened functions. However, with the coming of more Blockchain applications, if an organization were to guarantee new positions in Blockchain related functions, this could alleviate some of the resistance if communicated and executed properly.

8.1.2.3 Social

Another important factor, which plays a crucial role in the perception of Blockchain, is the ill-perceived heritage of the technology. The heritage of Blockchain goes back to the early days of Bitcoins, when the first active participants to utilize the currency, were participants who embraced the anonymity and the illicit aspect of removing third party oversight. Such participants included black-market dealers, drug traffickers and other unsavory individuals. This aspect of the technology still exists to a degree in the present-day, as a majority of the processing power for the Bitcoin network originates from large unknown parties (miners), in which many are ideologically opposed to corporations and governmental involvement (Hofmann et al., 2017). Although the technology has come far since then and has moved away from this illicit use of the technology, particularly with the addition of permissioned Blockchains, the negative association still lingers and plays a part in how the technology is perceived (Elnaj, 2018). This association with Bitcoin also came to show during the explosive growth in Bitcoin price during the winter 2017. Although the upsurge caused a huge increase in Blockchain awareness and enthusiasm, the subsequent recession lead many to lose interest and label the technology as a temporary fad, which had come and gone (Busby, 2018).

In addition, another notable social factor is that of "Blockchain fatigue". Although many business managers believe, that Blockchain could potentially disrupt their business, and are constantly reminded of such by tech-gurus and innovation experts, the facts are that there are very few use-cases to support this belief. For this reason, some managers may feel that the potential for Blockchain has been over-communicated, while its real-world benefits remain elusive (Deloitte, 2018). Although these are understandable viewpoints, they are somewhat self-fulfilling, and thereby, by extension, self-defeating.

The perception among many regarding Blockchain technologies balances on the issue, whether the technology has simply been overhyped or if there is actual credence to the technology. Blockchain, as any other technological innovation, is not limited to the instance of the technology (i.e. the radical innovation). As implied by Blockchain expert, Henry Miller, in an interview, using the iconic Ford Model T car (another of Perez's Techno-economic paradigms) as an analogy (Elnaj, 2018):

"...understanding removes confusion, and understanding the difference between Bitcoin (the car) and blockchain (the engine) will shed some light on the real problems and the likely future of Bitcoin, cryptocurrencies and blockchain."

8.1.2.4 Technical

Blockchain is perhaps one of the most advanced networking applications that has ever been created. The technical concepts, which were described in section 5, allow for an almost endless range of applications, which could disrupt whole industries, as we know them. However, despite all the technical ingenuity, BLT still faces many technical limitations, which hinder its widespread adoption. The primary technical limitation is the interoperability of different Blockchain systems and the complexity of adapting the technology to existing legacy systems.

Interoperability refers to the ability for one system to easily share information and communicate with another system. In the case of Blockchain systems, there are two types of Blockchain interoperability (Samani, 2018). The first type is the ability for Blockchain systems to relay messages about the state of its chain to another Blockchain system. In this way, the two systems relay the activities of participants between each other, which can then be interpreted and used. This is particularly useful in the case of smart contracts, as the potential of the applications only truly come to bear, when able to react to external events. The second type is the exchange of digital tokens between the two Blockchains, without the use of a trusted third party. For example, if a participant on the Bitcoin Blockchain wished to exchange his Bitcoins to Ethereum, interoperability would mean that he could exchange them without the need to go through a third party.

However, the type of Blockchain interoperability mentioned above is virtually non-existent at this time. The reason for this is that the current existing Blockchains operate as standalone environments, disconnected from each other (Ray, 2018). To achieve the interoperability mentioned above, the systems must overcome three levels of interoperability, described by Shaan Ray (2018) as:

1. **Foundational level.** Systems are able to exchange data between each other, but are not able to interpret it.
2. **Structural level.** Systems are able to exchange data between each other with a defined format. This level allows information to be interpreted, but not interacted with or used.
3. **Semantic level.** Systems are able to exchange data between each other in a way that allows them to interpret and use the data.

At the time of writing, there are many different initiatives in the works to solve the problem of interoperability and advance through the levels. Such initiatives include the creation of "Sidechains", which are Blockchain mechanisms that allow for the creation of a separate chain to be attached to the main Blockchain (Ray, 2018). Other initiatives include the Cosmos and Aion initiatives, which approach the problem of achieving interoperability in their own way (Ray, 2018). However, although these solutions provide some hope of achieving interoperability, at the current state, the technology has barely come close to overcoming the first foundational level. And with no means of communicating efficiently with each other, data transactions between different Blockchain systems must be facilitated by a third party intermediary, which defeats the principal purpose of the technology altogether.

In addition to the challenge of creating interoperability between Blockchain technologies is the issue of adapting or replacing legacy systems with Blockchain applications. In the Deloitte survey (2018), 37% of business managers (the second largest barrier after regulatory issues), answered that the difficulties of replacing or adapting Blockchain applications to existing legacy systems, was a deterrent towards greater investment in the technology.

8.1.2.5 Summary of Environmental analysis

A common theme among all environmental factors is the great amount of uncertainty surrounding the innovation. This uncertainty stems from an unclear regulatory framework, disparate opinions and assumptions of the technology and weak factual evidence that the technology can live up to the hype surrounding it. Although these are significant barriers, the analysis also highlighted the efforts made from various parties in overcoming these barriers. For this reason, given the above conditions, the technology can be said to be at the "Innovator"-stage of adoption. The reason for this being that the innovators, the true pioneers of the innovation, have yet to convince the early adopters, the change agents of the innovation, to fully commit themselves on the technology. However, should the efforts to overcome the barriers of adoption be successful, it could potentially greatly accelerate the innovation along the curve of diffusion, which could lead it into the early adopter category.

8.1.3 Sentiment analysis

In the adoption of Blockchain technology there is one factor, that plays a very crucial role in the adoption of the innovation. The factor is that of business managers and their perception and sentiment towards the technology. In a whitepaper by Vagnani and Volpe (2017), the researchers expanded upon Rogers (2003) theory, to uncover the relationship between attributes of an innovation and the managerial decision to adopt innovations in organizations. To this end, they highlighted the behavioral preference of the decision maker towards the innovation, as measured by how positively or negatively they feel forward the innovation, as a key criterion towards innovation adoption.

To analyze the managerial perception of Blockchain, the following section will use a sentiment analysis. A sentiment analysis includes identifying and extracting information within text, to analyze the opinion and perception of a selected group on a given subject. The method is a relatively new method, which closely resembles that of opinion mining or subjectivity analysis, which are almost interchangeable terms for the analysis (Pang & Lee, 2008).

The analysis will be conducted by using the results of two different empirical studies on the subject of management sentiment towards Blockchain. These include:

1. Open survey from Deloitte in April 2018 on 1053 senior executives, which aimed at generating insight into the overall attitude and investment in Blockchain as an technology
2. A textual analysis by Woodside et al. (2017) on the mentions of Blockchain in annual reports, as a method of evaluating business manager's sentiment towards Blockchain.

The section will begin with a brief discussion on managers and their relevance and role for the adoption of innovation. Thereafter, the empirical results of both abovementioned studies will be used to analyze the position of Blockchain on the diffusion of innovation curve.

8.1.3.1 The management issue

In the global business environment, managers are constantly vigilant of the newest technology megatrends, as means to position their organization for accessing new growth areas, as well as maintaining and creating competitive advantage. In a study conducted by PWC (2016b), eight key technology megatrends were identified. The top five being:

1. Analytics including machine learning and artificial intelligence
2. Cloud computing
3. Internet of Things and connected systems such as drones
4. Virtual augmented reality
5. Blockchain

While all these new megatrends impose daring and potentially revolutionary business models, adapting to them and implementing them in existing organization is far from a straightforward task. When Blockchain related business applications outside of cryptocurrencies started to appear, most of the early adopters at the time were businesses, which built their entire businesses model around Blockchain from the very beginning. However, this adoption of the technology has not been witnessed in existing legacy organizations at nearly the same pace (Deloitte, 2018). Most managers of legacy organizations understand the need to invest and focus on such megatrends, however, the changes to their organizations in response to them do not always come swiftly or effectively (Woodside & Giberson, 2017). Although, in the case of many legacy organizations, neither should they. While such organizations cannot afford to ignore Blockchains potential for long term disruption on their tried and tested business models, attempting to adopt new technology, before solid use cases have been identified and developed, could potentially waste precious management time and resources. In addition, many managers may have legitimate concerns for Blockchain technology, regarding legal and technical issues, which are not addressed by the use cases present. For this reason, managers may justifiably be cautious about launching Blockchain initiatives, before the full extent of costs saving, competitive advantages and ROI benefits become transparent.

8.1.3.2 Analysis

In the open survey from Deloitte April 2018, the consulting company uncovered several key findings, regarding the overall attitude on Blockchain. The survey focused on C-level (CEO, CFO, CTO, etc.) respondents in companies with USD 500 million or more in revenue, spread across America, Europe and Asia, working within a variety of industries.

The overall attitude of the respondents in the survey towards Blockchain adoption was primarily positive. In the survey, 84% of respondents agreed to the statement: "*Blockchain is broadly scalable and will eventually achieve mainstream adoption*", while 77% agreed to the statement: "*Suppliers, customers, and/or competitors are discussing, or working on Blockchain solutions to address challenges in the value chain*". In addition, 84% believed Blockchain solutions to be more secure than conventional information systems. In addition, 43% said that Blockchain adoption was among their top five strategic priorities. However, although primarily positive, the survey highlighted some skepticism among respondents. As explained in the survey (Deloitte, 2018, p. 5): *"Our survey data shows that a significant percentage of early adopters in the business community believe in Blockchains potential to disrupt and revolutionize their industries. The problem, responders say, is that for all the talk about Blockchain's promise, there are very few active use cases they can currently employ to advance their belief"*. To add to the skepticism, 39% of respondents believed Blockchain to "overhyped" to some extent. In addition, a significant number of respondents reported that barriers, such as regulatory issues, implementing – replacing or adapting legacy systems and potential security treats, were withholding them from further spending in the technology.

This skepticism was also shown in the textual analysis of Woodside (2017). This analysis included a text analysis, to find the occurrence of Blockchain related keywords within the annual reports of Fortune 50 companies. The reasoning of this method was that mentions of Blockchain in the annual report, would signal commitment towards the adoption and implementation of the technology. However, in all the 50 annual reports, Blockchain was only mentioned in a single report, which was that of IBM. In comparison, other technological mega-trends, such as Artificial Intelligence, was mentioned 26 times, while Cloud computing was mentioned 22 times. As Woodside (2017) suggested in his analyzes, although managers may have a positive sentiment towards Blockchain, this does not necessarily translate into direct commitment.

8.1.3.3 Summary of Sentiment analysis

The sentiment analysis revealed that there is a certain positive sentiment towards Blockchain amongst Business managers. However, this sentiment has not translated into direct commitment. Given these circumstances, the state of adoption can be set in between innovators and early adopters. The reason for this being, that although the majority of respondents in the Deloitte interview viewed Blockchain positively, this has not converted into large-scale commitment. Therefore, the respondents can be seen as early adopters, characterized by Rogers (2003) as being the change agents, which other adopters look to when deciding on adopting an innovation. The reluctance for commitment by the early adopter can then be seen as a failure of the innovators, which in this would be a company such as IBM (being the only fortune 50 company to mention Blockchain), to create a convincing case for the adoption of the technology. However, despite being situated between innovators and early adopters, the findings of the analysis suggest, that the technology may continue on the curve of adoption, should the commitment from early adopters increase.

8.1.4 Financial analysis

The third and final method to determine the stage of adoption is through a financial analysis. The analysis focuses on the investments in the technology (both current spending and predicted future spending), as a method for placing the technology on the diffusion of innovation scale. The financial analysis uses no particular methodological approach, apart from a thematic literature review, in which material was analyzed and divided into themes relevant for the analysis, which were then used in the analysis. The analysis will also exclude financial data related to cryptocurrencies, as they have been seen as irrelevant to the analysis. Although a significant amount of available information on Blockchain spending relates to cryptocurrencies, the analysis will focus on non-cryptocurrency related applications.

8.1.4.1 Analysis

In a report published by IDC (2018), a leading provider of market intelligence and advisory services IT, the company estimated that worldwide spending on blockchain solutions would reach almost USD 11.7 billion in 2022. This is a significant development in spending when compared to 2018, in which the spending was only USD 1.5 billion. The projected spending can be seen in the image below, in which IDC has forecasted a compounded annual growth rate (CAGR) of 73.2%:

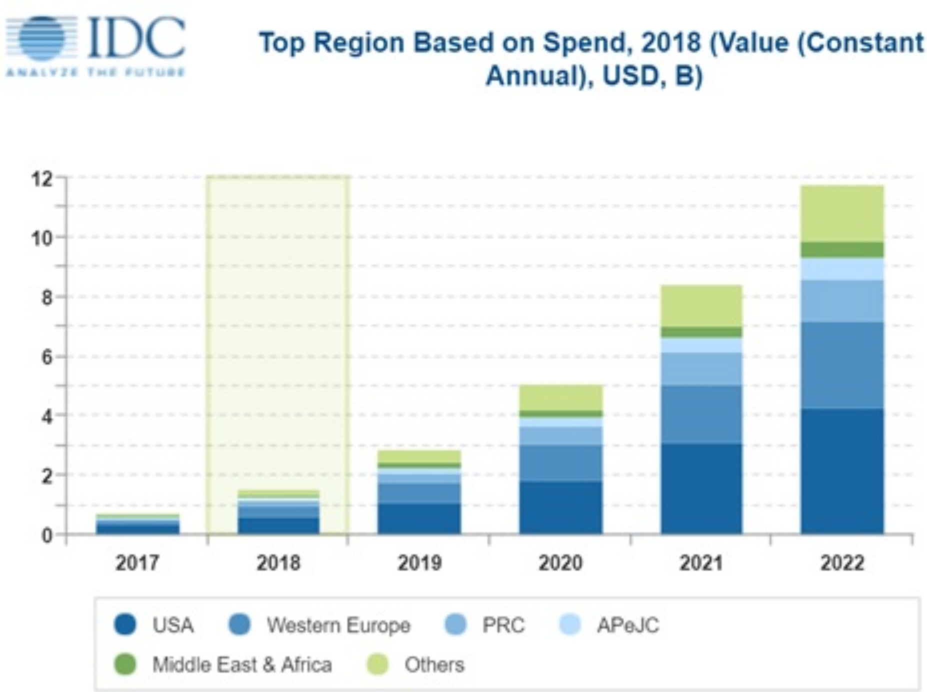


Figure 15: Blockchain spending guide, IDC (2018)

IDC predicts that the increased spending will primarily be led by the financial sector, which will be driven by a large adoption in the banking industry. In previous years, Blockchain spending was primarily driven by several of the large financial and consulting firms in the US, who have begun heavily researching and investing in the technology (Campbell, 2016). For example, one of the most notable initiatives include the R3 Consortium, a consortium of some of the largest financial institutions, including reputable companies such as Barclays, Goldman Sachs, J.P. Morgan and the Royal Bank of Scotland. From its founding nine companies, the consortium has now grown to include upwards of 200 companies. In addition to the financial sector, IDC predicts that the two follow-up sectors to lead the growth in spending are the distribution and services sector and the manufacturing and services sector. As Jessica Goepfert, program vice president, remarked in relation to the report (IDC, 2018): *"We continue to see the greatest spending and growth for blockchain around lot lineage and asset and goods management. Highly visible scandals combined with complex supply chains and incomplete information set the stage for investments and projects in these areas,"*

The global audit, tax and advisory service KPMG also supported this trend of Blockchain spending in their biannual report "The pulse of Fintech 2018" (KPMG, 2018). In a section named "Blockchain moving beyond experimentation", the report reviewed and commented on the significantly increased investments in the first and second quarter of 2018. In addition to mentioning R3 Consortium, the report highlighted the introduction of several new consortia focused on developing Blockchain to assist with supply chain management (KPMG, 2018). According to the report: *"In Asia, we continue to see Blockchain as a key priority for investors, similar to other regions of the world. While most blockchain initiatives remained at the proof-of-concept (PoC) stage, a small number have begun moving into production."* (KGMP, 2018, p. 44). The tendency for increased spending was also apparent in the Blockchain Survey, where 39% of respondents reported, that their organizations would likely spend USD 5 million or more in Blockchain related technologies in the coming year. In comparison, only 15% of respondents said they were likely to spend less than USD 500.000, or had no investments planned at all.

8.1.4.2 Summary of Financial analysis

The financial analysis suggests, that spending in Blockchain related services are likely to increase significantly in the near future. Given this significant growth rate, it can be argued from a financial perspective that the innovation has transitioned from an innovator state to an early adopter state. The analyzes highlighted how established companies are slowly positioning themselves to take advantage of the innovation, and have committed considerable resources to do so. Considering this development, it can be argued that Blockchain as an innovation has moved forward on the curve of diffusion, no longer being solely used by adventurous fintech companies, and is slowly being adopted by legacy organizations.

8.1.5 Triangulation Method Summary

The purpose of the preceding analysis was to determine the state of innovation diffusion of Blockchain technologies, through a triangulation method, to determine the appropriate innovation categorization of adoption for the innovation. The table below shows the adoption categorization suggested by each method:

Environmental Analysis	Innovator
Sentiment Analysis	Innovator ↔ Early Adopter
Financial Analysis	Early Adopter

The table above suggests that the state of adoption for BCT lies somewhere between the innovator and early adopter category, as each method assumed a different placement of the innovation on the innovation curve. However, although each method suggested a different placement, the conclusions of each method may not be mutually exclusive.

The PEST analysis highlighted the high uncertainty in the environment surrounding BCT. This uncertainty is to some extent mitigated by the managerial sentiment, as it is outweighed by the potential of the technology, as seen by the managers. This is also seen in the financial analysis, which argued that the financial commitment of new adopters forwards BCT solutions may very likely increase. The sentiment and financial analyzes therefore illustrate the factors, which are driving the diffusion of the innovation, while the sentiment analysis is highlighting the factors, which are limiting this diffusion. However, as argued in the environmental analysis summary, these factors are not unknown to the innovators, who are actively trying to overcome them.

For this reason, the adoption state of BCT is set to be on the verge of transitioning into the early adopter category. As such, BCT stands at a very pivotal moment in its diffusion. As explained by Roger's (2003), the commitment of early adopters will allow contributors to develop a common knowledge and language of communication, which when shared, can help improve and stabilize the innovation. In addition, the commitment of the early adopters typically marks a significant escalation in the diffusion of the innovation, as the early majority is attracted to the innovation, due to mass market appeal. The implications, which this state of adoption entails for SCF ecosystems, will be the focus of the following section.

8.2 The impact of Blockchain technology on SCF adoption

In the preceding sections, the analysis has highlighted the potential impacts of Blockchain technology-based SCF ecosystem on the process of adoption of SCF solutions into organizations.

In addition, the previous analysis of the adoption of innovation theory of Rogers, described in Section 2, has shown that Blockchain technologies may have reached a critical point in the diffusion of the innovation, situated between early adopters and early majority innovator groups.

Our research question is:

How can Blockchain technologies impact the evolution of the SCF ecosystem?

In the following sections, we will therefore answer our research question by building on our previous findings throughout the paper. We first analyze, through Moore's ecosystems stages, the implications of the diffusion of BCT on the evolution of SCF ecosystems. We will then focus on the implications of BCT adoption on the standardization of SCF ecosystems.

8.2.1 Moore's ecosystem stages

In the theoretical background, we have detailed the concept of the four-stage business ecosystem defined by Moore (1993). We have applied this concept on the SCF ecosystem in Section 6 (Analysis I) and we will now analyze the evolutionary theory of these stages as described by Moore (1993) and apply it to BCT-enabled SCF ecosystem.

Overall, SCF is a relatively new innovation despite having existed since the late 1990s. Our analysis of the SCF ecosystem in section 6 shows that BCT will impact significantly the dimensions of the SCF ecosystem. Greater connectivity and information flows constitute the innovations at the centre of the SCF ecosystem, implying a mutation of the classic model based on a dyad relationship between a buyer and a Tier 1 supplier to a distributed secured trusted multi-actor relationship.

We argue that SCF ecosystem stage is currently, as seen in Section 4, in the Expansion stage, by fulfilling its key criteria of scalability, growth and wider adoption.

However, in order to be able to transition into the next stage of evolution, e.g leadership, SCF ecosystem lacks one central attribute of this stage, namely standardization. As explained by Moore (1993, p. 80): *"It's in Stage three that companies become preoccupied with standards, interfaces, 'the modular organization,' and customer supplier relations"*

Lacking standards are causing interoperability issues between systems, which is hindering the technology from achieving the envisioned potential, that are described in section 6. However, the transition along the diffusion curve could potentially alleviate this issue. As explained by Viardot (2015), the transitioning into early adopters could stimulate the creation of anticipatory standards illustrated in the picture below:

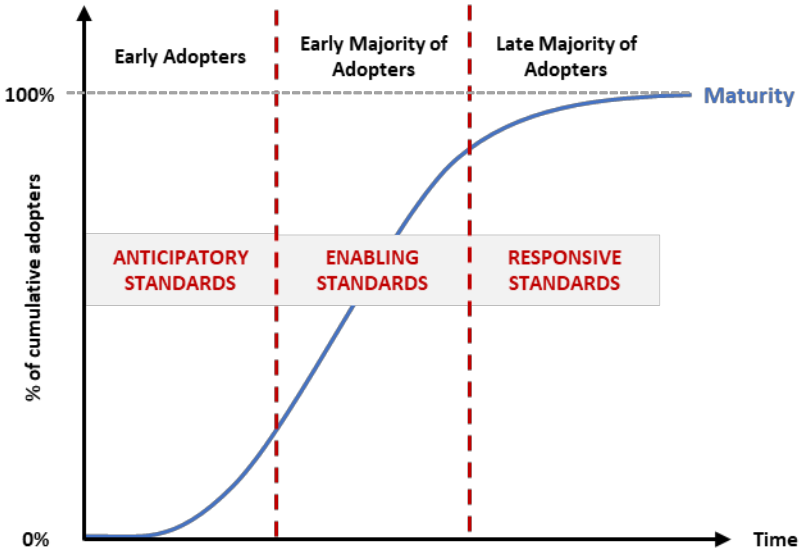


Figure 16: Diffusion of Standards, adapted from Viardot (2015)

As seen in section 6, BCT will allow SCF ecosystems, greater transparency, better credit risk assessment, trust-based relationship and standardization of secure processes through smart contracts.

8.2.2 Towards a standardization of SCF

As explained by Viardot (2015, p. 6) "*early users may contribute to the design of those anticipatory standards to help the development of a promising innovation they are investing in. Anticipatory standards significantly contribute to setting up the trust between early adopters and innovation providers, because they allow the various contributors to develop a common knowledge and language of communication, that they can share in order to improve and stabilize the innovation*".

For this reason, it can be argued, that the need for standardization of SCF ecosystem, to transit into Moore's leadership stage, may be highly influenced by a worldwide multisector diffusion of Blockchain technology. As a result, the buyer supplier-relationship will likely transform from an interest/incentives-based rationale to a standardization-based business.

Several practitioners also illustrate this relationship and interdependence with underlying information technologies. For example, in 2016 the ICC (International Chamber of Commerce) released a white paper on SCF, proposing standard definitions for SCF products and terms. In this paper, they highlighted how important automation and digitalization was for the creation of standardization within SCF. In addition, the importance of automation and digitalization was also highlighted by Caniato et al. (2016), who proposed that the "level of digitalization" was one of the most important criteria for the creation of SCF.

For this reason, Blockchain technologies stands to be the most suited medium, through which SCF ecosystems may evolve, to the next tier of evolution. As stated by Bals (2018, p. 11), *"To prosper further, the SCF ecosystem is dependent on efficient and effective exchange of information across stakeholders, enabled by common standards."*. These criteria, which Bals mention as necessary for SCF ecosystem evolution, are almost identical to the key features of Blockchain.

Therefore, standardization together with higher degrees of automation allowed by BCT, will enabled the SCF ecosystem to transit to the next stage of maturity according to Moore (1993). Future researches in this area could focus on the analysis of the enablers and barriers for standardization and automation / digitalization in a BCT-enabled SCF.

In a recent literature review, Manikas (2016) has emphasized the fact that actor interactions in relation to a common technological infrastructure influence the ecosystem. This offers other area of research papers in the context of the BCT- enabled SCF ecosystem, in which stakeholders in a BCT-enabled SCF ecosystem play a central role in either enabling the development of standardization?

8.3 Implications for SMEs

Increasingly, governments and policy makers, especially in Europe, are searching for alternative forms of financing to stimulate growth and innovation given the precarious situation SMEs find themselves in. This recognition that new forms of financing are needed to stimulate growth, is most notably emphasized in the Horizon 2020 EU framework for Research and Innovation initiated in 2013 (Claudia Alfieri, 2017). In particular, it highlighted the need to redesign the financial solutions available for SME finance and access to risk capital. While the traditional view of regulators and financiers is, that the financing for these initiatives should emanate outside the supply chain through the traditional channels (i.e. capital markets, banks, private equity), policy makers are open to the possibility of creating new frameworks to ease the access to capital for SMEs from within the supply chain, as advocated by the Horizon 2020.

There are other examples of governmental support across the world for SCF-like alternative financing solutions for SMEs. Most notably, in 2004, the World Bank praised the success of reverse factoring in helping provide liquidity to SMEs, showcasing the initiative by NAFIN and the Mexican Government, that allowed SMEs to enter trading agreement with large corporate buyers through reverse factoring financing (Klapper, 2004). The World Bank points to the liabilities that consumer experience as supply chain in developing economies, as in Asia, Eastern Europe and Africa, suffer from financial inefficiencies and hinders their entry into global markets.

The Financial Inclusion and Infrastructure initiative of the World Bank therefore sees SCF as being part of the solution by improving SMEs' liquidity requirements for growth and trading opportunities. The hope is that SCF will help accelerate economic growth in developing countries by supporting the financial health of SME suppliers from these countries.

Therefore, governments' priority, in the context of BCT and SCF ecosystems, should be to focus on clarifying the legal and regulatory framework for this new type of business interaction, both domestically and internationally. As we have highlighted the lack of coordination between different national jurisdictions, concerning notably movables assets and cross-border flows. The direct implication for governments is an urgent requirement for jurisdictional coordination, in order to allow international BCT-enabled SCF activities.

8.3.1 Managerial implications for buyers looking to develop a Blockchain-driven SCF solution for SMEs in their supply chain

After having discussed in depth the implications of Blockchain technology on SCF ecosystems, we argue that one of the academic contributions of our thesis is the implementation of the strategic decision-making process of any organization aiming to implement BCT-driven SCF programs to its suppliers in the supply chain.

Our analyses have demonstrated that the association of BCT and SCF is highly beneficial for both the overall performances of a supply chain and the business development of each participant.

Moreover, we have shown that the development of BCT during the next decade is growing steadily. To this end, we argue that BCT in business trade will bring about new standards of trading worldwide, thus imposing to the global SCF ecosystem a standardization of the SCF processes, including an extension of the range of SCF instruments available.

A likely scenario might result in the implementation of BCT becoming mandatory to any suppliers joining a buyer's supply chain, and thus, require them to onboard an SCF program as a standard procedure for becoming a new supplier. The implications of this dynamic evolution can be viewed through three different perspectives: 1) the large buyer's perspective, and 2) the technological perspective.

1) As we have demonstrated that a common interest of all the stakeholders should be to anticipate the adoption of a BCT-driven SCF, large buyers should therefore look to develop their internal capabilities to support the growth of the BCT-enabled SCF ecosystem. The objective is to

eventually be able to secure a more stable and financially healthy supply chain with leaner costs structures. In order to do so, large buyers need to consider creating a transformation plan to onboard as many suppliers as possible onto a common BCT-driven SCF platform. Therefore, in order to develop a BCT-enabled SCF platform, buyers need to (1) formalize a strategic plan to acquire BCT capabilities, (2) design an SCF program based on BCT capabilities to onboard first strategic suppliers (3) evaluate the financial provisions required to cover the costs of implementation, (4) internally clarify the role of BCT and SCF, and educate its workforce onto the new BCT-enabled SCF platforms, (5) expand the scope of its SCF program to include as many suppliers as possible.

2) Pertaining the technology perspective, we have highlighted that two different types of Blockchain network exist: permissionless networks, such as Bitcoin, where the participants are potentially anonymous, and permissioned networks, e.g fully private blockchains or consortium blockchains. Concerning supply chain and SCF, consortium blockchains architectures, where the consensus process is controlled by a preselected set of nodes, are likely to be the preferred choice for SCF ecosystem, as in such solution, the control of the SCF instrument is ensured and validated by all the stakeholders – not only one single player.

As already indicated in the sections above, BCT is maturing without any clear directions. The implication of our thesis in a technology perspective is that the research papers and the technological development researches should now focus on developing a deeper understanding of consortium blockchain architecture technology, in order to usefully accompany the scale up of BCT-enabled SCF ecosystems.

8.4 Section summary of the impacts of the state of Blockchain technology maturity on the evolution of the SCF ecosystem

A common theme among all environmental factors is the great amount of uncertainty surrounding the innovation. The true pioneers of the innovation have to convince the early adopters, the change agents of the innovation as characterized by Rogers (2003). The sentiment analysis reveals that there is a certain positive sentiment towards Blockchain amongst Business managers. The financial analyze suggests, that spending in Blockchain related services are likely to increase significantly in the near future. Considering these developments, it can be argued that Blockchain as an innovation has moved forward on the curve of diffusion, and is slowly being adopted by legacy organizations.

In this context, the need for standardization of SCF ecosystem, to transit into Moore's leadership stage, may be highly influenced by a worldwide multisector diffusion of Blockchain technology. As a result, the buyer supplier-relationship will likely transform from an interest/incentives-based rationale to a standardization-based business.

BCT could become mandatory to any parties willing to join a Supply Chain and thus, a SCF ecosystem. Pertaining to stakeholders' perspectives, we have thus demonstrated that a common interest of all the stakeholders is to anticipate the adoption of a BCT-enabled SCF.

Concerning more specifically the SMEs and the banks, the first implication for the buyers will be to identify business projects that will help them to transform while adopting BCT- enabled SCF, in order to mitigate the relative high costs of transformation.

On a broader academic perspective, we assess that the implication of our is that the next research papers in the domain should be focused on consortium blockchain architecture technology, in order to accompany usefully the scale up of BCT-enabled SCF ecosystems

9 Discussion & Limitations

After having conducted our analyses in **Section 6**, **Section 7** and **Section 8**, we have made several findings in relation to our research question. However, due to the scope of our paper, we have also made some assumptions throughout the thesis, which are subject to several limitations that need to be considered. These limitations also represent opportunities for future research to expand on this paper's findings.

As much of the existing literature has focused on SCF practices and BCT applications separately, our thesis aimed to further analyze the concept of a BCT enabled SCF environment. To this end, we found limited research on the implications of the combination of the two. Our overall analysis concludes that the BCT is likely to completely change the nature of the SCF ecosystem, therefore leading to define new theories on the Business Ecosystem itself. This opens a large range of new areas of research, centered on business relationship through standardized blockchain processes.

However, as SCF and BCT are both relatively new, our analysis stands on several limitations and assumptions.

First off, there is a definite lack of practical examples throughout our thesis. Although, we found indication of trends going into BCT enabled supply chain solutions, notably with the examples of large companies such as IBM and Maersk being pioneer in this domain, the conclusions drawn from our analysis is more a perspective, instead of a robust projection of a foreseen evolution of SCF ecosystems.

Second, there is still no unanimous consensus on the scope of what constitutes SCF within the currently existing literature. As such, SCF incorporates many different definitions and has a large breadth of meanings. We have therefore attempted to use a broad business ecosystem perspective to mitigate the effect of this ambiguity on the result of our paper.

Third, on a theoretical level, our research question takes a holistic approach to SCF and considers its evolution as a business ecosystem on a conceptual level, and therefore on a global level. Therefore, an interesting approach for future research could be by taking a more in-depth look at the development of relationship between Buyer and Suppliers in a BCT-driven SCF context by accounting for cultural, demographical, economical, or geopolitical differences, that stem from diverse regional contexts. According to Wuttke et al. (2013, p. 161) "*It is plausible to assume that distinct banking and industrial contexts would significantly alter the adoption process (e.g., limited use of electronic banking and strong use of checks in India)*". For example, we observed that some Chinese scholars are already looking for new perspective in SCF ecosystems: Liu et al. (2015) showed, by conducting a literature review of SCF in China, regional differences in the structure and approach to SCF.

Moreover, we have identified some limitations in Wuttke et al.'s (2013) model. As being an adaptation of Rogers' (2003) model, Wuttke et al. (2013) model helps to understand the rationale underlying the diffusion of SCF amongst business partners. However, Wuttke et al.'s (2003) model relies on a small sample of case studies: as only six European companies have been studied, the findings about the diffusion of SCF might not be generalized relevantly as a reference model for global studies.

Forth, the fast-evolving state of technology may lead to new unpredictable innovation that could completely change the basic assumption of our thesis. Therefore, we have assumed that Blockchain technology will not be supplanted by new innovations in the next decade. However, as discussed in section 5, although there are many breakthrough technologies, none have a viable solution for the issue of centralized systems. We therefore believe that our general conclusions about the change of nature of relationship between Buyer and Suppliers due to innovation remain globally relevant.

Fifth, we did consider SMEs as a generic category without seeking to discriminate them by business sectors, types of structure, size or by geographic locations. Although, this is a clear limitation for our conclusions, we have mitigated the impacts of these factors by analyzing macroeconomics trends without looking at SME's internal organic processes.

Finally, we can argue that SCF ecosystems has developed following the 2008 crisis, it would be therefore a relevant area of studies, to assess the robustness of a BCT enabled SCF concept in the context of a new crisis. The key question there would be to anticipate possible new vulnerabilities in order to adapt and shape future evolutions of BCT enabled SCF.

10 Conclusion

In a global context, business stand to benefit from technological advancements allowing new levels of interconnectivity and effective supply chain management, which has become essential for retailers to ensure the quality of their deliveries to end customers. As a part of SCM, a SCF concept associated with new Blockchain technology opens new fields of financial relationship between SCF stakeholders.

Our research paper therefore asked the following question: How can blockchain technology impact the evolution of the supply chain finance ecosystem?

To answer this research question, we first presented a theoretical background consisting of Moore's (1993) concept of the Business Ecosystems, the diffusion and adoption of innovation by Rogers (2003) and the notions of trust and risks, as crucial enablers of trade finance. Thereafter, we argued for the relevance and applicability of these theories for the proposed research ahead.

Having presented the pre-theoretical understanding going into the research, we presented the two main themes of the thesis, being SCF and BCT.

Concerning SCF characteristics, we have demonstrated that SCF aims to solve the direct conflict existing between suppliers and buyers in terms of payment terms. The analysis shows, that the markets case for SCF is growing steadily. Adopting the definition of the Global Supply Chain Finance Forum (GSCFF, 2016), we detailed the key characteristics of SCF instruments, considering the four principal elements impacting the choice of the SCF instruments: (1) the timing of the trigger event, (2) the focal point of credit risk, (3) the availability of collateral, and (4) the financed elements in the balance sheet.

Concerning BCT key characteristics, we have highlighted that BCT has arguably evolved significantly since its inception as a radical innovation. Although initially intended for use as a revolutionary new currency, blockchain has evolved into the best solution to facilitate a trust economy. Even though blockchain shares the spotlight with many other technological innovations, such as machine learning, artificial and new innovative business intelligence systems, none of these systems have a viable solution in overcoming the issue of trust in centralized systems. With the addition of permissioned ledgers, BCT has gained the opportunity to overcome many of the commercial limitation of the original Bitcoin. In addition, with smart contracts, BCT have been given the opportunity for applications, which are increasingly autonomous and decentralized.

Subsequently, we established 5 distinct key features of BCT, namely, notarization, clearing and settlement, smart contracts, immutable data storage and transparent real-time data.

Then, using the SCF ecosystems framework developed by Bals (2018), we conducted an in-depth analysis of how BCT enabled SCF might impact the SCF ecosystem as a whole. To this end, we argued that BCT enabled SCF solutions are inevitably centered around information and financial flows. Whereas previously, information flows were centered around inefficient paper-based transactions. With BCT enabled SCF, transactions are based around real time flows of distributed trusted data. In addition, BCT enabled SCF stand to change the very nature of relationships of companies in the supply chain. Whereas previously, relationships were primarily characterized by a buyer-centric model, dealing only bilaterally with tier 1 suppliers. However, with BCT, these relationships stand to be changed to a trans-border distributed network of buyers and suppliers, using trusted dataflows to assess the credit risk of participants. The introduction of BCT in the SCF ecosystem will also allow for greater transparency, better credit risk assessment, higher trust in buyer-supplier relationships and more available financial instruments, which are more suited to all tier suppliers. In addition, it will allow for optimized management of working capital through automated and more efficient processes.

Furthermore, drawing on organizational innovation adoption theories, Wuttke et al. (2013) offers an empirical approach to understanding the impacts of Blockchain on the innovation adoption of SCF. We have to this end demonstrated that BCT affects the innovation diffusion of SCF. BCT will improve processes, allow internal clarifying, transparent interactions in a SCF, provide a high level of standardization and will ease the ability to onboard suppliers across many more tiers of the supply chain.

The degree of automation of transactions will also inevitably become automated and integrated into each supplier's IT systems, as the BCT platform will already be implemented throughout the supply chain. This will allow the buyer to forego the need to set up SCF transactions on a case-by-case basis. Ultimately, BCT-driven SCF will also strengthen the quality of the buyer-supplier relationship, as actors will rely on BCT to act as a broker of trust. This will in turn reduce the importance of relational trust between the suppliers and buyers, which was previously essential in the process of SCF adoption.

Overall, most of the obstacles currently hindering the adoption and implementation of SCF will likely be solved through the implementation of BCT in organizations. We therefore argue that the implementation of BCT in supply chains will most likely accelerate the adoption of SCF amongst suppliers and buyers.

Finally, studying, the state of maturity of Blockchain technologies, using Rogers' diffusion of innovation theory (2003). By finding its placement on the curve of innovation, our analysis draws the conclusion, that the buyer supplier relationship will likely transform from an interest/incentives-based rationale to a standardization-based business. We have to this end shown, that the development of BCT for SME's during the next decade will likely grow steadily. We therefore argue, that BCT's state of maturity will lead to new standards within BCT, which in will impose standardization of SCF processes.

The managerial implications of our research suggest that BCT may very likely be mandatory for any parties willing to join a Supply Chain and thus, a SCF ecosystem. It is for this reason important for buyer, who will most likely be central to the process, to create a transformation plan to onboard as many suppliers as possible onto a common BCT-driven SCF platform.

Finally, SCF ecosystems has developed following the 2008 crisis, it would be therefore a relevant area of studies, to assess the robustness of a BCT enabled SCF concept in the context of a new crisis. The key question there would be to anticipate possible new vulnerabilities in order to adapt and shape future evolutions of BCT enabled SCF.

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12 Appendix

12.1 SCF Definitions - Supply Chain Finance

Authors, year	**SCF Definition**
Hoffmann, 2005	"SCF is an approach for two or more organisations in a supply chain, including external service providers, to jointly create value through the means of planning, steering, and controlling the flow of financial resources on an inter-organisational level"
Pfohl & Gomm, 2009	"Supply Chain Finance (SCF) is the inter-company optimisation of financing as well as the integration of financing processes with customers, suppliers, and service providers in order to increase value of all participating companies."
PWC, 2009	"SCF boils down to a balanced approach for enhancing working capital for both buyers and sellers in a transaction – using an intermediary tool to link buyers, sellers, and third-party financing entities – thereby reducing supply chain risk/costs and strengthen business relationships."
***Camerinelli*, 2011**	"SCF is the name attached to the collection of products and services that financial institutions offer to facilitate the physical and information flow of a supply chain"
Hofmann & Belin, 2011	"This study views SCF ... namely that financial flows are in contrast to physical flows and their related information flows along the C2C cycle. Thus, the optimization of a company´s SCF can be considered equivalent to working capital optimisation"
Wutkke et al., 2013	"Our definition takes an upstream supply chain perspective and focuses on the organizational structure to be implemented between the involved parties to achieve visibility and control and to recurrently take cash flow optimizing actions as outlined by the definitions presented above."
Steeman, 2014	"Financial used in collaboration by at least two supply chain partners and facilitated by the focal company with the aim of improving the overall financial performance and mitigating the overall risk of the supply chain."
EBA, 2014	"Supply Chain Finance can be defined as the use of financial instruments, practices, and technologies for optimizing the management of the working capital liquidity tied up in supply chain processes for collaborating business partners. The development of advanced technologies to track and control events in the physical supply chain creates opportunities to automate the initiation of SCF interventions."

12.2 Complete collection of possible SCF instruments

This section provides an overview of some practical examples of such instruments and how they differ in terms of collateral, credit guarantees, funding and beneficiary.

- **Advance payment discount:** before the product is shipped, the buyer gives a cash advance to the supplier at a discount for the supplier to finance its operations (and therefore its working capital requirements). Paying in advance not only allows the buyer to gain from a discount offered by the supplier but it also reduces the risk of a disruption in the flow of goods that the buyer needs.
- **Purchase order financing:** similar to advance payment discounts, the supplier (often an SME) gets payed in advance before the product is delivered. However, instead of the buyer paying in advance, a financial institution provides the funding by buying the purchase order and reclaiming it by the buyer at a later date. In order to secure the loan, the financial institution can either base its financing on the supplier's creditworthiness, which often translates into higher interest rates, or have the buyer guarantee the loan, which would base the interest rate that the supplier gets on the buyer's creditworthiness. The latter case, called "buyer-backed purchase order financing", is popular amongst SMEs given that they can finance their operations on lower financing terms thanks to the solid creditworthiness of large buyers.
- **Warehouse receipt finance:** A financial institution uses a warehouse receipt that specifies the quantity and quality of a stored product by the supplier that is to be delivered to the buyer as collateral for providing funds at a discount (of the total value of the products) to the supplier. The financial institution can then collect a certain quantity of the product at any time from the warehouse until the buyer pays the receipt.
- **Inventory pledge finance:** the financial institution uses the supplier's inventory as collateral for providing funds to the supplier's working capital needs This differs from warehouse receipt finance in the sense that it expands the collateral available for lenders to inventory that is not just related to the sale. These types of assets are generally used as collateral when the supplier's other assets are already leveraged.
- **Trade credit:** credit of a specific nature and often-short maturity. It corresponds either to a payment period granted by a supplier to his client or to a loan granted to a company by another company. Trade credit allows the company that benefits from it to finance its operating needs by keeping available (or, in the meantime, disposing of) cash that will be

transferred to the supplier on the agreed date. Trade credit is one of the most popular financing instruments worldwide.

- **dynamic discounting:** these are best suited for companies with excess cash and cash. This type of program is designed for companies seeking an alternative to short-term, low-return investments. With Dynamic Discounting, buyers pay their suppliers earlier with their own funds. The advance payment discount is calculated automatically by the system and is based on a pre-agreed financing rate and the number of days remaining before the payment arrives on the original due date. The sooner the payment is made, the higher the discount realized by the buyer.
- **Factoring:** consists of assigning a claim to a financial institution called the factor. The goal may be to either acquire immediate cash without risk, or to protect against late payments. When the purpose of factoring is the cash advance, the factor pays the company between 70% and 80% of the amount of the claim. The factor collects the amount due at maturity and transfers the balance to the company, less its commission. When the object of factoring is the protection against late payment, the factor pays the amount due to the company only on the due date, minus its commission. This facility is not to be confused with bank discount, where the company has to bear the defaults.
- **Reverse factoring:** a financing solution that involves three players: a customer, a supplier and a factoring company. Unlike conventional factoring, it is not the provider who initiates this payment solution, but the customer himself. Reverse factoring is for a customer to offer their suppliers to pay their cash bill for a discount. Invoice financing is provided by a bank or a factoring company in advance. The customer then pays the bill to the factoring company on the due date of the factoring. The advantage of this system for suppliers is to be paid in cash. The customer, meanwhile, can continue to benefit from payment deadlines, he also gets a discount for the cash payment and can more easily manage his cash.

- **Forfaiting:** technique that consists in being able to finance without recourse a commercial effect accepted and endorsed by the bank of the buyer abroad. The bank is the guarantor of the debtor's payment. This financing technique which makes it possible to effectively secure trading operations is used in countries where factoring is not eligible, but it requires good financial health.
- **Letter of credit:** financial contract between the bank of a company, the bank of a customer and a beneficiary. Issued most of the time by the bank of an importer, the letter of credit

guarantees to an exporter that it will be paid once the conditions of the letter of credit satisfied.

12.3 Reverse Factoring Numerical Example

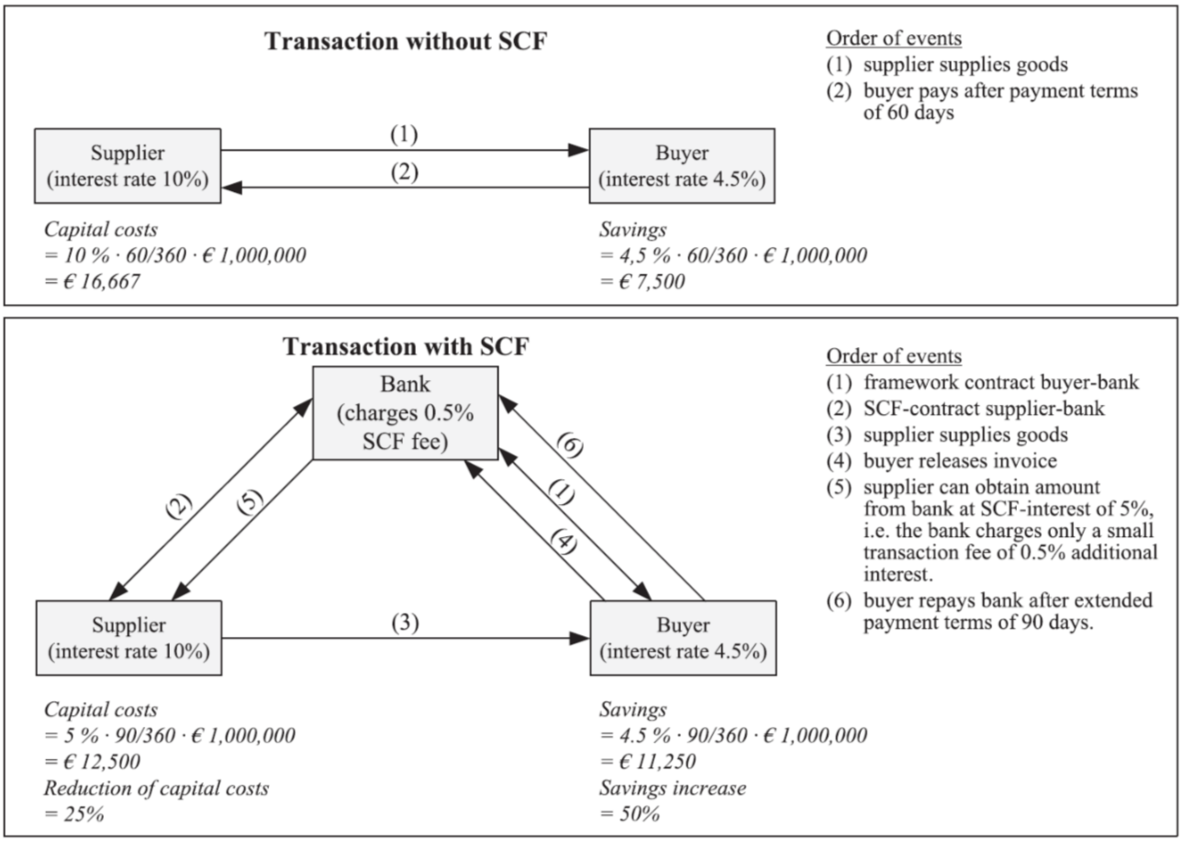


Figure 17: Supply Chain Finance mechanism (Reverse Factoring) showing the benefits of a transaction with SCF compared with a transaction without SCF. The Number presented are illustrative.

12.4 Dynamic Discounting model

The Global Supply Chain Finance Forum (2016) defines Dynamic Discounting as "based on trade credit, amounts to a discount on the wholesale price that decreases gradually over time—unlike a fixed discount rate for a certain number of days and then no discount afterwards. This SCF instrument enables the buyer to receive a slightly lower discount rate after the early payment period specified in a trade credit contract."

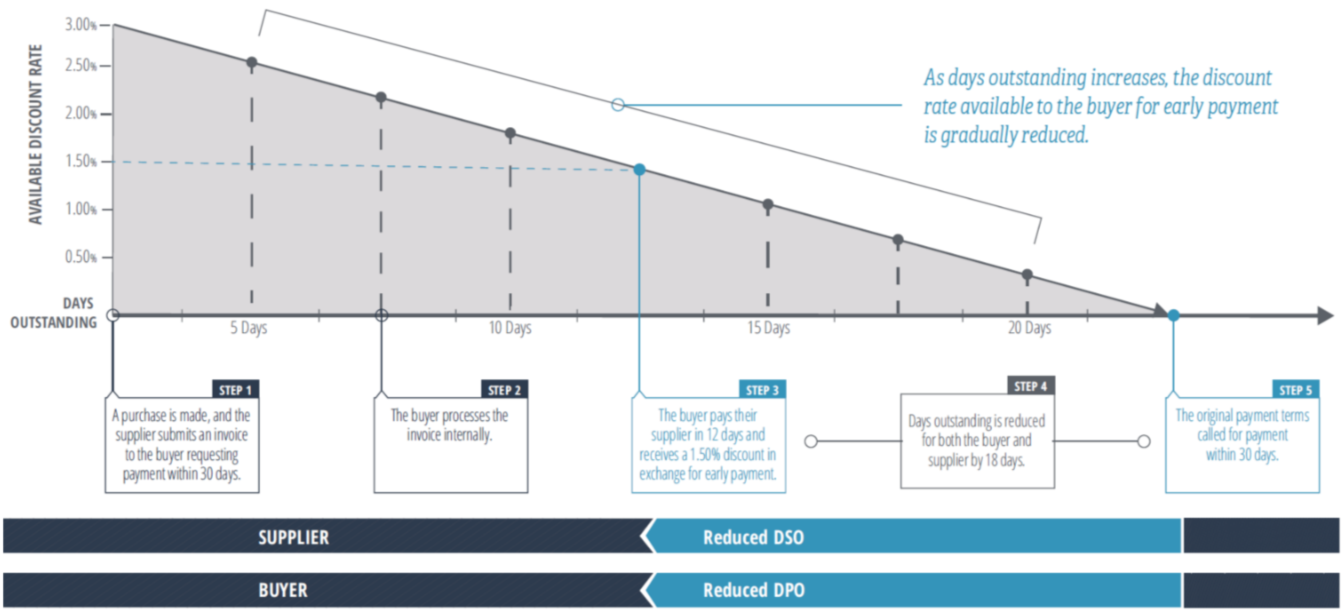


Figure 18: Dynamic Discounting Sequence of Events Example (Jeffery et al., 2017)

Dynamic discounting, like reverse factoring, is a buyer-led accounts payable financing method. An SCF instrument is considered buyer-led when the buyer is the 'anchor' for the transaction as it initiates it out of its own objectives (i.e. improving working capital and liquidity or supply chain stability, risk management, etc.) and facilitates to make the financing available on account of its relatively higher commercial and financial strength. The key difference with reverse factoring is that the finance provider is also the buyer, who then pay the suppliers directly from their own available cash. The absence of a bank or financial institution means that these solutions can only be offered by fintechs firms, or a third-party technology firm, in charge of managing and maintaining the SCF platform. That is why, it is often seen as a variation of reverse factoring.

For buyers, the attractiveness of a dynamic discounting solution does not come from an extension of payment terms but rather from the availability of early payment discounts. The discount is dynamic in the sense that it involves a sliding discount structure, in which the sooner the buyer pays the supplier, the larger the discount they receive. This differs from a classic trade credit structure, such as the 2/10 net 30 (in which if the buyer pays within 10 days it will receive a 2% discount or otherwise have to pay the full amount in 30 days), as not all buyers are able to meet the rigid early payment window. Often, this is because most companies need more than 10 days to process an invoice. With a sliding structure on the discount, the buyer will always have an incentive to pay earlier at any given point.

The benefit of using dynamic discounting for each party are then:

- **Buyers** benefit from dynamic discounting from the discount that they receive on early payment. Given that they have enough available cash on hand, self-funding the operation can be more attractive than alternative investment opportunities in the market, as the discount rate on invoices is often equivalent or higher than the returns buyers could generate on the market. Fintech firms offering dynamic discounting report that these discount rates often average between 4-7% over the payment period (Jeffery et al., 2017). Additionally, this method is considered relatively risk-free compared to alternatives, which makes the opportunity to inject liquidity in their own supply chain and generate high returns incredibly beneficial for buyers. A second benefit comes from the self-funded aspect: the buyer ultimately decides which supplier it wishes to onboard and is not restricted by the supplier's size or creditworthiness as a financial institution would. This allows the buyer to onboard as many suppliers to the SCF program as possible given its cash on hand.
- Aside from the obvious early payment, **Suppliers** benefit from being able to participate in the SCF program regardless of their creditworthiness. Fintech firms offering dynamic discounting generally register a high supplier participation rate as any supplier can virtually be onboarded (Jeffery et al., 2017). However, it should be noted that, because the onboarding of these supplier is at the buyer's discretion, suppliers with an already existing relationship with the buyer are more likely to be onboarded than suppliers further down in the supply chain. According to a study by McKinsey (2015), a key success factor in an SCF program stems from the ease at which suppliers can be onboarded.

12.5 Working Capital Optimization and Liquidity Management

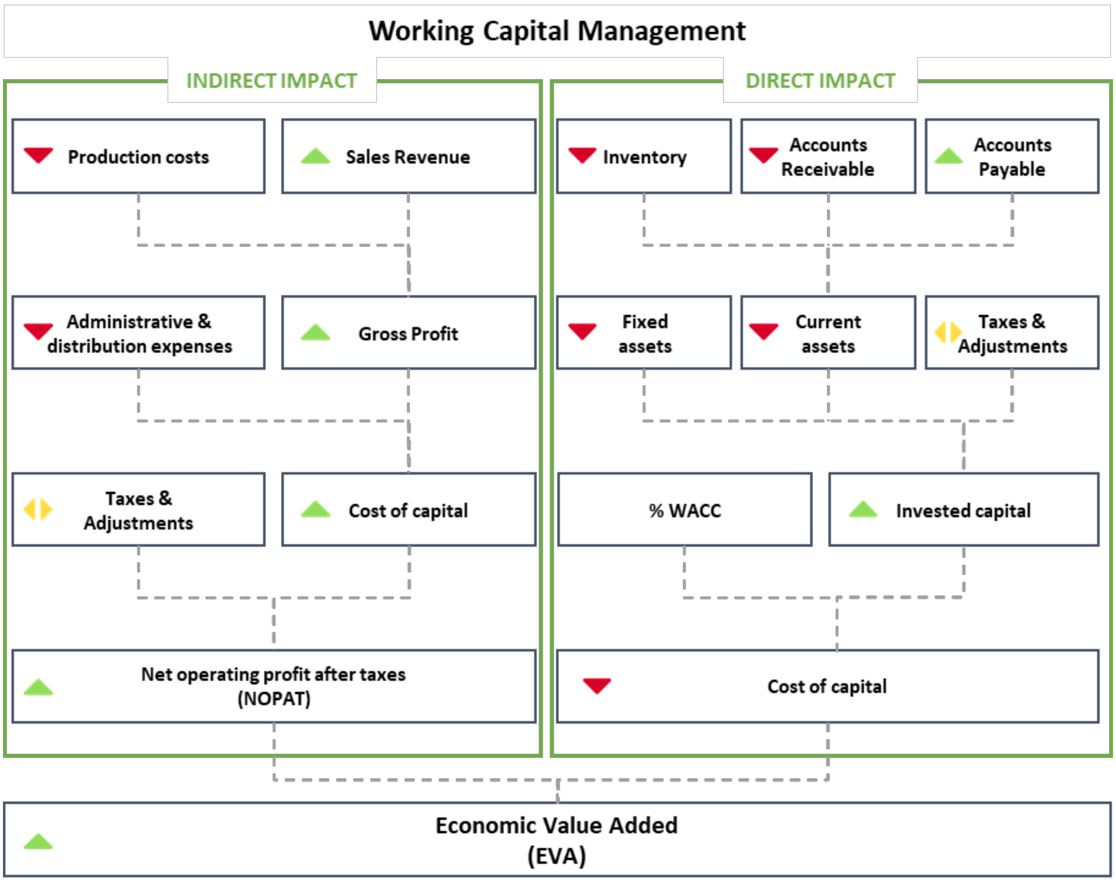
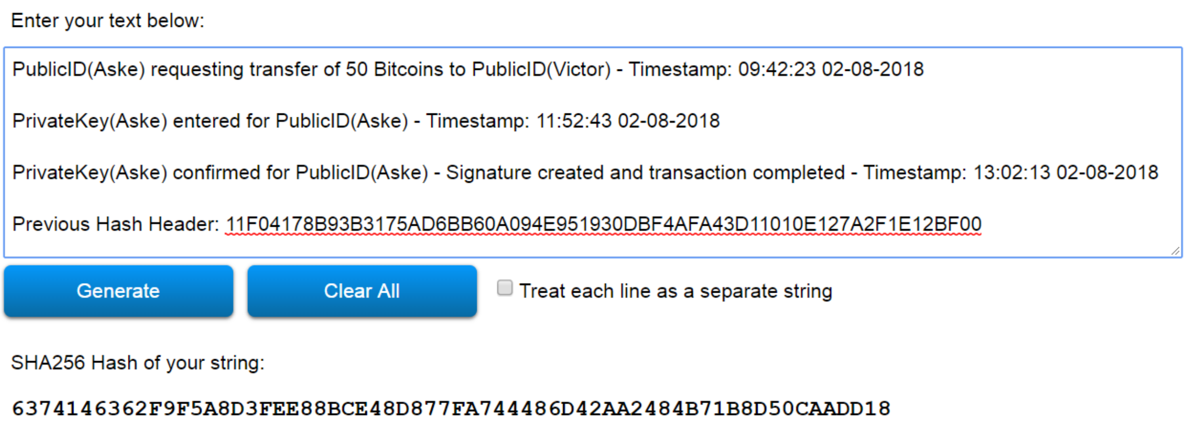


Figure 19: Impact of Working Capital Management on Economic Value Added, adapted from Hofmann and Belin (2011)

12.6 Cryptographic hashing

For a system to handle digital assets, there would have to be an authoritative record of all transactions. For Bitcoin, this authoritative record is the blockchain, a shared database of all transactions, which are registered in blocks of data by an architecturally distributed peer-to-peer network (Hofmann, 2015). Any transaction on the network is time-stamped to prove that the data existed at a given time and to give a chronological order to the blocks of transactions. All transactions are bundled together in blocks of data (hence the name "blockchain"), and each additional new block of data are cryptographically chained with the block before, reinforcing the history of transactions. The chain of data blocks therefore gives a complete history of ownership of the digital assets, and all the activities on the network, which are impossible to replicate. In, addition it is theoretically impossible for participants to alter or redo parts of the chain after a certain amount of transactions (Nakamoto, 2009).

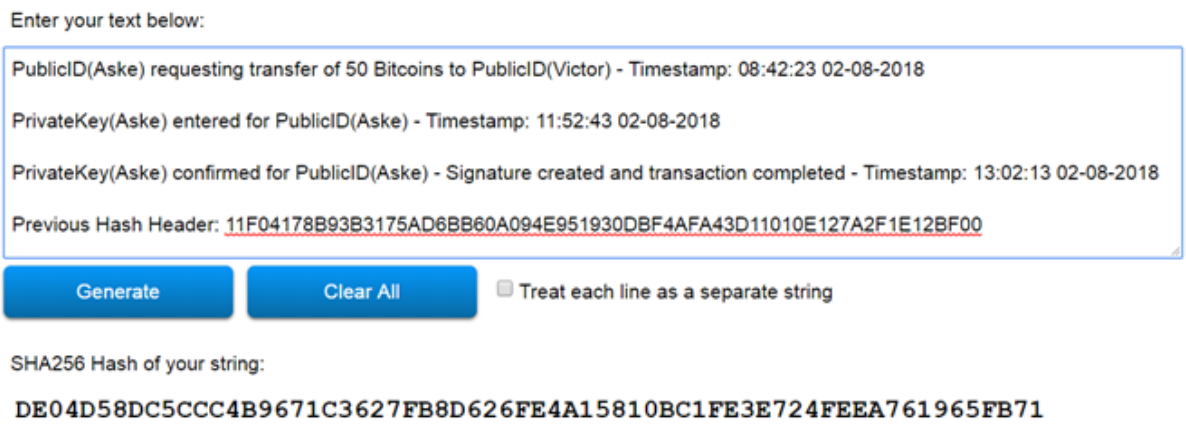
At the very core of any blockchain lies the process of hashing, which allows data to be securely stringed together. Hashing, in simple terms, is the process of converting an input (in this context a text or number input) and converting it through a hashing algorithm to an output of a certain length. This means, that no matter how much information is entered into the algorithm, it will always have a fixed length of a set amount of characters (Antonopolous, 2014). An example of such input-output is shown below using the SHA-256 Bitcoin Hash algorithm.



The text in the blue textbox above is an illustration of the different components of what is included in a block of data on the Bitcoin Blockchain. The input is converted through an online SHA-256 generator. In essence (although this is only a visual example), this is the only information included in transactions on the Bitcoin Blockchain. The different components and their significance will be discussed later.

As can be seen in the image, the input in the blue box is converted to a hash code, which is shown in the bottom of the page (6374146362….). This line of code is 64 characters long and is the hash code of the entire input written in the blue box. Should the input be significantly larger, the algorithm would still only relay a hash code of 64 characters. In addition, hashing has several key properties, which are essential for cryptography as according to Blockgeeks.com (2018):

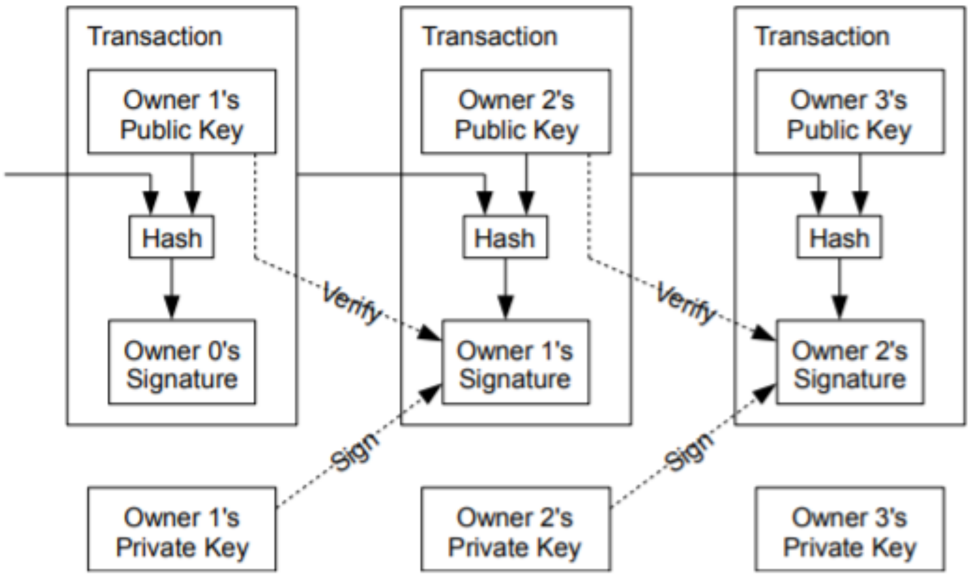
- The first property is that the same input in the hash algorithm will always give the same hash output. This means, that the same input will always relay the same hash code. For example, if the text above was copy-pasted into any other sort of online SHA-256 generator, the output should give the exactly same hash.
- Second, any input, no matter the size, can swiftly be converted to a hash. This is essential to facilitate a high number of transactions throughout the network.
- Third, it is near impossible to determine what the input of the algorithm was, by only viewing the hash output. For example, if a malicious third party had access to the hash code above, it would be near impossible for them to determine what text was written in the blue box.
- Fourth, miniscule alterations in the input will cause large alterations in the output. This is demonstrated in the image below.



The input in the blue box above is almost identical to the input in the first image. The only difference is that in the second image, a single digit has been changed in the timestamp in the first sentence. The resulting hash code is substantially different and bears no resemblance to the previous hash code.

In addition to hashing, the process of applying digital signatures to transactions are necessary to create a Block. The concept of digital signatures was first introduced as early as 1976 by W. Diffie and M. Hellman, but was later integrated into the blockchain design by Nakamoto (Hofmann, 2017). In the case of the Bitcoin, the digital signature of participants on the Blockchain consist of a public and a private key. The public key is the identity and digital address of the participant on the Blockchain. At any given time, the digital assets attributed to a particular public key will be visible for everyone (i.e. the balance of coins in terms of cryptocurrency). For visual representation, it can help to visualize the public key as an anonymous bank account username, located on a long ledger, where every single username in the bank, and their respective balances, are visible for all to see.

However, for the participant to be able to use the balance/assets attributed to that particular public key, a private key is needed. This private key is tied to the public key, so the only way a participant can use the assets, is by having both keys. For a transaction to occur, the owner of the public key must designate a recipient, and verify the transaction by using his private key. If the private key is recognized as belonging to the public key, the two keys will form a digital signature, which verifies the authenticity of the transaction (Antonopolous, 2014). The use of the private key also proves that the sender has consented to the transaction. The entire process is shown below:



Above are shown how Blocks are created on the blockchain. To understand the process, it if first necessary to explain all the different components, which go into each Block. These include:

- Information about the transaction (the amount of assets transferred)
- A timestamp of the transaction
- The digital signature of the sender to verify the transaction (which consist of the public key and the private key of the sender as seen in the illustration above)

- The public key of the recipient
- The header hash of the previous Block (explained below)

The last step in the process of cryptography is taking the entirety of this transactions data and turning it into a hash code, which is placed at the end of the Block. This is what is called "The Header Hash". For imaginative purposes, the content of the block can be visualized as a folder, with the header hash being the file sticker on the outside, indicating what the folder contains.

When adding new Blocks to the chain, the Header hash of the previous Block is inserted into the subsequent Block (Nakamoto 2009). As the header is the hashed value of all the information contained in the Block, changing but a single piece of information in the Block would result in a substantially different header hash (minute changes in the input, results in large changes in the hash code). If participants attempted to change information in any given block, the forged content of the Block would no longer reflect the existing header hash.

To illustrate this, let us assume a malicious third party wanted to change information contained somewhere in the Blockchain. To do so, they would first have to replace the information in the Block, and then replace the header hash with a new one, which reflected the forged information. However, as the header hash is also inserted in the subsequent Block, this would in create another dispute, as these linked blocks would no longer match. To alleviate this, the forgers could then attempt to change the header hash contained in the next block, to make them match. However, by changing information in the subsequent Block, the first mentioned dispute between Block content and header hash would present itself again. This means, that if a third party wanted to change a single bit of information contained on the Blockchain, they would have to change every single subsequent Block and header hash, which is nearly impossible (Nakamoto, 2009). The process can be viewed in the image above, showing how the information in the left Block is converted to a hash, which is inserted in the subsequent middle block. The information in the middle Block is then converted to a hash, which is inserted into the subsequent right Block, continuing the chain.

12.7 Product dimension - Spectrum of approved payables financing Instruments

Approved payables financing instruments

	Dynamic discounting	Reverse factoring (one bank model)	Reverse factoring (multi-bank model)	Reverse securitisation (multi-investor model)
Structure	Simple structure, few parties involved.	Classic 'three-corner' model.	Increased operational complexity, technical interdepen-dency, bilateral collaboration.	Complex legal structure and involvement of many financial and legal actors. High volume of eligible approved payables needed.
Buyers	Usually large cash-rich companies.	Stable and large high rated companies.	Large buyer with extensive supplier network.	Large buyer with extensive supplier network.
Suppliers	SME's, national and international.	Usually only 'top slice' suppliers.	Broader base SME's suppliers	Broader base SME's Suppliers and high rated ones.
Investors	Buyer, with the possibility of external financing or in combination.	Financial institution with factor license. Usually large global bank.	Financial institutions with factor license. Usually large global bank with smaller commercial banks.	Institutional investors and secondary market players (e.g. money market funds, pension funds, hedge funds and family offices).
B2B platform providers	B2B platform connecting the buyer with their suppliers.	Usually web-based proprietary platform.	Shared proprietary platform or bank-agnostic B2B platform.	Bank-agnostic B2B platforms, undertake KYC processes and plays as intermediary.

Figure 20: Spectrum of approved payables financing instruments (Hofmann et al., 2017)