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TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

The euphoria surrounding blockchain technology has reached the field of international development. National and international development organizations, either directly or indirectly, have been gradually increasing their interest and involvement with blockchain. Notwithstanding the above, the significance of blockchain for leveraging social and economic goals remains contested.

Several proofs-of-concept have been developed in recent years, and many pilot tests have been conducted. However, blockchain continues to be in its early development stages. While the above can explain why most discussions about its relevance for the field have mostly focused on exploring its potential rather than its shortcomings, Pisa (2018, 81–82) argues that this imbalance has led to unrealistic expectations about what blockchain can really do.

By taking Pisa's assertion as a starting point, this dissertation aims to shed light to the underlying assumptions of the blockchain and development discourse to assess the extent to which blockchain can be considered as an instrument providing opportunities for the Global South (GS). For that purpose, this study investigates the ways in which blockchain's potential to support the attainment of developmental goals is approached, evaluated and legitimized.

This endeavor is based on a text analysis of relevant publications of some of the main international development organizations. The findings are then systematically contrasted with critical views of previous attempts in which technology was used to achieve similar ends. The objective is twofold: First, to challenge the discourse of newness underlying blockchain discussion as a potential instrument for development; Second, to offer a framework that considers the frequently ignored political and economic factors influencing technological advancement in the GS. In this way, this dissertation seeks to offer a wider perspective from where expectations could be re-assessed.

The study is structured as follows. The upcoming chapter introduces blockchain's basic concepts, technical variants, and operational foundations, all necessary to properly analyze its potential. Chapter three elaborates the grounds of the study and presents the methodological process followed for investigating the blockchain-development nexus. Chapter four performs a text analysis of a selection of international development organizations publications. Chapter five offers a critical discussion of the narratives underlying the discussion of blockchain and development. The last chapter will set out the general conclusions.

CHAPTER 2. WHAT IS BLOCKCHAIN?

The confusing terminology surrounding blockchain, its accelerated pace of expansion and a common overstatement of its capabilities make it difficult to have a common understanding of its true significance for the development field. In light of the above, this chapter will explore, from a non-technical perspective, the theoretical foundations needed to objectively analyze its potential to address social and economic challenges. The chapter is organized as follows. The first section presents a brief historical perspective aiming to locate the inception and evolution of the technology. The second examines some of the most relevant concepts around blockchain. Against this background, the third section explores its operational foundations. The fourth gives an overview of the most important technical variants. Finally, the fifth and sixth sections offer a discussion about its commonly perceived advantages and limitations.

2.1 Historical overview

2.1.1 Blockchain and Bitcoin in perspective

The distinction between blockchain and Bitcoin was sometimes unclear, especially in the early years when both were often mentioned as interchangeable terms. Even though they go hand in hand, and they hold a close and even historical relationship, some clarifications should be made. Released at the beginning of 2009 by Satoshi Nakamoto,[1] Bitcoin is fundamentally a peer-to-peer (P2P)[2] digital currency[3] which is neither maintained nor controlled by any central authority, but instead, by automated consensus among participants (or *nodes*)[4] of the network (Swan 2015, vii–ix). In other words, Bitcoin's users are connected in a network that operates without a central unit of control (or *server* in computer sciences terms) and in which the trust that the latter usually provides, is replaced by a validation process based on an algorithm-ruled consensus.

Although Bitcoin was not the first digital currency that has ever existed, it proposed a groundbreaking solution to the so-called double-spending problem (Brito and Castillo 2013, 4). Since digital information can be easily created, copied and deleted, a trusted third party was usually required to guarantee the integrity of the system and to give its participants the

[1] Satoshi Nakamoto is a pseudonym used by the person or entity who created the Bitcoin (Swan 2015, ix).
[2] In a P2P network, *peers* (or computers) share information and resources without the need of a central unit of coordination. For more information, see https://techterms.com/definition/p2p Accessed on Aug 2, 2018.
[3] "Digital currency is an umbrella term encompassing fiat currency (like bank deposits and mobile wallets denominated in U.S. dollars) and non-fiat virtual currency" (Nelson 2018, 13). "A non-fiat currency is simply any form of monetary value that is not endorsed or issued by a government as legal tender" (Nelson 2018, 13).
[4] A *node* in computer science, can be either a device or a data point on a network (e.g. a PC, a smartphone or a tablet), see "What is a *node*?" https://www.cbronline.com/what-is/what-is-a-node-4927877/ Accessed on Aug 2, 2018.

confidence that each amount of the digital currencies was to be spent only once (Drescher 2017, 51). Bitcoin addressed this problem by allocating the information of all transactions performed in a public ledger known as the blockchain (Brito and Castillo 2013, 4). The information contained in the blockchain is not only public, but it is also continuously distributed among all participants, so each one of them receives a copy of the ledger which contains a registry of all transactions ever made (Morabito 2017, 6–7). For this reason, it can be said that blockchain was created initially with the intention of serving as a repository; a database for recording transactions of Bitcoin.

Despite this close connection, blockchain remained for a long period as the underlying technology behind Bitcoin without getting enough attention to individually assess its capacity (Zambrano, Seward, and Sayo 2017, 6; Swan 2015, 1). Conversely, Bitcoin received most public attention, especially in 2013, the so-called "year of Bitcoin"[5], when it experienced important price changes, going from around $12 per unit to a record-high of $1,242 (Christensen 2013). At the end of that year, Bitcoin trading price was even compared to that of an ounce of gold (Rooney 2013).[6]

While 2013 was of great significance for Bitcoin, it represented at the same time an important turning point for blockchain because it was also the year when blockchain started to distance itself from Bitcoin. In words of Vitalik Buterin, one of the most well-known personalities in the blockchain space,[7] "at the end of 2013 people were getting interested in blockchain technology; [they] were getting interested [in] the idea particularly that you can use it for applications other than Bitcoin […]" (TechCrunch 2016). That is to say, the excitement surrounding Bitcoin paved the way for the rise of blockchain as a standalone technology with the capacity to offer more functionalities beyond storing Bitcoin transactions.

This transition gained momentum at the end of 2014. It started with the price downfall of Bitcoin at the beginning of the year and deteriorated in March when the once biggest cryptocurrency exchange, Mt. Gox, announced that approximately 850,000 Bitcoins belonging to its customers

[5] On December 10, 2013 the Forbes Magazine published an article titled "2013: the year of bitcoin" quoting the statement of Guillaume Babin-Tremblay, executive director of the Bitcoin Embassy in Montreal, Quebec: "You can definitely say that 2013 has been the year of the bitcoin," see https://www.forbes.com/sites/kitconews/2013/12/10/2013-year-of-the-bitcoin/#19fcd933303c Accessed on Aug 3, 2018.

[6] Admittedly, the media attention that Bitcoin received must have acted in benefit of its tainted reputation related with SilkRoad, one of the largest black-market websites with $1.2 billion in sales (Leger 2014). Here, Bitcoin was used as the standard payment method.

[7] The Fortune magazine made a list with young personalities who are transforming business called "The Ledger 40 under 40." Vitalik Buterin is ranked second in the list due to its "visionary's experiment" called Ethereum, an open-source blockchain platform and the second-most-valuable crypto network next to Bitcoin, with a market value of about $48 billion. See http://fortune.com/the-ledger-40-under-40/vitalik-buterin-2/ Accessed on Aug 20, 2018.

and the company itself were missing; an amount valued at more than $450 million at the time of the events (Huang and Dougherty 2014). At the end of that year, mentions as “Bitcoin had a very bad year” (Kosner 2014) and even more controversial ones as “Bitcoin is dead” (Last 2014) were dominating the media. In contrast, blockchain received more attention and started to be surrounded with positive statements like the one of having "a greater disruptive potential than Bitcoin" (Rosenfeld 2014).

2.1.2 From blockchain 1.0 to blockchain 2.0

Even though an increasing number of applications and alternative cryptocurrencies[8] were developed (Ahamad, Madhusoodhnan, and Biju 2013, 43–44), until 2013 most of them were related with exchanging, sending and receiving payments.[9][10] However, the possibilities for blockchain extended beyond moving value from point A to point B since the creator of Bitcoin anticipated additional features like the possibility to have *programmable money*[11] (Swan 2015, 21). Therefore, it can be said that digital currencies were only the first application.

By the end of 2014, discussions turned around the different ways in which an increased functionality of blockchain could be attained. As a consequence, the term *blockchain 2.0* began to be gradually adopted. Unfortunately, due to the lack of standard classifications there is no generally accepted definition of what precisely the term entails (Swan 2015, 9). Broadly speaking, it refers to the transition that introduced a number of embedded functionalities, like the so-called like *smart property*[12] and *smart contracts*[13] (Swan 2015, 20). *Smart property* enables assets to be recorded and hence exchanged on the blockchain. It includes all kinds of tangible assets like a television, an apartment or a boat as well as intangible assets such as patents, trademarks and licenses (Swan 2015, 14).

On the other hand, *smart contracts* allowed users to harness the envisioned *programable quality* of Bitcoin and other digital currencies (Swan 2015, 13–18). A *smart contract* is a

[8] The term cryptocurrency is considered within the category of digital currencies. Cryptocurrency “is a type of virtual currency secured and transacted with using cryptography (like bitcoin or ether)” (Nelson 2018, 13). “Virtual currency is itself a broad term encompassing digital representations of value” (Nelson 2018, 13). Additionally, some views consider cryptocurrencies as a new type of asset because their characteristics differ to a large extent with the already existing ones. See for instance (Burniske and White 2017; Sontakke and Ghaisas 2017; Krueckeberg and Scholz 2018).

[9] For instance, at the end of 2013 the website Coinpursuit presented a long list of applications exclusively related with cryptocurrencies. To consult the list, see https://www.coinpursuit.com/pages/apps/ Accessed on Aug 10, 2018.

[10] It is worth clarifying that at this point in time most of these alternative cryptocurrencies, also known as altcoins, employed the Bitcoin code base and by experimenting with it, they progressively offered new functionalities.

[11] For a more detailed explanation of the term *programmable money*, see (A. M. Antonopoulos 2016, 37–39).

[12] *Smart property* is a term which refers to the act of encoding assets with a unique identification number such that it can be tracked on the blockchain (Swan 2015, viii). For a more detailed explanation, see (Swan 2015, 13–15).

[13] The idea of *smart contracts is* not new. It was proposed back in 1994 by Nick Szabo. However, the context, functionality and market adoption were changed dramatically when they became integrated to the blockchain.

computer program that enables an automated enforcement of terms agreed between two or more parties (Morabito 2017). Whereas in a conventional contract the clauses are written in a language of everyday use, the clauses in *smart contracts* are written in lines of computer code. Another difference is the fact that its execution does not require an authority or external enforcement mechanism since *smart contracts* are self-executed programs (Drescher 2017, 240–41). That is, once previously agreed conditions are met, the program automatically executes an action. For example, a *smart contract* can be a bet between two parties about the result of a football match. Using an external data feed, also known as an *oracle*, to check the official result (from a previously and mutually agreed source) the contract can automatically transfer the amount held in escrow to the winner.[14]

In sum, while *blockchain 1.0* involves operations related to digital currencies (e.g. Bitcoin) and payments, *blockchain 2.0* encompasses exchanges of a wide range of assets beyond currency (Swan 2015, 9). Furthermore, it can be mentioned that the possibility to employ smart contracts in combination with smart property to carry out automatic exchanges of digital currencies and virtually any kind of asset that can be represented in lines of code, opened up an entirely new dimension of opportunities for blockchain to be employed across a multitude of economic sectors.

2.1.3 Reshaping business models

Some authors have explained the structure of Bitcoin using a layered approach. Swan (2015, 1–2), for example, explains that it can be distinguished three main layers: The base layer, constituted by the blockchain which, as it was explained at the beginning of this chapter, works as a ledger where all the information and transactions are recorded. The middle layer is represented by the protocol, which can be understood as a set of communication rules that allows the transactions to occur (Drescher 2017, 4). Finally, in the top layer, Bitcoin and potentially any other kind of applications are allocated. Interestingly, this layer-like architecture in which Bitcoin is built seems to find some parallels with the internet; not only regarding the structure but also in the way in which the latter expanded and started reshaping many industries. In the following paragraphs, this link will be briefly explained.

[14] A similar example can be found in (Swan 2015, 22–23).

Back in 1974, Vint Cerf and Robert Kahn designed the Transmission Control Protocol (TCP) and Internet Protocol (IP), also known as the TCP/IP[15] Internet Network Protocol.[16] Their invention aimed to enable any computer to connect and communicate with the Advanced Research Projects Agency Network (ARPANET), an experimental computer network that was the forerunner of the internet. Eventually, the project expanded allowing to establish communications between any computer, but the set of principles introduced by the invention of Cerf and Kahn remain almost unchanged (Bheemaiah 2015). Thus, the TCP/IP served as the base layer that provided the possibility of more layers to be added. For example, the HyperText Transfer Protocol (HTTP) which allowed web browsers to communicate with web *servers*, was built on top of the already existent TCP/IP protocol.

The process in which more layers were added intensified when the introduction of the World Wide Web allowed a broader public use in the mid-1990's. At that time, new technology companies quickly emerged to provide "the plumbing—the hardware, software, and services needed to connect to the now-public network and exchange information" (Lansiti and Lakhani 2017, 4). Their contributions enabled further developments of the technology and prompted its broad adoption by facilitating its users' interactions. Notoriously, platforms like Yahoo, Altavista, Excite and Infoseek for the latter and the creation of Java[17] for the former (Lansiti and Lakhani 2017, 4).

In this sense, the first version of blockchain *(blockchain 1.0)* has been compared to the TCP/IP protocol; a platform which offers the opportunity to add new layers of protocols and applications on top of it (Swan 2015, 10).[18] In a similar way to the internet in its time, new as well as existent companies are adding or providing services[19] to add more and more layers. Just as the formative years of the internet, this process is occurring on a very accelerated pace. As an illustration of the above, the funding and investment of blockchain startup companies

[15] The Transmission Control Protocol (TCP) and Internet Protocol (IP) are two different things. However, they are commonly mentioned as one single term since they usually work in combination. In favor of clarity, the IP "acts like a unique postal address that enables any phone, tablet or computer to identify itself on the internet, while the TCP technology guarantees delivery of the data packets by dividing them into segments" (Bheemaiah 2015).

[16] When computers communicate with each other, there have to be in place a standard set of rules that each computer need to follow. This specific set of communication rules is called a protocol. See https://techterms.com/definition/protocol Accessed on Aug 20, 2018.

[17] First released in 1995, Java is a programming language and computing platform created by the company Sun Microsystems, see https://www.java.com/en/download/faq/whatis_java.xml Accessed on Aug 20, 2018.

[18] There are also views that dismiss the perception that Bitcoin (which clearly belong to Blockchain 1.0) can be equated with the TCP/IP protocol. For instance, Vitalik Buterin commented: "Bitcoin was designed to be a [Simple Mail Transfer Protocol] SMTP. It is a protocol that is very good at one particular task. It is good for transferring money, but it was not designed as a foundational layer for any protocols to be built on top" (Dienelt 2016, 4).

[19] As it is the case of Ethereum. Founded in 2014 but publicly released until 2015, Ethereum is a platform with its built-in programming language that enables developers to build new applications on top of it (Buterin 2016). In addition to *smart contracts*, the platform also allows the use of decentralized applications (DAAPs) and decentralized autonomous organizations (DAOs). See, https://www.ethereum.org/ Accessed on Aug 20, 2018.

worldwide went from $93 million in 2013 to 357 million in 2014 and reached an all-record high of $1 billion in 2017; an increase of 283% and 1000%, respectively.[20]

Under such circumstances, blockchain as a potential disruptor of many of the current business models across a wide array of economic sectors increasingly started to dominate the discourse.[21] Notwithstanding, in order to critically analyze the perceived ways in which blockchain could attain this goal and in particular how the latter is already having an impact on the field of international development, it becomes crucial to understand its most basic theoretical foundations. The next section leads this endeavor by delving into some of the usual concepts and definitions surrounding blockchain.

2.2 Contested terminology

2.2.1 Blockchain and Distributed Ledgers

The early stages of standardization and a general scarcity of regulatory and legislative frameworks have, to a large extent, contributed to nuance blockchain's real capabilities and limitations (Walch 2017, 763). Blockchain is often referred to interchangeably through a loose conglomeration of euphemisms such as "distributed ledger technology"(DLT), "mutual distributed ledger," "consensus ledger," "shared ledger technology", or even decentralized or "distributed database" (Walch 2017, 719–20). Additionally, while some authors have opted for the use of a combination of two terms, like DLT/Blockchain,[22] others have fallen back on the common practice of citing both terms as if they were interchangeable (Rutland 2017, 2).

In light of the above and considering that at this point it is impossible to have single and widely accepted definitions, this work will employ Distributed Ledger Technologies (DLTs) as an umbrella term encompassing systems in which transactions of records or data in general are continuously distributed among the participants of a network without the need of a central authority figure. Two key concepts are comprised within the boundaries of this term: Distributed Ledger (DL) and blockchain.

[20] Author's own calculation with information obtained from the statistical portal Statista. All numbers are expressed in U.S. dollars. See "Funding and investment of blockchain startup companies worldwide from 2012 to 2017" https://www.statista.com/statistics/621207/worldwide-blockchain-startup-financing-history/ Accessed on Aug 20, 2018.
[21] Consider the contributions following of (Castilla-Rubio, Robins, and Zadek 2016; Olavsrud 2016; Bakey 2016; Waters 2017; Nowiński and Kozma 2017; CB Insights 2018; Potts 2018).
[22] See for example (Deshpande et al. 2017; Santo et al. 2016).

Based on the ideas of Brakeville and Perepa (2018) and Natarajan, Krause, and Gradstein (2017),[23] the following working definitions for this dissertation are proposed. DL is a type of database that is distributed, preserved, and updated through the combined action of its members and customarily in the absence of a central authority. Blockchain is a particular type of structure that some distributive ledgers employ and in which information is sequentially appended in digital blocks.

Regarding the previous two definitions, some remarks should be made. First, the groundbreaking feature of DLs relies on the fact that these types of databases (or ledgers)[24] can dispense the need of a central authority to operate (Ray 2018). Instead, this task is usually spread across the participants who independently construct and record updates to the database (or ledger) (Ray 2018). However, it is important to realize that the set of rules and algorithms that govern this process are entirely dependent on the design of each system. Their specific characteristics will be examined in depth in section 2.4 of this chapter.

Second, blockchain can also be considered as one form of a distributed ledger (Ray 2018). What makes a blockchain unique, however, is the way in which the information is grouped and stored. In a blockchain, data is clustered in sealed digital blocks. Every certain amount of time (in the case of Bitcoin very 10 minutes) a new block is created. Each newly added block is provided with a time stamp and a *hash*.[25] The stamp registers the date and time the block was created. The *hash*, which works as an identification number, links the block to the previous one. The successive union of blocks form a constantly growing chain that follows a chronological order. Hence the term blockchain.

Third, while every blockchain is a distributed ledger, not every distributed ledger is a blockchain (Ray 2018). This frequent confusion between the two can also be explained since many, though not all, distributed ledgers use blockchains (Nelson 2018, 4).

All points considered, from this point forward, the acronym DLT will be used as an umbrella term that encompasses both: DLs that use blockchains and those that do not. Nonetheless,

[23] The original definitions proposed by the authors are as follows. "A *distributed ledger* is a type of database that is shared, replicated, and synchronized among the members of a decentralized network" (Brakeville and Perepa 2018). "A 'blockchain' is a particular type of data structure used in some distributed ledgers which stores and transmits data in packages called 'blocks' that are connected in a digital 'chain'" (Natarajan, Krause, and Gradstein 2017, vii).

[24] Despite that the word ledger does not appear in the original white paper that introduced the Bitcoin, the first blockchain that has ever existed, it has become a widely used term (Walch 2017, 726).The above can be explained using the resemblance of the record-storing process that occurs in blockchain with the those made in the book of final entries, in which business transactions are recorded.

[25] A *hash* is a digital fingerprint, a unique cryptographic string of data (A. M. Antonopoulos 2014, 15).

for purposes of explanation and only if required, an explicit differentiation between the two will continue to be made.

2.2.2 Decentralized and distributed

Just as there is no common agreement on the features that can accurately define what a blockchain or a DL is, there is a significant discrepancy between two terms that frequently come along with them: decentralized and distributed. As this section will argue, this confusion can be sometimes attributed to a semantic problem. It is important to realize that DLT is incredibly interdisciplinary. It brings together knowledge from a wide array of fields ranging from economics, finance, cryptography, philosophy, sociology and political science (Walch 2017, 725). Accordingly, it should be clarified that both concepts are discussed below only from a computer sciences perspective and using a computer network as a framework.

On a centralized network, the information is stored, maintained and administered in one central *node* known as the *server*. On this type of system, the data is not openly shared among other *nodes*, but instead obtained individually by each *node*. Thus, the *server* has overall control over which *nodes* can access the information and under which conditions they can do it. In contrast, on decentralized and distributed networks control is not concentrated in one *server* but spread across the entire network. The specific ways in which this de-concentration of power is achieved in each of the two types continues to be a subject of debate. However, some general similarities and differences can be pointed out.

On both decentralized and distributed networks, the above is attained without the need of having a central *server* or authority figure. This decision-making process is instead apportioned among the *nodes* of the network. One of their differences lies in the way in which this process takes place. While in a fully distributed network, no single *node* has a vantage point because all *nodes* are, in principle, endowed with the same privileges, on a decentralized network, the distribution does not necessarily follow the same rule. Depending on specific operational needs, a *node* or group of *nodes* can have different and even unequal prerogatives over other *nodes*.

As it could be noted, even within a specific context, it is difficult to make clear-cut distinctions between the two without delving deeper into the details. Therefore, it would be misleading to use them as if they were overarching concepts with the capacity to retain the same meaning indistinctly of the field or discipline in which they are used. In the context of DLT discussions, this is often the case. Titles of some influential publications such as “the future is decentralized”

(UNDP 2018), “the future of trust is distributed” (Roberts 2017), “the blockchain: decentralized trust to unlock a decentralized future” (Casey 2016), or “the blockchain, or distributed trust” (Caseau and Soudoplatoff 2016), are just some examples of this pervasive problem.

2.3 Operational foundations: The consensus mechanism

In general, it can be stated that the consensus mechanism constitutes the technical basis that makes it possible for DLTs to operate without the need for a central authority or third trusted party. It facilitates the process in which participants (or *nodes*), without necessarily trusting each other, take and execute decisions to maintain and update the system (Nelson 2018, 11). In the particular context of blockchain, the aforesaid reflects on the ability of the *nodes* in deciding whether a block contains valid information or not and if it should be added to the chain (Drescher 2017, 156). Regarding DLs which do not use blockchains, the consensus mechanism allows the *nodes* to determine if transactions are valid and hence must be added to the ledger (Stevens 2018). The entire process is assisted by the combined action of two instruments: the *hash function* and the consensus algorithm. However, in order to simplify their explanation, only Bitcoin that uses a blockchain will be taken as an example.

A *hash function* is a cryptographic tool that takes an input of any length and creates an output of a fixed length (Drescher 2017, 72). Concerning Bitcoin, this output is always a set of sixty-four alphanumeric characters.[26] In this process, the *hash* of the next block in the chain always depends on the previous one. That is to say, in order to calculate a new *hash*, the information of the previous block is taken as input (Morabito 2017, 61). As a result, once the information is added to the chain it cannot be altered without modifying all previous blocks which extend back as far as the first block ever created, also known as the genesis block (Morabito 2017, 65).

The immense amount of resources required to achieve the above-described task grant the system with a significant level of security. Nevertheless, given the growing capacity of computers, the *hash function* is applied in combination with a consensus algorithm. The function of the latter is to regulate the intervals in which blocks can be created and added to the chain (Caseau and Soudoplatoff 2016, 17).[27] In *Proof-of Work*, the consensus algorithm employed in Bitcoin, the former is achieved employing mathematical puzzles. The first *node*

[26] Bitcoin, in particular, uses the *hash function* SHA-256, which was originally developed by the US National Security Agency (NSA). The number 256 alludes to the number of bits of the output produced equals 64 characters of length number.

[27] As, in any competition, the demand and amount of resources invested by the miners to achieve this goal can occasionally fluctuate. For this reason, the *Proof-of-Work* algorithm continually adjusts the level of difficulty needed to solve the puzzles. In other words, *proof-of-work* can speed up or to slow down the process in which new blocks are created and added to the chain (Caseau and Soudoplatoff 2016, 17–18). In the case of Bitcoin, this goal is set at six times per hour.

that solves the puzzle, which in practical terms means the practically translates in the calculation of the next *hash function*, is granted with the ability to process the transactions in that block. For completing this job, the *node* receives a reward in the form of the token used in the system (e.g. in Bitcoins).[28] The above-described process is ordinarily identified as *mining* and the *nodes* or participants of the network that dedicate their computational power to solve the mathematical puzzles are called *miners*.

Finally, the results obtained by the *mining* process are then broadcasted to other *nodes* of the network to be validated before being added to the chain (Morabito 2017, 10). It is important to point out that while producing *proof-of-work* can be a very time-consuming and resource-demanding process, its revision turns out to be a much simpler task. The above enables the participation of a higher number of *nodes* of the network, which with much less computational power, can corroborate if the process was successful and no mistakes were made (Drescher 2017, 157–62).

In brief, the consensus mechanism facilitates the coordination of a network of independent *nodes* towards maintaining and updating shared information. This is attained not only through the combination of cryptographic tools like the *hash function* but also through a model of incentive systems embedded in the consensus algorithms like *proof-of-work*. The previous, however, is not the case for all DLT systems;[29] as technology grows and expands, the number and types of DLs along with the number of consensus algorithms[30] and *hash functions*[31] utilized also increases.

2.4 Technology variants: Permissioned and permissionless ledgers

There is a significant number of different types or variants of DLTs. However, two main sets of categories can be distinguished: permissioned and permissionless and public and private.

In a permissionless DL, there are no restrictions regarding who can join the network. It can be either public or private. While in the first any user can join and start performing and validating

[28] Depending on the purpose and design of a distributed ledger, it might employ a digital asset (a non-fiat digital currency) as a means to (a) compensate the participants responsible for processing transactions on the ledger, or(b) facilitate the exchange of assets via the ledger.

[29] For instance, neither Hyperledger Fabric nor Corda requires work of miners in order to operate (Nelson 2018, 12).

[30] Although with many different technical differences, it can be mentioned that most of consensus algorithms follow similar logical foundations. For more information on types of consensus mechanism, see https://www.logicsolutions.com/5-types-blockchain-consensus-mechanisms/ Accessed on Aug 30, 2018.

[31] For a detailed explanation of the recent design and trends in cryptographic *hash functions*, see (Al-Kuwari, Davenport, and Bradford 2010).

transactions, in the latter only a group of previously defined *nodes* is granted with full access to the network (Zambrano, Seward, and Sayo 2017, 28).

In a permissioned DL, some functions require users to go through an authentication process (e.g. via passwords). It can also be either public or private. In a public permissioned DL, all users can join the network but need to authenticate in order to perform changes to the ledger. In contrast, on a private permissioned DL all users need to authenticate for both, joining and performing changes (Zambrano, Seward, and Sayo 2017, 29).

The concerns of the proponents of more restricted networks are in many instances related to two dimensions: data privacy and scalability. First, on a permissioned ledger, there is more control over the use and distribution of information as well as over the identities of the users that can access and modify it. Second, by reducing or eliminating some processes, such as *mining*, permissioned DLs can potentially process more transactions at a lower price (Kadiyala 2018; Corda 2018).

Likewise, the possibility of having more control over information and users' identities makes them more suitable to comply with the current regulatory frameworks. Consequently, they become more attractive from both the business and the authority perspective (Natarajan, Krause, and Gradstein 2017, ix). As it turns out, the industry in general but especially the financial sector, seems to be opting for a mix of private and permissioned alternatives. As an illustration, with more than 200 members, mostly banks and financial firms, the New-York based startup R3 is leading the largest financial consortium testing with private DL applications (Irrera 2017).[32]

Despite the outlined benefits, permissioned and private DLs appear to come with the cost of affecting one fundamental feature, namely centralization (Buterin 2015). Similarly, according to some early technology advocates, private and permissioned systems, disregard the set of characteristics that made the technology groundbreaking and revolutionary (A. Antonopoulos 2018).[33] With this overall perspective of the technological variants, the next section will look through the most commonly mentioned advantages and limitations.

[32] R3 has proposed Corda enterprise, a platform developed to mostly suit the needs of the financial industry (Micobo GmbH 2018). This version of a DL, which also does not use blockchain, is built upon a "highly-client sensitive private ledger" (Kersten 2016).
[33] During a talk that took place on May 18th, 2018 at the 'We Are Developers World Congress' in Vienna, Antonopoulos explains why it is the open [DLTs] truly matter in building a borderless, censorship-resistant applications that are open-source, open-access, and built through permissionless innovation, see https://www.youtube.com/watch?v=uZPIz3ArQww Accessed on Aug 26, 2018.

2.5. Advantages

With the background information provided until now, the last two sections of this chapter propose a discussion of the advantages and limitations of DLTs. The aim is to provide a general overview of DLTs potential which will be absolutely essential for the analysis of DLTs in the particular context of development presented in the fourth chapter.

2.5.1 Tamper-resistant

The DLTs feature of tamper-resistance is often described as 'immutability', but the use of the term remains controversial.[34] Some authors as Lansity and Lakhani (2017, 9) opted for using the expression "irreversibility of records". In many other cases, it is mentioned as "tamper-evident" because fraudulent changes can be detected by other *nodes* (Hanson, Reeson, and Staples 2017, 62). Nevertheless, while the probability of altering a record is very low, the possibility of this to happen is not entirely removed. Therefore, it can be said that a DL is highly resistant to unintended changes but not immutable.

2.5.2 Transparency

The *nodes* of the network are continually sharing all the information on the ledger. The above makes the information as well as the changes and updates ever performed public and accessible. In practical terms, this implies that *nodes* can verify past transactions in order to confirm their legitimacy. Taking as an example the scenario of a bet on a football match between two participants above described (see sub-section 2.1.2), it would be possible for any *node* to verify if the result was legitimate.[35] All information regarding conditions, the result, and the payment, create a permanent record that can be later examined. Thus, this advantage has been pointed out of greater significance for the use of DLTs as a means of record-keeping for *hashes* of documents, identities and property (Swan 2015, viii).

2.5.3 Accountability

The possibility of having a public record of all the transactions that have ever been carried out is discussed as one of the potential advantages of DLTs for tackling corruption. Every single transaction creates an indelible mark. This mark is not only very difficult to change, but it is usually public. Nevertheless, it should be emphasized that the latter is not a common feature

[34] For a detailed analysis of the use of the term 'immutable' in the context of DLT, see (Walch 2017, 735–45).

[35] It is important to emphasize that this legitimation information depend to a large extent on the external data feed. If erroneous information enters the blockchain *nodes* cannot automatically distinguish if it is true or false. This is also known as the *oracle* problem.

among all DLTs variants. On the one hand, permissionless ledgers like Bitcoin does not necessarily make the users accountable for the transactions conducted in the ledger. That is to say, the ledger stores the records and the public keys[36] associated to them, but it does not store any personal information of the users owning those keys.[37] Conversely, in many permissioned versions, the authentication process which all users need to go through to gain access or conduct transactions can be used to associate them with their transactions. In this sense, it is very likely to make users accountable for misbehavior in permissioned versions, while on their permissionless counterparts this probability is significantly lower (Herlihy and Moir 2017, 4).

2.5.4 Security

In general, the absence of a central *server* makes the entire system less vulnerable to cyber-attacks. DLTs commonly employ advanced public and private encryption to protect all transactions (Zambrano, Seward, and Sayo 2017, 30). Nonetheless, some points need to be considered. On the one hand, redundancy makes public DLTs slower and resource intensive, since more computational power is usually required to maintain the ledger, but it also makes the ledger more secure (Kotha 2018). On the other hand, private versions tend to centralize a number of processes and information. Concentrating information in one place (or in a reduced number of them) also rises security concerns (Berke 2017). Given these points, it can be said that while DLTs are considered very secures they have, like any other system, their own security flaws. The extent to which these flaws can represent a threat will entirely depend on the design and structure of each system.

2.6 Limitations

2.6.1 Scalability trade-offs

The processing capacity has been progressively increasing. Due to the integration of innovations such as the lightning network in Bitcoin,[38] the number and speed of transactions have increased. Notwithstanding, its current capacity does not seem to be ready for broader

[36] A public key is a small piece of code that works as a digital signature of a user. In the particular context of Bitcoin, it can be understood as a bank account number that can be shared with friends in order to receive money transfers.
[37] This possibility has also raised concerns among governments since it is difficult, however not impossible, to unveil the identity of the person owning a particular public key. This is also why, the website silk-road contributed to taint the reputation of Bitcoin (see section 2.1.1).
[38] The lighting network is often called the off-chain approach. This upgrade aims to reduce the load of transactions by preventing small and routine transactions to be stored in the main blockchain, see (Glazer 2018).

adoption.[39] As an illustration, Bitcoin transaction volumes are still around 1/10,000th of those of VISA (Peter Evans-Greenwod et al. 2016, 43).

On the other hand, while technical improvements continue to offer more potential to scale up, they often pose a predicament for decision makers. Three core features, in particular, are considered very difficult to change without significantly affecting the others: decentralization, scalability and security (Konstantopoulos 2018). Buterin coined this problem as the 'scalability trilemma' (Wang 2018). For example, permissioned ledgers are usually faster and capable of handling a higher number of transactions. Nevertheless, this enhanced capacity implies that the decentralization and security will be equally affected.

2.6.2 Centralization of mining

There are high costs associated with *mining* hardware which nowadays is conducted more in an industrial-like manner. As more *nodes* have joins the network with the intention of carrying out this process, the competition increases and consequently the complexity of the consensus algorithm puzzles. The high availability of specialized hardware coupled with comparably low electricity costs has led China to host the largest concentration of *mining* operations (Homakov 2017). In the case of Bitcoin alone, China is accountable for nearly eighty percent of the *mining* pools worldwide.[40] Moreover, centralization has not only led to the creation of monopolies in terms of market share but also regarding the production of mining specialized which is dominated by a handful of companies (Haig 2018).[41]

2.6.3 Environmental impact

One of the main concerns has been the high energy consumption of DLTs. The latter are usually associated with the *mining* process which most public permissionless versions require to secure their networks. Incentivized by this concerns, more efficient consensus algorithms are being developed (Panda 2018).[42] However, due to its reliability and robustness, Bitcoin and a considerable number of distributed ledgers[43] continue to use *proof-of-work*. Just Bitcoin

[39] This assertion is especially valid for the public permissionless ledgers.
[40] Author's own calculation with information obtained from the company Blockchain. See, https://www.blockchain.com/en/pools Accessed on Aug 28, 2018. In favor of clarity, a *mining* pool is a conglomerate that brings together the resources of smaller *mining* operations into a single *mining* entity.
[41] In an open letter, the co-owner of Bitcoin.org and Bitcointalk.org outlined his concerns of centralization of *mining*, commented: "More and more of the network *hash rate* is starting to become concentrated into the hands of one man [Jihan Wu] and his company [Bitmain]. The security of our network depends on them acting honorably, and us being prepared to respond to it" (Cøbra 2018).
[42] Prominently, *proof-of-stake, delegated proof-of-stake, proof-of-authority.*
[43] Notably, Litecoin and Dash, see (Devoe 2018).

alone has a current estimated annual electricity consumption of 73.12 TWh,[44] a number close to the entire consumption of Austria.[45] From different perspective, the energy used by a single Bitcoin transaction could power the average US household for eight days (Reed 2017). The environmental impact further aggravates if the centralization of *mining* is considered. In China, the coal-fired electricity remains to be the largest source of energy production.[46] The above, would certainly increase the estimations of CO2 emissions that were estimated in 2017 at around 118.36 kg per transaction (Reed 2017).

2.6.4 Interoperability

The lack of standardization among DLTs can be the source of additional problems related to systems integration. For example, the costs of integrating DLTs into financial infrastructures like payment and settlement systems not only requires industry-wide coordination and collaboration but also demands significant expenses (Natarajan, Krause, and Gradstein 2017, 18). In this context, some economic sectors try to cope with the interoperability related issues by creating new systems, tailored to their specific needs which reflect in an increase of private and permissioned DLs, especially in the financial sector.[47]

2.6.5 Governance and regulatory frameworks

The incipient stages of standardization and contested terminology of DLTs are only two of the many of challenges that regulators have to face. The problem is twofold. On the one hand, the lack of regulation limits the capacity of governments to cope with fraud, local regulatory compliance evasion, financing of illicit activities, scams and Ponzi schemes. On the other, it hinders technology adoption and innovation, especially affecting entrepreneurs and start-ups which are often confronted with the uncertainty of being incurring a legal problem (Universa 2017).While it is true that regulatory and legislative frameworks have begun to be established in some countries, they can be seen more as a reaction to an impending problem that poses

[44] Retrieved from the Bitcoin Energy Consumption Index elaborated by the platform Digiconomist, see https://digiconomist.net/Bitcoin-energy-consumption Accessed on August 28, 2018.
[45] Retrieved from the Bitcoin Energy Consumption Index elaborated by the platform Digiconomist, see https://digiconomist.net/bitcoin-energy-consumption Accessed on Aug 28, 2018.
[46] Information obtained from the International Energy Outlook 2018, published by the US Energy Information Administration, see https://www.eia.gov/outlooks/ieo/ Accessed on Aug 29, 2018.
[47] Apart from the already mentioned example of Corda and R3, it can be pointed out the platform Hyperledger Fabric which is supporting business-oriented applications for the financial sector and supply chain management (Natarajan, Krause, and Gradstein 2017, 18).

a national threat[48] than as a deliberate and carefully thought-out act.[49] The above explains their scattered nature, and in some cases, even their ambiguous condition.[50]

Under such circumstances, the issue referred to the governance of DTLs has become more relevant. For instance, in a system that is powered by the combined computational power of *nodes* with different geographical locations, under different legislation, and where there is no central party governing and operating the system; who should be held responsible and accountable for misbehavior or failure? Alternatively, how liability can be apportioned? Both questions related with just two dimensions, accountability and liability, shed light to the pitfalls that DLTs proponents and regulators will have to overcome.

2.7 Conclusion

This chapter has shown that the process of development and expansion of blockchain through a wide array of economic sectors find close resemblances with those that the internet had during the 1990's.

It has explained how through augmented functionalities strengthened around 2014, blockchain could be further distanced from Bitcoin and started spreading beyond the financial realm. It has argued that the lack of standards and a general scarcity of regulatory and legislative frameworks continues to nuance the real capabilities and limitations of blockchain.

Special attention has been paid to shed light to the thick and confusing haze of terminology usually surrounding blockchain. In this context, it has been expounded why in favor of clarity the acronym DLT will continue to be used.

Finally, this chapter has provided the general background for this study by examining the ways in which the consensus mechanism facilitates the coordination of shared infrastructure in absence of central authority, exploring its different variants, and discussing its commonly perceived benefits and drawbacks. The next chapter will introduce the methodological scheme through which the link between DLTs and development will be approached.

[48] The government of China has, for example, imposed bans to cryptocurrencies and more recently it has attempted to forbid *mining* inside its territory. In contrast, legal frameworks in the words of the Chinese Central Bank governor "will move slowly to regulate cryptocurrency" (Coleman 2018).
[49] See for example (Das 2018).
[50] As an illustration, the Arizona statute claims that the data stored "provides an uncensored truth", which is itself a very debatable statement, see (Walch 2017, 743–45).

CHAPTER 3 METHODOLOGY

This chapter introduces the methodological process followed in the second part of this dissertation. The first section presents the general framework of the analysis. The second outlines the structure and guidelines of the study. The third, explains the process in which sources have been chosen. The fourth provides an overview of how the results of the analysis will be discussed and interpreted. Finally, the fifth section looks over some theoretical considerations around the concept of development.

3.1 Grounds of the study

In 2015, the World Economic Forum reported that at least 25 countries were investing in DLTs; more than 2500 patents have been filed; more than 90 large corporations have joined DLT consortia; more than 80% of banks had plans to initiate DLT projects (World Economic Forum 2016). Between 2016 and 2018 alone, 3.7 million related Google searches were done, and more than half a million papers were published (Carson et al. 2018). While more and more companies announce their intention to test with DLTs, leading technology firms like IBM, Microsoft and Google continue innovating and investing in DLTs.[51] All of the above helps to build an image of the euphoria surrounding DLTs which has been even compared by Steve Wozniak, the co-founder of Apple, to the hype that the internet once had (Paden 2018).

In this context, national and international development organizations, either directly or indirectly, have been gradually increasing their participation and involvement with DLTs. In 2017, during the 72nd Session of the UN General Assembly, the Blockchain Commission for Sustainable Development was established. The objective was to support the UN system — along with Member States, Intergovernmental Organizations, the private sector and civil society— in utilizing blockchain-based technologies to develop solutions to accelerate the progress towards meeting the Sustainable Development Goals.[52]

Already by mid-2017, at least fifteen UN agencies were already conducting [DLTs] initiatives (Starkie 2017). On the other hand, the World Bank (WB) is employing DLTs to issue debt instruments for financing sustainable development projects.[53] Similarly, the WB *Blockchain Lab*, established for the first time in 2017, is now conducting tests for employing DLTs in areas like education, financial services, and agricultural supply chains (Orcutt 2018).

[51] See (Sharma 2018; Vena 2018; Writer 2018).
[52] See, http://blockchaincommission.org/ Accessed on Aug 28, 2018.
[53] See "World Bank Prices First Global Blockchain Bond, Raising A$110 Million" https://www.worldbank.org/en/news/press-release/2018/08/23/world-bank-prices-first-global-blockchain-bond-raising-a110-million Accessed on Sep 9, 2018.

Indirectly, those organizations, as well as specialized research institutes, have been supporting the publication of a growing list of studies which deepen into the relevance of DLTs for development. For instance, the white paper funded by the International Development Research Centre in Canada titled "Unpacking the disruptive potential of blockchain technology for human development" or the most recent “Primer on Blockchain” published by the United States Agency for International Development (USAID).[54]

The augmented engagement of development organizations with DLTs it is of utmost importance. Their steps taken towards greater integration of DLTs are frequently mentioned and reproduced across blogs, forums and specialized websites. In those spaces, where a “global network of technology supporters” (Atzori 2015) often express their ideas and opinions, development organizations’ contributions usually end up framing arguments about the social and economic utility of DLTs.[55]

At this intersection point, information is often detached from its particular context and devoid of negative connotations. Indeed, technology supporters continuously fall into the common practice of exaggerating its capabilities (Pisa 2018, 87). Moreover, given the early stages of development of [DLTs],[56] attention has lean disproportionately towards exploring their potential and not its shortcomings. This unbalances of their assessment has led to unrealistic expectations for DLTs and development (Pisa 2018, 80).

So, despite the hype, greater participation of development organizations, a common overstatement of their capabilities and considering the unbalances in their assessment for social transformation, the future of DLTs remains uncertain and their significance for development contested.

[54] See (Zambrano, Seward, and Sayo 2017; Nelson 2018). Another notorious example is the working paper published in 2016 by the United Nations Research Institute for Social Development (UNRISD) titled "How Can Cryptocurrency and Blockchain Technology Play a Role in Building Social and Solidarity Finance?", see (Scott 2016).

[55] Consider the following three examples. First, the article published in the Food and Agriculture Organization (FAO) titled "World Bank launches a blockchain lab to help fight against poverty", see http://www.fao.org/in-action/agronoticias/detail/en/c/903647/ Accessed on Sep 9, 2018. Second, the article published in Singularityhub titled "5 Reasons the UN Is Jumping on the Blockchain Bandwagon", see https://singularityhub.com/2017/09/03/the-united-nations-and-the-ethereum-blockchain/ Accessed on Sep 9, 2018. Third, the article published in Cointelegraph titled "United Nations Puts Blockchain at Center of New ‘High-Level Panel on Digital Cooperation'", see https://cointelegraph.com/news/united-nations-puts-blockchain-at-center-of-new-high-level-panel-on-digital-cooperation
Accessed on Sep 9, 2018.

[56] Michael Pisa uses in his elaboration the term blockchain. For the reasons provided in the first chapter and to keep consistency across this dissertation, the term has been replaced with the broader term DLTs.

3.2 Aims and objectives of the analysis

Bearing Pisa's critiques in mind, this dissertation aims to answer the following research question: To which extent DLTs can be considered as an instrument providing opportunities for the GS's development? To provide an answer to this question, it will be conducted a text analysis of relevant publications making a correlation of DLTs with the field of international development. Subsequently, the outcomes and results will be contrasted with critical examinations of the field of Information and Communication Technologies for Development (ICT4D).

To further this end, the enquiry will be guided by three categories: Assessment of the potential, identified limitations, and recommendations for implementation.

The category assessment of the potential intends to reveal which features and characteristics of DLTs are identified as relevant for development ends and to expose the conceived ways in which they could be leveraged to support current efforts in the field.

Regarding the limitations, the objective is twofold. First, to explore the recognized shortcomings and drawbacks which potentially could hinder DLTs abilities to cope with development challenges. Second, to spotlight the significance assigned to each of them.

The last category aims to determine how does DLTs feasibility of implementation is evaluated. Here, special attention will be paid to distinguish implementation hurdles and their correspondent recommendations to overcome them.

Concerning the structure, it should be noted that the analysis will follow a point-by-point organizational scheme. That is, all documents will be placed side-by-side and discussed alternately within each of the proposed categories. This arrangement will simplify founding parallels between their observations and remarking their contrasts and trends.

Finally, the analysis will be assisted by a computer software called MAXQDA.[57] Mainly, it will be employed to perform a language analysis in all three documents. Relevant information regarding the use of language, the words employed, their frequency and significance will be collected.

[57] MAXQDA is a software package for qualitative and mixed methods research. It can work in the context of different methodological frameworks, including literature reviews and qualitative content analyses see, https://www.maxqda.com/what-is-maxqda Accessed on Sep 18, 2018.

Summing up, the three proposed categories could provide a clearer understanding of how some of the main development organizations perceive DLTs as an instrument that might support them to meet their goals.

3.3 Discussion of sources

For the selection of sources, several types of documents (reports, research papers, studies, outcomes of meetings, presentations, inter alia) inquiring into the significance of DLTs for development were collected. This endeavor was delimited to the period between 2016 and 2018.

Although there is a considerable amount of publications, not all of them exclusively investigates DLTs, in particular documents published before 2016. During that period, most publications examine DLTs in combination with other technologies like the internet of things and artificial intelligence.[58] Even more, their content is sometimes restricted to a few couple of pages or limited to a specific geographical area.[59]

Furthermore, documents released between 2014 and 2015 paid greater attention to examine the significance of Bitcoin and other digital currencies. As it has been clarified in the first chapter, the transition which allowed a greater distancing of DLTs from the financial domain began only in 2014. Nevertheless, the data collection for this research suggests that a clear separation at the institutional level, particularly among the members of the UN system, occurred until 2016.

Once the collection of data was completed, documents were classified and ranked according to their subject, content, scope and length which facilitated to determine their relevance. All points considered; the following publications were chosen. First, the report of the United Nations Development Program "The Future is Decentralized: Block chains, distributed ledgers & the future of sustainable development" (UNDP 2018). Second, the "FinTech Note No. 1: Distributed Ledger Technology (DLT) and Blockchain", published by the WB (Natarajan, Krause, and Gradstein 2017). Third, the report titled "Blockchain: Opportunities for Private

[58] For example, the United Nations Environment Programme (UNEP) report titled “Fintech and Sustainable Development”, examines how the combination of IoT (internet of things), blockchain and A.I. (Artificial Intelligence) would enable the sustainable development agenda (see Castilla-Rubio, Robins, and Zadek 2016).

[59] Such is the case of the report published by the Economic Commission for Latin America and the Caribbean (ECLAC) which exclusively focuses on the Caribbean region. See “Prospects for blockchain-based settlement frameworks as a resolution to the threat of de-risking to Caribbean financial systems” (Williams 2017).

Enterprises in Emerging Markets" published by the International Finance Corporation (Niforos, Ramachandran, and Rehermann 2017).

All three publications were produced with the support of agencies or institutions pursuing development objectives. The WB is an international institution which aims to reduce poverty and promotes development.[60] The International Finance Corporation is a member of the WB Group and the most relevant international development institution focusing exclusively on the private sector in the GS.[61] The United Nations Development Program is a specialized agency at the center of UN's efforts to decrease poverty around the globe.[62]

The final selection also sought to include different views and approaches broaden the perspective and to amplify the results of the analysis. For instance, the International Finance Corporation (henceforth the IFC) proposes a discussion conducted from the standpoint of the private sector in emerging markets. The report is constituted by a compilation of a series of notes individually published by the IFC throughout 2017. Despite the fact it received diverse contributions from members of the IFC, its authorship is mostly attributed to Marina Niforos, an external contributor who is currently a member of the EU Blockchain Observatory and Forum, a European initiative to accelerate blockchain innovation and the development of the blockchain ecosystem within the European Union.[63]

In contrast, the WB Note (henceforth the Note) was authored by a team lead by Harish Natarajan and a team of financial sector specialists; all current staff members of the WB.[64] The WB Note, just as the IFC report, paid greater attention to the significance of DLTs for the financial sector. Nonetheless, unlike the report, the results and findings of the Note are intended for directing the actions of the WB regarding DLTs. In this way, the perspective offered by the Note distance itself from the private standpoint provided by the IFC report.

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[60] Information retrieved from the IFC website, see http://www.worldbank.org/en/about/what-we-do Accessed on Sept 18, 2018.
[61] The IFC aims to create opportunities for people to escape from adverse economic conditions and to improve their lives, see https://www.ifc.org/wps/wcm/connect/corp_ext_content/ifc_external_corporate_site/about+ifc_new Accessed on Sept 18, 2018.
[62] Information retrieved from the website of the UNPD see, http://www.undp.org/content/undp/en/home/about-us/faqs.html#undp Accessed on Sep 18, 2018.
[63] Information retrieved from the website of the EU Blockchain Observatory and Forum see, https://www.eublockchainforum.eu/news/eu-blockchain-observatory-and-forum-names-members-core-working-groups Accessed on Sep 18, 2018. Additionally, Ms. Niforos is "an international professional with extensive Profit and Loss (P&L) management experience in strategy, marketing, operations and business development, with positions in the public and private sector spheres", see http://www.oecd.org/forum/oecdforum2012marinaniforos.htm Accessed on Sep 18, 2018.
[64] The unit is constituted by Harish Natarajan, Solvej Krause and Helen Gradstein. Harish Natarajan is a financial sector specialist in the Finance, Competitiveness and Innovation Global Practice department of the WB, see http://www.worldbank.org/en/about/people/h/harish-natarajan Accessed on Sep 18, 2018. Solvej Krause is a consultant in the Finance & Markets Global Practice of the WB, see https://blogs.worldbank.org/team/solvej-krause Accessed on Sep 18, 2018. Helen Gradstein is a Financial Sector Analyst working on financial inclusion also part of the WB, see https://blogs.worldbank.org/team/helen-luskin-gradstein Accessed on Sep 18, 2018. Additionally, it is worth mentioning that the Note received contributions and insights of other experts, not all part of the WB, see (Natarajan, Krause, and Gradstein 2017, iii).

Finally, the United Nations Development Program (henceforth UNPD) report was elaborated in collaboration with the private company Blockchain.[65] Aside from this fact, the report received the input and insights from an extensive list of external contributors. Unlike the Note and the IFC report, the UNDP aims to target a wider audience.[66] Also, contrarily to the above-described publications, the UNDP report covers a broader array of economic sectors beyond finance.

To summarize, all three publications chosen for the study exclusively investigate the relevance of DLTs for achieving development purposes, though from three different perspectives and orientations, and targeting different audiences.

3.4 Discussion of the results

In chapter five the results of the analysis will be challenged by contrasting them with critical views of previous attempts of using technology for attaining development ends. This endeavor will be guided by the analysis that of ICT4D that professor Jan Nederveen Pieterse presents in his book Development Theory: Deconstructions and Reconstructions (Pieterse 2010).

Pieterse (2010, 176) identifies eight dimensions from where ICT4D can be interpreted. For this dissertation three of them will be primarily employed: Technology embedded in capital, technology as a means of control and the so-called technological fetishism. Pieterse (2010, 175) argues that technologies are an intrinsic part of capital, and under that condition, they entail what he calls development from above. While public and private partnerships are often encouraged to facilitate the implementation of technologies, they are often capital intensive and highly technical which prevents them from being participatory (Pieterse 2010, 75).

For Pieterse (2010, 175) technology can be employed as a means of control with attached rents and maintenance services, thus, it creates dependency. Finally, the arguments around the digital divide between the GN and the GS continue to influence approaches that prioritize the need for modernization. The above is led by a logic which Pieterse calls technological fetishism, which stresses the need for infrastructure development (Pieterse 2010, 176).
Altogether, the proposed structure aims to link the enthusiasm around DLTs for leveraging a social and economic transformation with previous attempts to integrate technology to support

[65] The company Blockchain, usually written with capital letter, should not be confused with the technology blockchain. According to their website, Blockchain is the world's leading digital assets platform. See, https://www.blockchain.com/ Accessed on Sep 18, 2018.
[66] Although this assertion is not overtly declared, it can be implied by considering the use of language and the level of simplicity procured throughout the entire document.

similar objectives. Especially at a time where a thorough reassessment of the expectations of DLTs and development is becoming increasingly necessary.

3.5 Theoretical considerations

Development remains to be a very contested term. Overtime, it has been transformed and shaped, acquiring a wide array of meanings and interpretations. Generally, definitions tend to be either normative or instrumental and imply that the condition of the current state of affairs can be perpetually improved (Rist 2014, 9). Likewise, development is often attributed to some of the high aspirations and highest human hopes. Under this logic, criticizing the term and its aims seems to be a very challenging task (Rist 2014, 10–11). Notwithstanding, development exists, and it continues to legitimate the actions of institutions pursuing its fulfillment. Even more, their objectives and especially their activities carried out under the banner of development have been the subject of a great deal of criticism.

For instance, development has been criticized as an attempt to universalize the way of life of the Global North (GN); as a hierarchic construct that categorizes as inferior those forms of social existence far from the model that it promotes; as a vehicle to intervene in the life of non-industrialized and non-modern societies in order to achieve a superior evolutionary state; as an economic rationality which prioritize accumulation and favor economic activities embedded in the capitalistic logic of the market (Ziai 2017, 2547–48). Nevertheless, development seems to be constantly changing, adapting to the existing conditions.

The adoption of the 2030 Agenda for Sustainable Development (ASD) marked the beginning of what Kevin Watkins coined “the post-2015 moment.”[67] For Gore (2015, 718), for instance, the above represents “a moment in time in which multiple efforts are being made to envision a better long-term future for humanity and to forge, post-2015, a new and different global development trajectory."

In this sense, the post-2015 moment has been entrusted with high aspirations. Although the opinions concerning development are usually divergent, in recent years and especially prior to the adoption of the agenda, some views emerging from the GS seem to have coincided that development is in need of a profound paradigm shift.68 The post-2015 moment was expected

[67] Kevin Watkins coined 'the post-2015 moment' in his contribution to the Opening Plenary Session of the Development Studies Association (DSA) conference held in London (Gore 2015, 717–18).

[68] The Journal of International Development, for example, offered in a special issue a collection of six articles providing perspectives from the GS amidst discussions of the Post-2015 development agenda. Four out of the six papers (Leach, Moore, Meagher, Xu and Carey) coincided on the need to produce a profound paradigm shift in development, see (Tiwari 2015). Originally quoted in (Gore 2015).

to be the inflection point driven that change. Nevertheless, after three years of the adoption of the ASD, this anticipation seems to be waning.

A new global development paradigm change would require not only new insides to the already contested definitions and new goals as guiding principles but new institutions, new models of practice, a new core set of values (Gore 2015, 722). Nonetheless, it does not seem that development is heading towards such a historic step. The ASD fell short to redefine the worn-out word *new*. *New* is not an alien adjective for the field of development; it has come along with its discussion throughout all its evolutionary trajectory.

Coincidentally, an analogous discourse of newness seems to be also accompanying the evolution of DLTs. The following analysis presents the possibility to shed light into the perceived ability of DLTs to redefine institutions companies, and business models by changing the very nature in which they operate. Alternately stated, to redefine the meaning of word new within the technological and developmental discourse.

3.6 Conclusion

Considering that a common overstatement of their capabilities and a disproportionate evaluation of DLTs potential have already led to unrealistic expectations (Pisa 2018, 80), this chapter proposed a thorough analysis of the underlying assumptions of DLTs for development to determine to what extent DLTs can be considered as an instrument providing opportunities for the GS's development.

To answer this question, this chapter introduced the methodological approach to be followed in the second part of this dissertation. It elaborated on particular objectives that will guide the study and explained how the analysis of the implications of ICT4D made by (Pieterse 2010) will shape this endeavor.

Special attention was given to the process in which data were collected and classified, and sources were selected. It was explained how the proposed structure will link the enthusiasm around DLTs for leveraging a social and economic transformations with previous attempts to integrate technology to support similar objectives.

Finally, this chapter elaborated on the contested nature of the concepts and definitions of development and outlined how the results and findings of the analysis will be examined under the framework of ICT4D, to challenge the discourse of newness accompanying DLTs.

CHAPTER 4. EVALUATING THE POTENTIAL

This section will explore how DLTs are perceived as providing opportunities for the GS's development. It will present an analysis of three recent influential publications. First, UNDP report titled *"The Future is Decentralized: Block chains, distributed ledgers & the future of sustainable development"* (UNDP 2018). Second, the *"FinTech Note No. 1: Distributed Ledger Technology (DLT) and Blockchain",* published by the WB (Natarajan, Krause, and Gradstein 2017). Third, the report titled *"Blockchain: Opportunities for Private Enterprises in Emerging Markets"* published by the International Finance Corporation (Niforos, Ramachandran, and Rehermann 2017).

Before presenting the analysis, important linguistic asymmetries should be pointed out. The use of different terms, their frequency as well as their assigned meaning, widely differ among all three publications. The UNDP report, for example, employs the phrase *block chain* (with a separation between the two words), whereas the IFC report and the Fintech Note No. 1 (henceforth the Note) utilize the single word *blockchain*. Similarly, while the frequency of use between the terms *distributed ledger* and *blockchain* are more balanced in both the IFC report and the Note,[69] the UNPD report resort to *block chain almost* exclusively.[70] Besides, it prevails, a lack of consistency in the meaning assigned to the terminology employed among all three. Moreover, this inconsistency even occurs within the same document, as is the case of the IFC report.[71]

Uniform terminology has not been sought until the publication of this dissertation. Consequently, the above-outlined differences cannot be regarded as right or wrong. Notwithstanding, as it was argued in the first chapter, heterogeneity has a critical role in undermining the ability to analyze the potential of DLTs objectively. Against this background and with the intention of facilitating the comparison, this analysis will continue to use the already proposed acronym (DLT) making specific differentiations between blockchain and distributed ledgers only when necessary.

[69] In the IFC report, the terms distributed ledger and blockchain are repeated 22 and 17 times respectively. In the case of the Note, both terms have a frequency of 138 and 151 times, respectively.

[70] Throughout the entire document, the term distributed ledger is only mentioned seven times. In contrast, the term *block chain* is used 118 occasions.

[71] In the first chapter, a distinction is made between blockchain and distributed ledger, see (Niforos, Ramachandran, and Rehermann 2017, 9). Nevertheless, as the document develops, both terms are sometimes used interchangeably, see for example (Niforos, Ramachandran, and Rehermann 2017, 23, 2017, 29, 2017, 38).

4.1 Assessment of the potential

4.1.1 UNDP

The UNDP report moves away from the theoretical valuations and focuses on practical implementations. It presents a compilation of case studies in six areas in which DLTs are already being used: development aid effectiveness, digital identity, remittances, supply chain management, energy and property rights.

Overall, the document seeks to demonstrate how DLTs can represent a relevant instrument for governments, private companies and civil society to address corruption, distribution and "trust-related problems" (UNDP 2018, 8). The report is structured as follows. Firstly, it introduces a brief context of each studied area. Secondly, it offers an overview of the problem and its most common challenges. Thirdly, it considers how key features of DLTs could be harnessed to cope with those challenges. Fourthly, it presents one or more case studies already using DLTs in that particular area. Finally, it briefly discusses the possible implication of a broader adoption.

Certainly, the followed approach allows emphasizing the relevance of DLTs for each scenario. Nevertheless, it should be noted that in doing so, the report often overlooks the limitations of DLTs and ignores to consider their individual implementation trade-offs. Like any other technology, DLTs have their advantages and disadvantages. The balance between both will always depend on the conditions of every individual cases. In this sense, it would be insufficient to elaborate only on the suitability of DLTs to address a given problem; a more realistic assessment of its potential would need to consider its shortcomings and implementations hurdles within the context of each particular study

For this reason, it may well be argued that it is not enough for DLTs to be technically superior. The vast array of already existent technologies also demands to ponder the costs and benefits of DLTs vis-à-vis more economically viable alternatives. Although the UNDP report often provides numbers and statistics, the latter is only employed to highlight the complexity of the problem and to quantify the benefits achieved through the use of DLTs.

In a like manner, the document insistence on the revolutionary character[72] of DLTs is weakly supported. Then again, without a broader context that include the successes and flaws of

[72] As an illustration, consider the following two expressions employed in the report: "this unconventional technology", "[…] block chains have brought new levels of efficiency and effectiveness" (UNDP 2018, 2).

previous technologies addressing similar problems, it becomes devious to estimate their innovative character. A discussion of how DLTs can mitigate the shortcomings of those technologies would undoubtedly lead to a clearer understanding of their potential. Notwithstanding, the report does not include substantial references of previous solutions nor a discussion of their inadequacies for each specific case. On the contrary, their innovative nature is mostly measured through their contributions towards greater efficiency gains.

Another aspect worth mentioning is the authorship and contributors to the report. For this paper, the UNPD worked in collaboration with the company called Blockchain.[73] Neither the document itself nor on the UNPD website, where the report can be accessed, is clearly stated who can be attributed with its general authorship. However, Sergio Fernandez de Cordova, Vice-Chair of the Blockchain Commission for Sustainable Development[74] (henceforth, the Commission), asserts that the document was prepared by Nicolas Cary, also a member of the Commission (Fernandez de Cordova 2018, 1). Apart from his position in the Commission, Mr. Cary is also the co-founder and Vice-Chairman of the company Blockchain. As it turns out, the nexus between the affiliation of the author with a company with activities related to DLTs is also a common feature among the long list of contributors to the report.

At the beginning of each of the six areas evaluated in the document the name of the person of their contributors is stated. Remarkably, in half of them, the contributor has a direct relationship with the company of the case study presented in that particular area. As an illustration, George Harrap, the co-founder and CEO of Bitspark, collaborated with the UNPD Altfinlab in the writing of the remittances section. The project that Bitspark is conducting in Tajikistan was selected as one of the two case studies presented. Admittedly, the knowledge and experience of the director of the company as well as those people directly involved in the operation and execution of the project are unmatched.

Although this may be true, in a way, the involvement of those contributors might also be undermining an in-depth analysis of the limitations and shortcomings drawn above. This seem to be the case for Bitspark. While the section extensively discusses the advantages of the DLTs-based solution offered by Bitspark and the importance of remittances for citizens of Tajikistan, the discussion of the limitations is disproportionally short. Indeed, the latter is only

[73] The company Blockchain, usually written with “b” in capital letter, should not be confused with the technology blockchain. According to its website, Blockchain is the world’s leading digital assets platform. See, https://www.blockchain.com/ Accessed on Aug 18, 2018.

[74] "The Blockchain Commission for Sustainable Development was established to develop a multi-sectoral framework to support the United Nations System along with Member States, Intergovernmental Organizations, the private sector and civil society, in utilizing blockchain-based technologies to develop, local, national and global solutions for the most pressing issues of our day", see www.blockchaincommission.org Accessed on Aug 18, 2018.

limited to state that the ongoing initiative "is still in its early stages and needs to be further piloted, not simply to prove the technology but to ensure that regulators are helped rather than hindered in their work" (UNDP 2018, 20).

It should be clarified that this analysis does not suggest that a conflict of interest should be revised but rather, to insist that an objective evaluation of the potential necessarily requires pondering the benefits and drawbacks of each proposal as well as those that the latter has in comparison with other already existing alternatives. The case of Bitspark is a good example of the way in which the evaluation of the potential is approached throughout all the document. On the whole, the latter seems to follow a business-like approach that paid more attention to the characteristics of a product or service instead of an objectively inquiring into its social impact.

Finally, even if the report points out some shortcomings of the technology, those are overwhelmed by the arguments extolling their advantages. To name a few, it asserts that DLT is “still an experimental and evolving technology”. Similarly, it comments that despite DLTs have a “vast potential”, they are “neither perfect nor universally applicable” (UNDP 2018, 7). At the other end of the spectrum, the report claims that “[DLTs] have an important role to play in promoting equitable economic development, good governance, and global sustainability” (UNDP 2018, 34). Concerning the global development efforts, it even suggests that DTLs can accelerate the progress and leverage the ongoing efforts aiming to achieve the agreed targets and goals of the 2030 Agenda for Sustainable Development (UNDP 2018, 1–8).[75]

4.1.2 IFC

Overall, the IFC report presents an extensive evaluation of potential. With respect to the UNDP report, some significant differences and similarities can be pointed out regarding the perceived limits, structure, orientation and focus. Concerning the boundaries of DLTs, the existent resemblances between the two reports can be explained by way of two fundamental contentions. First, the perception that DLTs are in early stages of development. Second, the observation that DLTs are not universally applicable (UNDP 2018, 7; Niforos, Ramachandran, and Rehermann 2017, 15). Nevertheless, in contrast to its UNDP counterpart, the IFC report does insist across large portions of the document that adopting decisions related to the

[75] Despite that the UNDP report does not address each goal individually, the visual representation of the general set of goals that could be potentially be attained by the uses cases always accompany the title of each section. Therefore, the evaluation of the potential of DLTs for development is made using the SGDs as a framework. In regard to the specific ways in which DTLs can contribute to the agenda, the report observes that they can “bring transparency to opaque or corrupt systems”; “bring security and resilience to vulnerable infrastructure”; and “reduce the frictions that prevent a vast array of sustainability, humanitarian, and environmental initiatives from fulfilling their potential” (UNDP 2018, 1).

engagement with DLTs should consider a detailed cost-benefit analysis vis-à-vis another alternatives.

Also, in both reports, the capacity of blockchain for disrupting a wide array of sectors beyond the financial is clearly stated.[76] However, in comparison with the UNDP, the IFC report typically illustrates the potential in those sectors by only naming already existing cases without delving into further detail. Thus, it can be stated that the structure of the IFC fosters a more theoretical appraisal.

Concerning the focus and orientation, it can be declared that while the evaluation of the potential of DLTs in the UNDP report considers a greater number of economic sectors, the IFC report has a narrower financial orientation. Furthermore, in opposition to the UNDP report which targets a general audience, the IFC report centers the attention on the private sector in emerging markets.[77]

Finally, although the IFC report follows a chronological order[78] and most of them were written by the same author,[79] the document does not necessarily have a clear line of argumentation. Moreover, the evaluation of the potential has no specific delimitation but rather, is spread throughout all the paper. The latter is discussed within two main areas: finance and global supply chains.

4.1.2.1 Finance

In relation to the possible contributions of DLTs to finance, two main subjects are discussed. The capacity of DLTs for addressing de-risking[80] and the potential of DLTs for improving or creating more efficient financial services. The report explains that the practice of de-risking, in which entire segments of markets and customers can be excluded from financial services, is

[76] On the one hand, the IFC report emphasizes that the ability of blockchain to work as a ledger, a database and a transaction platform, opens up a window of opportunity to be harnessed in other areas such as digital identity, health, rights or votes (Niforos, Ramachandran, and Rehermann 2017, 14–15). On the other, the UNDP report elaborate on the wide array of sectors in which immutability, verifiability and transparency can be harnessed, ranging from art to telecommunications and supply chains (UNDP 2018, 6–7).

[77] Indeed, the declared objective of the IFC report is to examine the possible implications that DLTs have in those markets (Niforos, Ramachandran, and Rehermann 2017, 6–7). It is important to note, that the IFC is the largest global development institution focused exclusively on the private sector in the GS, see https://www.ifc.org/wps/wcm/connect/corp_ext_content/ifc_external_corporate_site/about+ifc_new Accessed on Sep 21, 2018.

[78] Except for chapter three (or note 38), all sections are organized chronologically.

[79] Five out of the six chapters compiled in the report were written by Marina Niforos, the founder and Principal of Logos Global Advisors, a strategic advisory firm.

[80] "De-risking refers to the phenomenon of financial institutions terminating or restricting business relationships with clients or categories of clients to avoid, rather than manage, risk", see https://www.state.gov/e/eb/tfs/tfc/derisking/index.htm Accessed on Sep 22, 2018.

most likely to impact the poorer and most vulnerable portions of the population (Niforos, Ramachandran, and Rehermann 2017, 24). In order to comply with stricter regulations that aim to prevent money laundering, terrorism financing and tax evasion banks now have to conduct usually expensive processes for the verification of the identity and credentials of new clients. As a result, de-risking is likely to severely affect global remittances, access to credit for small-medium companies, and the ability of NGOs delivering aid assistance (Niforos, Ramachandran, and Rehermann 2017, 25–27).

Given the above, the report concludes that DLTs can contribute to widening access to financial services in emerging markets by reducing the costs associated with verification and validation (Niforos, Ramachandran, and Rehermann 2017, 24–28). As a whole, they represent a more cost-efficient solution to comply with specific regulations like Know Your Customer (KYC) and AML/CFT[81] (Niforos, Ramachandran, and Rehermann 2017, 25). In particular, features like transparency, traceability and difficulty to alter past transactions of DLTs make them suitable to help banks to comply with the current requirements and consequently promote financial inclusion (Niforos, Ramachandran, and Rehermann 2017, 23–25). Said differently, by reducing the compliance costs triggering de-risking, the report suggests that DLTs could make an indirect contribution to counteract its negative consequences associated with financial inclusion primarily affecting the GS (Niforos, Ramachandran, and Rehermann 2017, 23–28).

However, this exposition of arguments remains theoretical. It is important to note that any of the examples provided directly support of the assumptions that share the view that DLTs could cope with de-risking. On the contrary, examples illustrate the economic impact caused by de-risking in different areas and activities, like the case of remittances. Truly, de-risking is a very complex financial phenomenon with highly debated implications.[82] Thus, presenting an exhaustive discussion of the consequences in one chapter would be undoubtedly a very challenging task. Nevertheless, if the aim is to explore the potential of this technology for addressing a well-documented problem, it becomes essential to consider probable bottlenecks, draw reasonable boundaries and further elaborate on how the existent applications coils be configured to cope with de-risking. Although the above can downgrade the optimism of the usefulness of DLTs for tackling this particular issue, it can offer at the same time, a more proportionated and realistic appraisal.

[81] AML/CFT stands for Anti-Money Laundering and Combating the Financing of Terrorism, both of which are considered financial crimes, see https://www.imf.org/external/np/leg/amlcft/eng/ Accessed on Sep 22, 2018.
[82] The pilot tests, extensive surveys and reports published by the WB concerning the topic and presented in the brief "De-risking in the Financial sector" can provide an outlook on the intricacy of this practice, see http://www.worldbank.org/en/topic/financialsector/brief/de-risking-in-the-financial-sector Accessed on Sep 22, 2018.

In support of this contention, it can be mentioned the report published by the Economic Commission for Latin America and the Caribbean[83] (ECLAC) analyzing the prospects of DLTs for coping with the threat of de-risking in Caribbean countries. The ECLAC report acknowledges the potential of DLTs to reduce costs of compliance (Williams 2017, 7–10). Nevertheless, it latter does take into consideration the shortcomings of DLTs in achieving this particular goal, that is, their current instability and the lack of privacy of transactions, that for financial operations, it represents a substantial concern. (Williams 2017, 11–21). Moreover, the report concludes that although this possibility might be real in the very long run, it recognizes that until now DLTs are not able to address the threat of de-risking (Williams 2017, 22). With this comparison, the aim is neither to measure the success of the IFC report nor to contradict its statements but to highlight existent differences to argue that a fragmentary and disproportioned appraisal may lead to making misleading false assumptions of the prospects for DLTs.

Regarding the potential of DLTs for financial services, the report has narrowed down the analysis to three areas: anti-money laundering and customer identification programs, trade finance, and global payments (remittances). For each of them, it introduces a brief context, discusses the areas of opportunities, and presents a short selection of cases. The structure and clarity of this section provide a quick understanding of the plausibility of DLTs for saving costs through greater transparency and efficiency (Niforos, Ramachandran, and Rehermann 2017, 37). Nevertheless, the report falls short to elaborate on the link between each of the areas analyzed and their socio-economic relevance. Although, the importance of remittances in the international capital flows is well explored, there is no consensus for remittances positively impacting economic growth in the long-run (Catrinescu et al. 2009). Therefore, how remittances (aided by DLTs) will "boost growth and improve the living standards in poor countries" would probably need further explanation (Niforos, Ramachandran, and Rehermann 2017, 6).

Equally important, is the distribution of benefits, which in the case of the adoption of DLTs in financial services seems to be disproportioned. On the one hand, one could argue that entrepreneurship can have substantial positive effects on the economy of emerging markets (Bruton, Ahlstrom, and Obloj 2008, 1–2). On the other, it is also clear that those economic gains can be better captured by the communities when those projects are locally owned (Edmiston 2007, 91–92). To illustrate this point, an economic impact study conducted in Texas

[83] The report is titled “Prospects for blockchain-based settlement frameworks as a resolution to the threat of de-risking to Caribbean financial systems” and can be accessed on the website https://www.cepal.org/en/publications/41139-prospects-blockchain-based-settlement-frameworks-resolution-threat-risking

by the American Independence Business Alliance, concluded that "for every $100 spent at a chain, $13 remained in the community while $45 remained when spent with hometown businesses" (Milchen 2003, 2).

In the context of the report, the vast majority of the quoted examples are either well large and well-established companies (mostly financial) or start-ups experimenting with DLTs. Despite that the report recognizes that not all start-ups and entrepreneurship projects are based in the GN, it states that "the best ones are, for now, US-based" (Niforos, Ramachandran, and Rehermann 2017, 32). Indeed, statistics show that the total number of financial services start-ups in the United States surpasses any other country with a vast difference, both in number of operations and in total investments (Deloitte 2017, 12). In this sense, the report does not seem to seriously consider the significance of the lopsided geographical appurtenance of the examples used to support its argumentation in favor of DLTs for financial services.

4.1.2.2 Global supply chains

Based on the assumption that global value chains can bring many of “the promises of globalization” (Niforos, Ramachandran, and Rehermann 2017, 45), the report investigates the potential of DLTs mainly in two sectors: food and agribusiness and pharmaceuticals. For both, it introduces a general context of the challenges to emphasize their relevance and provide a series of examples for each of them. In the context of agriculture, DLTs can diminish risk and increase efficiency thanks to their enabling capacity to trace commodities throughout the entire supply chain (Niforos, Ramachandran, and Rehermann 2017, 46). This risk mitigation coupled with the simplification of KYC and AML/CFT regulations (described above), could facilitate many of the often complex and burdensome procedures, in particular, those related with payments (Niforos, Ramachandran, and Rehermann 2017, 46). On the one hand, the preceding could secure the cash-flow of farmers and lead to relief their working capital constraints. On the other, it can increase the liquidity of buyers, facilitate government's tax and customs duties collection, improve the accountability of the actors and ensure the accuracy of the safety and quality of the products (Niforos, Ramachandran, and Rehermann 2017, 46–47).

Not very different from the financial services discussion, the elaboration of the potential of DLTs for agriculture remains very theoretical, even bucolic and reticent to acknowledge the unequal distribution of benefits. According to the logic of the report, the efficiency gains are to be attained through the automation of the workflow from the producer to the consumer. In this regard, DLTs assisted by devices such as smart contracts, sensors and smart-meters and aided by other technologies like the internet of things (IoT) or artificial intelligence (AI), are

frequently revealed as the enablers of this momentous shift. Nevertheless, the above require a significant investment for purchasing hardware, receive the appropriate training, and ensure internet connectivity in the fields. Thus, this may be plausible only for a reduced number of farmers or large-scale agricultural business. While for the vast majority of producers, it becomes highly improbable.

To illustrate this point, an analysis conducted by Lux research has identified that affordability remains one of the two most significant bottlenecks for the adoption of sensors in agriculture and that only larger farmers (farms over 2,500 acres) and farmers with crops of higher value (like the case of wine grapes) are likely to find them attractive (Fisher 2015). Under those circumstances, the arguments expounded in the report seem to expand the prevailing asymmetries between the partakers of the global supply chains and not really to bring the "promises of globalization", whatever the author consider they may be (Niforos, Ramachandran, and Rehermann 2017, 44).

With attention to the pharmaceuticals supply chain, the report quotes the World Health Organization estimations that set the consumption of counterfeited drugs in the GS at around fifty percent (Niforos, Ramachandran, and Rehermann 2017, 48). Here, the potential of DLTs is more clearly stated: consumers in the GS could benefit from a mechanism built upon DLTs that ensure drugs authenticity and in turn pharmaceutical companies could avoid losses related with counterfeiting valued at $18 billion annually (Niforos, Ramachandran, and Rehermann 2017, 48).

In contrast to the agricultural sector, the pharmaceutical industry can integrate sensors and new control mechanisms to their processes with relative ease. However, the industry is confronted with other significant challenges, namely geographical concentration. Despite that Chinese pharmaceutical sector expanded in the past few years, the larger and most important companies worldwide are still from Europe and the United States.[84] Moreover, companies in North America alone are responsible for the largest portions of the total revenue, which in 2014 exceeded one trillion dollars.[85] Therefore, the report once again overlooks the asymmetrical and disproportionate distribution of the benefits. On the whole, it could be said that the lack of this broader context within the report analysis, represents in itself a limiting factor in its estimation of DLTs potential for development.

[84] Retrieved from the Global Pharmaceutical Industry -Statistics &Facts. See, https://www.statista.com/topics/1764/global-pharmaceutical-industry/ Accessed on Oct 2, 2018.
[85] Retrieved from the Global Pharmaceutical Industry -Statistics &Facts. See, https://www.statista.com/topics/1764/global-pharmaceutical-industry/ Accessed on Oct 2, 2018.

4.1.3 WB

In conducting its evaluation of the potential to support the WB to meet their goals, the most common shortcomings are related to the depth and scope of the analysis. Despite that the Note recognizes that the potential of DLTs extends beyond cryptocurrencies in the financial sector (Natarajan, Krause, and Gradstein 2017, 21), the areas explored in the document mostly remain within the finance boundaries. The study of other sectors is limited by mentions of current applications without further elaboration. Altogether, it explores in depth four areas: Cross-border payments and remittances, ID systems, asset registries, and digital currencies. In doing so, it follows a similar approach to the IFC and UNDP reports; introducing a brief context and then citing examples for each of them.

It identifies an excellent potential for DLTs to cope with the elevated costs and long waiting times for inter-bank payments across borders and soaring remittances fees which remain around 20% of the total cost (Natarajan, Krause, and Gradstein 2017, 23). This assertion is based on the assumption that by lowering settlement costs and increasing the efficiency of inter-bank and cross-border transfers, DLTs could potentially contribute bringing down the remittances fees which principally affect the poorer segments in the GS (Natarajan, Krause, and Gradstein 2017, 23). Put it differently efficiency would be the driving force for lowering market fees.

In appraising the potential of DLTs, it can be declared that the Note has, by large, the most cautious optimism. It continuously avoids the use of absolute terms and prefers, in general, a more moderate use of language. Consider statements like "DLT has the apparent potential to enhance efficiencies" or "could potentially help" (Natarajan, Krause, and Gradstein 2017, 23) in contrast with “[DLTs] can positively transform a number of industries” (Niforos, Ramachandran, and Rehermann 2017, 34) or “[DLTs] can bring transparency to opaque and corrupt systems” (UNDP 2018, 2). Additionally, on many occasions, it emphasizes the need for further research to corroborate the viability and validity of some prevailing views regarding the potential of DLTs.

Concerning the case studies and start-ups cited in the Note, it is worth mentioning that many of them match with those employed by the reports. Nevertheless, one remarkable difference is the perception of how the distribution of benefits as a result of the integration of DLT could occur. Concisely, the Note states that "in the near-to-medium term, many of the benefits and efficiency gains of DLT are likely to be reaped by start-ups and financial institutions in the

developed world" (Natarajan, Krause, and Gradstein 2017, 23).[86] Otherwise stated, the Note shares the idea that DLT can improve efficiency, but it assumes at the same time a more critical stance on who will benefit as a part of this shift.

Just as the UNDP and the IFC, the Note highlights the relevance of DLTs in promoting financial inclusion and positively impacting the unbaked individuals in the GS. Similarly, it also remarks how the lack of ID and reliable proof of property are hindering financial inclusion and access to credit (Natarajan, Krause, and Gradstein 2017, 26). Notwithstanding, the use of digital currencies is usually required and therefore it points out three critical concerns in how this potential could be harnessed apart from regulatory-related issues.

First, in many cases its transactions in DLT-based digital currencies usually cannot be reversed which raises questions related to dispute resolution and recourse mechanisms (Natarajan, Krause, and Gradstein 2017, 26). Second, no insurance company is currently covering deposits in digital currencies and that frauds related with them are sometimes not followed up by law enforcement agencies, at least not in the US (Natarajan, Krause, and Gradstein 2017, 26). Third, the volatility displayed by many of the digital currencies make them less appropriate as fiat currencies as a store of value (Natarajan, Krause, and Gradstein 2017, 26). Thus, it dismisses the views that dispense the need of converting digital currency into fiat currency. Fourth, “the most promising DLT-based applications utilize and build on existing infrastructures” (Natarajan, Krause, and Gradstein 2017, 26–27). All points considered, it is very improbable that DTLs can completely substitute institutions or financial structures (Natarajan, Krause, and Gradstein 2017, 27). Therefore, the potential of DLTs for financial inclusion can be only complementary and not supplementary.

Also, by employing DLTs to promote financial inclusion in the GS, the Note raises some concerns regarding usability and utility. It emphasizes the need for promoting accompanying elements like user-friendly designs and promotion of financial literacy and capability (Natarajan, Krause, and Gradstein 2017, 27). In that sense, the Note points very aptly to one of the issues usually ignored in both reports, namely, technical capabilities and financial literacy of the potential beneficiaries. Notwithstanding, in this contention, the Note fails to consider a more pervasive problem, namely, the lack of infrastructure. While remittances and digital currencies can potentially play a key role in delivering public and private goods, they might not necessarily foster financial inclusion of those poorer segments of the population. Lack of crucial

[86] Regarding the medium-to-long term, the report does not indicate that redistribution will occur, but instead, it only asserts that "DLT hold potential to expand financial inclusion" since they could address many of the barriers that are now hindering financial services (Natarajan, Krause, and Gradstein 2017, 23).

infrastructure in the GS in general and the need of the beneficiaries, especially those poorer segments, to manage public and private keys to make use of [DLTs]-based solutions locates this idea far away from reality (Zambrano, Seward, and Sayo 2017, 12).

As it is mentioned in one of the cited examples in the Note, African importers who need to pay their Chinese counterparts, are already benefiting from cross-border payment service providers like Bitpesa (Natarajan, Krause, and Gradstein 2017, 24). However, despite that, the Note acknowledges that benefits are to be unequally distributed the discussion of the usefulness of DLT for promoting financial inclusion goals does not seem to take serious steps in considering how the poorest social strata can access and benefit from DLTs solutions.

4.2 Identified limitations

4.2.1 UNDP

The UNDP report recognizes that the DLTs are an evolving and experimental technology and emphasizes that despite their potential, they are neither flawless nor universally applicable (UNDP 2018, 7). Apart from this assertion, the report does not make additional comments or further elaborations on the limitations and disadvantages of DLTs. Instead, it only conveys that there are significant costs that need to be considered. Among others computational power and storage capacity required as well as those related to security and coordination (UNDP 2018, 7). Additionally, it underscores that the risks associated with the costs as mentioned earlier should be managed rather than avoided but without proposing any suggestions of how this should be done (UNDP 2018, 34).

Given this points, two statements can be made. First, the report falls short in addressing the limitations of DLTs. Second, explained by means of the scarcity of identified shortcomings, it can be declared that the report maintains in general the most positive stance about the role of DLTs in supporting development goals.

4.2.2 IFC

The report discusses the overall limitations of DLTs first, from a general perspective and second, in the specific context of financial services and supply chains. Most of their drawbacks can be classified into three categories: technical, regulatory and costs. As for the technical scalability, security and data privacy are the most remarkable (Niforos, Ramachandran, and Rehermann 2017, 21). For instance, the transaction speed, continues to be a hindrance,

especially in the case of permissionless DLs (Niforos, Ramachandran, and Rehermann 2017, 36). In connection to security concerns, the report only cites the Ethereum Decentralized Autonomous Organization (DAO) attack to illustrate how many security flaws are affecting DLTs.[87]

Concerning regulation, the lack of clarity in the legislative and regulatory frameworks are perceived as a severe limitation (Niforos, Ramachandran, and Rehermann 2017, 21–36). Similarly, the absence of common industry standards can critically affect interoperability between systems as well as scalability (Niforos, Ramachandran, and Rehermann 2017, 50).

As to the supply chains, the report estimates that transition costs needed for upgrading the existing financial infrastructure could be very significant (Niforos, Ramachandran, and Rehermann 2017, 35). On the other hand, the elevated costs related to the design and implementation of DLTs should be seriously considered (Niforos, Ramachandran, and Rehermann 2017, 21).

4.2.2 WB

The WB Note remarks that DLTs still lack the characteristics of a mature technology like robustness and resilience, especially when managing a large volume of transactions. In this regard, the document also points towards scalability issues that DLTs, in particular their permissionless variants, are currently facing (Natarajan, Krause, and Gradstein 2017, 17). Thereon, the Note makes some necessary clarifications between permissioned and permissionless DLs.

It is worth mentioning that making clear distinctions between both variants is unique among the documents analyzed. As it was expounded in the first chapter, its importance lies in the fact that the limitations that may hamper DLTs vary to a large extent among their different variants. Permissioned DLs usually limit the ability of participants of the network to access and conduct transactions. Therefore, the number of resources needed for securing the system is much lower and can also results in a reduction of electricity consumption (Natarajan, Krause, and Gradstein 2017, 20). Nonetheless, despite these advantages, while permissioned ledgers allow a higher rate of transactions per second and need less computational power, they often require a coordinating entity to function (Natarajan, Krause, and Gradstein 2017, 11). As a

[87] Despite that the so-called Ethereum hack is usually referred as an example of the security concerns that need to be addressed, some clarifications that need to be made. A hacker found and exploited one deficiency in one software run on top of the Ethereum platform, called the DAO, but the Ethereum blockchain remained unaffected (Falkon 2017).

result, the outlined benefits come with the cost of altering the decentralized nature of the ledger which is considered to be one of the chief advantages of permissionless systems (Natarajan, Krause, and Gradstein 2017, 17).

The differences between permissioned and permissionless also have important implications for regulation. Unlike permissioned DLs which usually require the identity of the participants, permissionless DLs systems mask their identities (Natarajan, Krause, and Gradstein 2017, 19). Thus, their differences must be signaled to avoid falling into generalizations. To illustrate this, the deeply explored potential of DLs to improve the efficiency of KYC regulations, thoroughly examined in the IFC report, it would not be valid for most of the permissionless variants. Consequently, the low degree of privacy of transactions of permissionless systems which has been identified as a limitation for many financial services (Natarajan, Krause, and Gradstein 2017, 20), questions about some of the assumptions made in the IFC report. The point, however, is not to contradict, but to highlight the need of taking into consideration those stark variances.

In brief, it can be summed up that the Note offers a much broader perspective of DLTs limitations by including in its analysis some of the differences between their variants. Moreover, it does not only explore areas ignored in the IFC and UNDP reports like governance and environmental costs, but it also discusses in greater depth the same areas including scalability, interoperability and security. To illustrate this point, the Note, just like the IFC report, addresses the issue of cybersecurity. However, while the report relates the topic by mentioning the so-called *DAO hack* and suggest that DLTs are not entirely secure and immature (Niforos, Ramachandran, and Rehermann 2017, 21), the Note apart from a detailed explanation of complex event, it underlines another potential security setbacks to which each of the variants has a higher susceptibility (Natarajan, Krause, and Gradstein 2017, 18).

Given these points, it becomes clear the importance to consider these subtle differences in order to offer a comprehensive analysis of the possible drawbacks. In spite of its occasional shortcomings, the Note adequately addresses these issues.

4.3 Recommendations for implementation

4.2.1 UNPD

In comparison with the evaluation of the potential, the share of the UNDP report devoted to the recommendations for implementation is much shorter. As such, the document identifies factors

that may affect DLT adoption and groups them in seven categories: Telecom infrastructure, legislative barriers, data integrity, project management, barriers to communication and education and inadequate institutional capacity. The report contends that in the deployment of DLT it is crucial to count with the “appropriate technology” in place; to enforce the “appropriate communication and education techniques”; to apply the “appropriate data and security protocols”; to select an “appropriate management approach”; and to have the “appropriate operational capacity” (UNDP 2018, 33–34). Nonetheless, a description of what appropriate means in each of the cases is often vague. In this sense, the debate of how to cope with the potential constraints that the implementation of DLTs can face remains shallow.

Furthermore, the report aims to draw suitable conditions that should exist in any given country to enable a successful implementation of DLTs. For instance, it underlines the need of having a certain level of technical knowledge; institutions with a sufficient degree of technological know-how; and educated customers (how the report calls them) about the advantages, capabilities and the use of technology (UNDP 2018, 33–34). The previous, however, raise some questions about the suitability of DLTs when employed for leveraging development goals, in particular about their design.

Regarding the above, the report expounds a set of suggestions that projects for the development and humanitarian sector need consider. It asserts that its crucial to "design ‘with’ and not ‘for’". Thus, the rights and interests of the individuals need to be considered as the top priority (UNDP 2018, 34). Similarly, to avoid policy implications during the implementations, it is critical to always have on sight the existing systems and ways of working in each context (UNDP 2018, 34).

Considering the proposed suggestions, one could assume that technology needs to adapt to the existent infrastructure and current ways of living and not the other way around. In such a case, the premises previously expounded by the report concerning the conditions that the environment should meet would lead to a clear contradiction.

As any other project or initiative implementation DLTs will face countless challenges. Nevertheless, their persistence and prevalence can point towards two possible explanations: either the conditions are the ones hindering their implementation, or rather, the problem is attributable to the design of the initiative instruments. Thereon, the report initially points towards the conditions and then it elaborates an argument in favor of the design. Certainly, weather the current conditions or the instruments’ design are to be found responsible will undoubtedly depend on every single case. But it seems more plausible or following the logic

employed by the report, even more efficient for the design to guide implementation in order to avoid the complexity that adaptation usually brings about.

Before the existence of DLTs, international development organizations have been testing how ICTs can help them to achieve their goals. As a result, this and similar questions have emerged and as expected, also attempts to address them. For example, the Digital Impact Alliance, which by gathering the experiences of development organizations and development practitioners with ICTs, created a set of nine principles known as the Principles for Digital Development (PDD).[88] The PDDs aim to guide development organizations and development practitioners when designing and conducting technology-enabled programs.[89] Nevertheless, without contradicting each other, like it seem to be the case in the report, the first and second PDDs principles, emphasize the importance to design with the user and deem essential a deep understanding of the existing structures and needs of every country for planning initiatives.[90]

On the whole, the UNDP report inner contradiction has accentuated the importance of the design of DLTs. Thereunder, if a given DLT-based alternative is consistently challenged by the reports' identified factors (described in the first paragraph), it could be assumed that there is a high probability that the proposed solution was not intended primarily for attaining that particular need. On the contrary, it was probably aimed for achieving another purpose in a different context, and after acknowledging its potential elsewhere, for instance for development, its implementation becomes more of an intricate adaptation exercise. In such a scenario, not only technical needs increase the complexity, but also political, institutional and cultural as the UNDP report has accurately pointed out.

4.2.2 IFC

The IFC report contends that emerging markets seem prepared for a fast adoption of DLTs due to their large portions of financially underserved populations, elevated banking risks and verification costs, lower banking coverage and legacy systems and the substantial presence of digital financing (Niforos, Ramachandran, and Rehermann 2017, 6–17). The report offers a brief exploration of Latin America, Africa and Asia to support this argument. For instance, the

[88] The PPDs have become of broad acceptance, and they have been endorsed by many of the biggest organizations pursuing development goals, including the WB and several UN agencies, see https://digitalprinciples.org/endorse/endorsers/ Accessed on Oct 7, 2018.
[89] See, https://digitalprinciples.org/ Accessed on Oct 7, 2018.
[90] As described in the first and second PDD principles, respectively, see https://digitalprinciples.org/principles/ Accessed on Oct 7, 2018.

current broad adoption of digital finance in Africa could translate in lower transition costs and less cultural resistance (Niforos, Ramachandran, and Rehermann 2017, 38–39).

Likewise, political instability, high volatility of local currencies, elevated rate of illegal activities incentivizing de-risking, are already driving the adoption of digital currencies and DLTs in Latin America. In Asia but China in particular, displays positive regulatory efforts, a robust technological ecosystem, exceptional access to venture capital and significant willingness of the government to collaborate and support adoption of DLTs (Niforos, Ramachandran, and Rehermann 2017, 42–43).

At the same time, considerable implementation perils are pointed out. The principal risks identified are technical, organizational and regulatory. First, the substantially high amount of computational resources usually needed by DLTs raise concerns associated with scalability and difficulty to attain economies of scale. Second, organizational costs can be significantly high, even when conducting pilot tests. Third, the regulations have just not evolved as fast as the technology, and therefore it continues to represent one of the most critical hurdles for adoption (Niforos, Ramachandran, and Rehermann 2017, 21).

Under those conditions and to evade risks the report suggests that companies should create partnerships with start-ups and other companies to share costs, associated with infrastructure and confront regulatory threats (Niforos, Ramachandran, and Rehermann 2017, 22). To this effect, the report insists on the need of having a legislative and regulatory ecosystem that facilitates the creation of public-private cooperation (Niforos, Ramachandran, and Rehermann 2017, 37). Finally, it critically considers an environment with a certain degree of technological development with the disposal of the necessary technical skills (Niforos, Ramachandran, and Rehermann 2017, 37).

Despite that the IFC report explains how emerging markets in Africa and Latin America provide "a fertile ground for adoption" it also elaborates in depth on the factors that could affect a successful implementation (Niforos, Ramachandran, and Rehermann 2017, 36–40). In this sense, it could be said that those factors point, like in the report of the UNPD, to the conditions that those markets need to meet to minimize the risk that companies implementing DLTs have to face. Then again, these assertions raise some questions about design and conditions previously discussed. According to the report, China represents by far the most prepared market for implementing DLTs. That is, the report aims for those places where the conditions are more suitable and not necessarily where it is needed the most. Otherwise stated, the appropriateness of the market dominates over the possibility of an appropriate design. Hence,

it becomes clear that regardless of their purpose, DLTs implementation are inevitably tied to the current dynamics of capital.

Even more, the report puts forward the idea that public-private collaboration support and the creation of partnerships are highly desirable to share the costs and to curb the risks. One might think that the above represents in itself a greater integration by allowing governments to assume a more active and participatory role in their own development. However, this might be overshadowed if the conditions in which this collaboration occurs are unequal. Certainly, equitable public-private partnerships need a solid state able to level the playing field for interaction between partners with unbalanced capacities (Miraftab 2004, 93).

Ultimately, the ability of the state to enforce distribution and the power of local communities will determine whether introducing these schemes of collaboration will encourage factional, independent growth or if them will have a destabilizing effect on those states (Miraftab 2004, 98). The information on the examples provided in the report is not enough to make this determination. However, the IFC reports' suggestions can serve to emphasize the importance of analyzing the conditions of DLTs implementation within each particular context to be able to make an objective estimation of their potential.

4.2.3 WB

In the road of implementation, the WB report identifies many challenges ahead. Considering the early stages of development and constant technical changes of DLTs, the Note remarks that "the World Bank Group cannot, at this stage, issue any general recommendations about usability independent of specific contexts" (Natarajan, Krause, and Gradstein 2017, 37). Instead, a list of suggestions of the areas in which the WB could play a more active role is presented.

The recommendations are divided into four categories: monitor developments, foster collaboration, enhance awareness of and explore applications, and engage with WB client countries working on these topics (Natarajan, Krause, and Gradstein 2017, 37–39). As it can be noted, the recommendations made are intended explicitly for the WB. Nevertheless, if after being analyzed, they are, decontextualized and treated as if they were aimed for any other development organization or national government, they can contribute to widen the perspective of this analysis. A short selection of them is presented below.

First, the WB should monitor the steps undertaken by development organizations and governments and assesses the developments of DLTs as well as the regulatory barriers hindering them (Natarajan, Krause, and Gradstein 2017, 38). Second, it advises the WB to encourage companies "to explore the applicability of the technology for a development context" and supports pilot tests and proofs-of-concept (Natarajan, Krause, and Gradstein 2017, 38). The latter, coupled with the examinations of the recently created WB *blockchain Lab*, can lead to a comprehensive analysis of the cost and benefits of DLTs. Third, the report recommends taking part in reviews of pilots implementations to further increase the understanding of the costs and benefits of DTLs (Natarajan, Krause, and Gradstein 2017, 39).

In the steps advised by the Note, it is possible to appreciate much more caution. Although the Note acknowledges a significant potential of DLTs, it also recognizes the complexity related to its implementation. Accordingly, before conducting a project associated with DLTs, it is vital to analyze the level of integration and participation of other actors.

According to the document, the need for prioritizing a real understanding of the costs and benefits can also be achieved either by participating as an observer in other initiatives, or, in the case of the WB or larger organizations, by conducting their own explorations aided by a specialized research institute. While the first can be more easily obtained, it is also true that organizations and governments often face budget constraints.

Notwithstanding, the point worth highlighting from the Note perspective is essential to develop expertise and understanding to make informed decisions regarding the use of DLTs. Accurately determining whether or not a DLT-based solution is the most suitable option can only be attained when a broader and deeper understanding of the cost, benefits and limitations are already in place.

4.3 Conclusion

This chapter presented an inquiry into the potential of DLTs for development based on the analysis of three international development organizations' publications. The similarities and contrasts pointed out in the analysis, which constitutes the core of this dissertation, have provided insights of great significance.

Notwithstanding all documents acknowledges that the potential of DLTs extends beyond the finance realm, in their appraisals a more thorough examination of the latter continues to have a marked predominance over other economic sectors. Altogether, the discussion of the

potential remains mostly theoretical; the deeper examination of case studies in the UNDP report is outshined by the overwhelming amount of arguments extolling their advantages and capabilities and a pervasive disregard of their cost and benefit trade-offs.

The analysis suggests that the evaluation of the potential of DLTs is being discussed at length in terms of efficiency. It argued that the perceived efficiency gains are prone to be unevenly distributed between the groups of beneficiaries since the prevailing asymmetries among direct recipients and the significance of the lopsided geographical appurtenance of DLTs providers are often overlooked.

The examination has shown that attention leans disproportionally towards an exploration of DLTs potential, thus confirming the contentions of Pisa (2018, 80). All three publications raised concerns regarding scalability, interoperability and especially implementation costs. However, except for the Note, none of them was addressed considering the crucial differences between permissioned and permissionless variants.

The inquiry identified that the suitability of the conditions where DLTs are to be implemented dominates over an appropriate design tailored to each individual case.

CHAPTER 5 RE-ASSESSING THE EXPECTATIONS

"[DLTs] are considered as the innovation that will lead to the next generation of Information and Communications Technologies". (Kogure et al. 2017, 56).

The previous chapter analyzed and critically discussed the assumptions supporting the idea that DLTs can be seen as valuable tools for assisting public and private actors to achieve developmental goals. This chapter will contrast its findings with prior attempts of employing Information and Communications Technologies (ICTs) for similar ends and contextualize the discussion within a framework that takes into consideration the largely ignored political and economic conditions in which technology unfolds. In doing so, this chapter aims to challenge the discourse of newness underlying DLTs and to offer a wider perspective from where expectations could be re-assessed.

5.1 The newness of technology

When the radio appeared at the beginning of the twentieth century, "world peace was said to be one dial away" (Price 2001, 1885). Similarly, by the end of the century the internet was believed to be about to bring a revolution in development (Kleine and Unwin 2009, 1045). Just as the radio and the internet in the past century, DLTs seems to be drenched in a rhetoric of utopian change and technological optimism that does little to consider that the challenge is as much as technical as it is political. This section will argue that the discussion underlying the evaluation of DLTs as instruments for development is often based on deterministic views reminiscent of the discourse of the digital divide.

5.1.1 Bridging the digital divide

The digital divide is commonly referred as the gap between those who has the capability and knowledge for accessing and using ICTs and those who do not (Warschauer 2004, 6–8). It is grounded on the perception that the unevenness of technological diffusion reflects the long-standing divides between material poverty, education and individual freedoms (Weber and Bussell 2005, 66–67). Whilst the term reached its height at the end of the 1990s, its core ideas continue framing the orientation and significance given to DLTs for development.

It is important to emphasize that the digital divide is a highly contested term. Its preponderance within a growing number of development interventions, in particular at the turning point of the millennium, gave rise to a fair amount of criticism (Kleine and Unwin 2009, 1045). Pieterse (2010, 167), for example, maintained that the digital divide is an essentially misleading

approach inasmuch as it turns a blind eye to the multidimensional nature of socio-economic problems by reducing them to a set of technical deficiencies. In other words, the digital divide tends to prioritize limited technical responses to address complex socio-economic phenomena.

The findings of chapter four suggest that, despite being more nuanced, this rationale continues underpinning the technology-development nexus. For instance, as analyzed in section 4.1, the assessment of DLTs potential is ordinarily rooted in the following logical structure: First, the main problem is identified (e.g. 1.5 billion people without formal identity). Second, the current challenges to cope with the problem are discussed (e.g. the need of having a unified, tamper-proof and reliable digital identity system). Third, by linking the challenges with DLTs capabilities and introducing case studies, it is extensively insisted on the suitability of DLTs for addressing that particular problem (See UNDP 2018, 13–16).

From this perspective, it certainly becomes difficult to deny the advantages and appropriateness of DLTs to address that particular problem. Nonetheless, as Pieterse (2010) suggests, this approach is tremendously restricted as it ignores the intricacy and entangled nature of social phenomena. Proposing plain technical solutions for addressing portions of a broader arrangement of intimately interrelated social, cultural and political components pays down importance to the integrated nature of the problem. Concomitantly, this strategy allows to shift the attention away from the root-causes that accentuate and influence the recurrence of the perceived problem.

A concrete case in point is how the integration of the GS into global markets is contended in all publications analyzed. Firstly, it is highlighted that the comparatively low access to financial services and lack of formal identification are among the main factors hindering a greater integration to productive activities (Niforos, Ramachandran, and Rehermann 2017, 33; UNDP 2018, 31–32). Secondly, it is detailed how DLTs can provide a reliable digital ID and a transparent registry system. Thirdly, it is explained how the combination of both, the digital ID and registry system, could facilitate the access to credit and thus promote a more active participation and assimilation into the global markets (Natarajan, Krause, and Gradstein 2017, 25; UNDP 2018, 31–32; Niforos, Ramachandran, and Rehermann 2017, 49).

Leaving aside for a moment the dubious assumption that greater market integration is a vehicle for development (it will be further discussed in section 5.3), this approach circumvents historical, social, political and cultural factors causing or accentuating the identified problem

(Wilson 2002, 90).[91] At the same time, this view presumes that technological and social contexts can be detached from each other and implies that these two seemingly separated components interact through a mechanism of causality that moves from technology to society (Warschauer 2004, 202). In other words, the implementation of DLTs-based solutions is expected to have a unidirectional transformative effect in the GS, irrespective of the particular circumstances and regardless of the wide array of factors affecting low market inclusion.

Certainly, technology and society are closely interrelated, but the belief of the existence of a causal link moving from technology to social change to has been widely criticized and conceptually associated with what is known as technological determinism.

5.1.2 Technological determinism

Simply stated, technological determinism is an ideology which assumes that technological progress is the overriding constituent impelling social change (Xinbo 2018, 206–7). It commonly supports two distinct but complementary ideas. First, the idea that irrespective of society, technology is constantly evolving following its own inherent an unilinear path. Second, the idea that technological change is a determining factor of social change (Cherlet 2014, 3).

Technology seems to be ubiquitous. We often hear that technology is shaping every single aspect of our lives; from the way we communicate and commute to how we interact and consume (Bijker and Law 1992: 11-12). However, while it is clear that technology has been a crucial factor enabling the transformation of a wide range of socio-economic activities, the perception that causality moves unilaterally from technology to social change, as technological determinism suggests, is highly debatable.

As it happens, technological change does not occur independently, but it is instead the result of a process in which it is contested, fought over and shaped throughout an extensive network of actors where the local, regional as well as the global converge. So, technology and society are indeed constantly evolving, but the causality between them is also shifting (Bijker 2008: 5031-36).

Based on this understanding, it is clear that ICTs, neither DLTs alone cannot determine social change. Nonetheless, during the past decades of development interventions ICTs have been

[91] It is worth noting that although the IFC report mentions that DLTs alone are insufficient to address cultural and structural issues it also states that they present “a strong toolkit to tackle significant facets of the issue” (Niforos, Ramachandran, and Rehermann 2017, 49).

directly or indirectly attributed with this capacity (Kleine and Unwin 2009, 1045). Especially between the mid-1990s and the turning point of the millennium when the internet appeared more prominently, ICTs became a fundamental constituent of the development discourse (Walsham 2017, 18–25).

At this crucial juncture Wilson (2002) conducted an analysis to several publications of some of the main development organizations with the aim to understand the assumptions underlying the international public ICT and development discourse. Wilson's inquiry concluded that to the international public ICT and development discourse was built upon assumptions of technological determinism (Wilson 2002, 80–90).

Now, after nearly two decades of Wilsons' analysis, it seems that technological determinism has sturdily stood the test of time. The ongoing discussions of DLTs for development continue to be accompanied by analogous deterministic views. Consider the following introductory remarks of the UNDP report:

> *"We suggest that the transformative power of [DLTs] should not be seen as a threat […] rather as an opportunity for national and international institutions to defend the rights of those they represent and to accelerate our collective progress towards meeting the United Nations Sustainable Development Goals."* (UNDP 2018, 2)

Either explicitly, such as the quote mentioned above, or subtly, like the perception that DLTs will play an essential role in prompting market inclusion (as illustrated in section 5.1), nuanced versions of technological determinism subsist in the interstices between the international public ICT and development discourse and it continues furnishing technological innovations like DLTs with exceptional capabilities to address socio-economic challenges.

The presence of deterministic notions that ignore the shifting causal relationship between technological and social change as well as an argumentative structure reminiscent of the apolitical conception of the digital divide, situates DLTs professed potential not far away from the optimistic rhetoric that once surrounded the radio and in particular the internet.

5.2 The path of development

In chapter two, it was contended that DLTs have followed a process of growth and expansion similar to those that the internet had during the 1990s. Chapter four explored how this

expansion reached international development and led a critical examination of the narratives that are now contributing to shape the discourse. Based on reflections of the field of ICT4D (explained in chapter three), the preceding section proposed to build a wider dimension for assessing the perceived potential of DLTs as an instrument for development. This section will continue this undertaking by offering a brief historical exploration of the ICT and development discourse to argue that DLTs discussion also brings backs contested notions of catching-up and technological transfer.

5.2.1 Development stages

As it was maintained before, the sense of urgency and the priority assigned to DLTs are commonly based on an essentially deterministic view which assumes that technology will be the primary driver of social change and guided by the oversimplified notion of a digital divide. This sub-section will contend that DLTs discussion reproduces a binary opposition between the GN and GS which presumes that the latter must follow a nearly pre-defined path once followed by the former.

Wilson's analysis also exposed that to the international public ICT and development discourse underlay a dichotomy set up between those countries defined as the GN and those as the GS, which even extended to create a category of information haves and have-nots (Wilson 2002, 84). Wilson clarifies how this separation was well suited to fit a model of development based on a seemingly natural and straightforward process of catching-up to the ideal represented by the GN (Wilson 2002, 90).

Simply put, catching-up is the idea the GS could reach the living standards of their counterparts of the GN by following a similar path to that trodden by the latter. Based on this premise, the GS is expected to emulate the practices of the GN with the promise that at some point it will be able to match its counterpart (Mies 2002, 107–9).

This evolutionary-like thinking has been in fact a central pillar of the development discourse. After long decades of development interventions this view has expectedly come in for a great deal of criticism. For instance, some authors have, among other issues, emphasized the tremendous amount of time that the GS would actually need to succeed in this endeavor. At the beginning of the 1990s C. Douglas Lummis observed:

> *"Supposing the growth rates in the [World Bank's 1988] World Development Report remained unchanged, we can calculate that the poor countries would*

achieve the 1986 income level of the rich countries in 127 years' time. So, they would be able to catch-up with the rich countries in half a millennium, 497 years to be precise" (Lummis 2009, 47).

As the gap between both does not seem to narrow, it becomes increasingly difficult to believe that the image of the GN is a condition available to all (Lummis 2009, 48–50). In this regard, technological innovation plays a crucial role in strengthening and extending the belief that such an objective is attainable. From industrial applications at the end of the second world war to internet at the beginning of the 1990's, technology has been attributed with the capacity to accelerate the process and in a number of instances even to bypass (usually referred as leapfrog) some of stages of this process.

A commonly cited example of the above is how mobile phones can fast-track the progress of African countries. It is believed that by dispensing the need of making large investments in telephone wiring as the GN once did, African governments can allow their citizens to communicate with each other at a much lower price (Szirmai 2005, 132). Thereby, African governments typically need to collaborate with private companies to be able to harness the opportunity.

As it was argued in section 4.2.2, it might seem that these collaborative schemes are allowing African governments to assume a more active and participatory role in their own development. However, this collaboration does not necessarily occur under even conditions. Equitable public-private partnerships inexorably need a solid state able to level the playing field for interaction between partners with unbalanced capacities. (Miraftab 2004, 93). Nevertheless, when technological innovations are attributed with the capacity for leverage or accelerate the process of catching-up, the uneven economic and political conditions are generally played down (Pieterse 2010, 172–74).

Notwithstanding the above, DLTs discussion supports a similar reasoning. For example, it is suggested that the existent mobile penetration in sub-Saharan Africa could be now leveraged to offer decentralized mobile banking and digital payment solutions and hence to avoid large investments to reach unbanked population segments (Niforos, Ramachandran, and Rehermann 2017, 40) Likewise, it is implied that the adoption of DLTs "could result in a technological leapfrog that boost financial inclusion and growth" (Niforos, Ramachandran, and Rehermann 2017, 6).

Beyond this already contested deterministic view, the logic in which DLTs are rooted remains highly problematic because it reinforces the sense of existence of a pre-determined and nearly universal path of development that need to be followed. Moreover, as it will be detailed later in this chapter, it also implies the need of the GS to make the necessary adjustments in order to receive the technology and not the other way around (see sub-section 5.2.2).

As it happens, the presumption of the existence of stages of development was already prominent during the nineteenth century. Built upon theories of social evolution, it helped to justify European supremacy and colonial expansion (Pieterse 2010, 20). From savagery to civilization, it was assumed that the type of knowledge and technology that a society had, indicated their current stage of development (Cherlet 2014, 10). With Europe at the top of this perceived evolutionary process, their colonial intervention even attained a philanthropic status. In words of the former French minister of external affairs, Jules Ferry:

> *"Superior races have rights over inferior races, because they also have obligations towards them; they have the obligation to civilize the inferior races" (Ferry, 1885, originally quoted in Cherlet 2014, 11)*

In this regard, the idea of levels or stages of development contributed to some extent to furnish colonial intervention with a moral justification. From the diffusion of Christianity, the expansion of markets for the growing European industry at the end of the nineteenth century, the transfer of scientific knowledge and industrial technology to prevent the expansion of communism at the end of the second world war, and the diffusion of ICTs from the 1990's for the expansion of global markets and the capitalist economy, the idea of stages of development is continuously changing adapting itself to the conditions of the time (for a comprehensive history see Pieterse 2010, 20–35; Cherlet 2014, 8–19).

At present, the philanthropic logic underlying Ferry's words subsists and somehow it continues to be rooted in the perception on how DLTs should be utilized. DLTs' innovative character is thus dimmed by the long-standing belief of a stage-like and pre-determined path of development which they ultimately support.

DLTs might have the capacity to lead the GS towards the path that the GN once traveled or even more, to bypass some of the stages as the IFC report suggests, but the real question is that if in doing so, DLTs will not be contributing to build a new face for the same old perception by extending the illusion that the GS will be capable of occasionally catching-up.

5.2.2 Adaptation vs. ground-up innovation

Even if this stage-like and linear model of development is accepted by the GS, the utility of DLTs as any other technological innovations, is confronted with challenges associated with the transfer of technology and knowledge to places with different conditions to those where they have originated.

Since the end of the second half of the twentieth century, when the term *technical assistance* made its way into the development field, the transfer of technology to the GS was already in the center of much controversy. As David Owen, Chairman of the UN Technical Assistance Board wrote back in 1950:

> *"[It is] natural that technical experts from any one country will be inclined to recommend a duplication of the institutions, organization, and techniques which have proved successful in their own country, though in many cases these solutions are not necessarily compatible with the social and political structure of the recipient." (Owen, 1950, cited in Cherlet 2014, 12–13).*

Among others, Owen's contention suggests two main possible answers to address this challenge: either technical assistance needed to be aligned with local specific conditions and requirements or rather local social and political structures required to be transformed to benefit from technology. Against all logic and in spite of having faced severe criticism, the subsequent decades were marked by a clear inclination towards the latter (Cherlet 2014, 13).[92]

It was not only until the early 1970s, when the concept of *appropriate technologies* set the tone for a change of course. This concept brought forward the need to give more attention to the local conditions where development projects were implemented (Murphy, McBean, and Farahbakhsh 2009, 158–61). Broadly speaking, it makes reference to "any technology that is small scale, labor intensive rather than capital intensive, energy efficient, environmentally sustainable, and controlled and maintained by the local community of a developing region" (Cherlet 2014, 13).

With the primary objective to improve technology transfer, but also to prevent the expansion of communism, the concept gained ground in the WB models and helped, to certain extent, to provide greater sensibility to local expertise and knowledge (Cherlet 2014, 13). Although some

[92] Notably, the critics that emerged from the so-called dependency school during the 1960's and early 1970's.

success was achieved, especially during the 1970's, like the WB support to agricultural research centers, this approach was occasionally replaced by one of adaptation. As it was detailed in a later WB publication:

> *"For ICTs to deliver on their promise of economic and social development, it is critical that countries adopt enabling legal and regulatory environments […], that is, policy, legal, market, and social considerations that interact both at domestic and global levels to create fertile conditions for ICT-led growth." (Guermazi and Satola 2005, 25)*

Following this assertion, governments were now given the responsibility to put in place the appropriate conditions or, stated differently, to create the "right enabling environment for ICT" if they wanted to benefit from technology (Guermazi and Satola 2005, 25). From regulatory reforms in communication services to a call for larger investments in public infrastructure, this set of recommendations implied altogether a complete shift to the concept of *appropriate technologies*.

As it was extensively discussed in section 4.3, and illustrated early in this section, DTLs diffusion draw on similar arguments. As it is stressed in the IFC report:

> *"Governments and regulatory authorities are compelled to adapt quickly to these [new] emerging trends […] and encourage public-private collaboration, […] to ensure they are not excluded from [DLTs] future developments and potential benefits" (Niforos, Ramachandran, and Rehermann 2017, 40).*

Likewise, governments are expected to act decisively and to assume "a hands-on approach to understanding the new regulatory needs" (Niforos, Ramachandran, and Rehermann 2017, 21).

The UNDP report goes even one step further by declaring that for any DLTs initiatives implementation it is crucial to have the "appropriate technology" in place; to enforce the "appropriate communication and education techniques"; to apply the "appropriate data and security protocols"; to select an "appropriate management approach"; and to have the "appropriate operational capacity" (UNDP 2018, 33–34).

After an examination of these and other of the recommendations proposed, section 4.3 concluded that the suitability of conditions where DLTs are to be implemented dominate over a design tailored to the local needs and conditions. Consequently, the adjective 'appropriate'

is no longer concerned with qualifying the adequacy of technology to meet local needs, but to describe the suitability of local conditions to ostensibly meet technological needs.

While it is also deemed essential to promote user-friendly designs (Natarajan, Krause, and Gradstein 2017, 27) and to 'design with' and not 'for' the beneficiaries (UNDP 2018, 34), the documents analyzed do not take serious measures to consider how the poorer social strata could benefit from DLTs (see sections 4.1.3 and 4.2.1). In this respect, the deployment of DLTs seems to be poised to avoid the most marginalized sectors, in particular those without access to internet, from being the primary target of DLTs initiatives.

Hence, given that very specific population clusters can use and take advantage of technology, DLTs diffusion could indirectly contribute to expanding the existent asymmetries; not only between the GS and the GN, but also at the national level (this will be discussed further below). In such scenario, the promotion of DLTs as an instrument for development would be prone to enter, as many other ICTs already did, in an endless process of adaptation.

Adaptation instead of ground-up innovation is problematic not only because of the high costs needed for emulating the often-incompatible institutions and technics of the GN as Owen's annotated, but also because it implies promoting an external, unidirectional and non-participatory development that devalues and dismisses locally produced knowledge.

In fact, local organization forms and practices have been regarded before as an obstacle for advancing the development agenda (Pieterse 2010, 96–97). On the contrary, a greater disarticulation of traditional forms and familiarity with modern techniques are perceived as a favorable condition. For example, the existence of a wide range of alternative payment methods is Kenya is considered a positive sign for deploying DLTs since the population acquaintance with digital payments is expected to offer "less cultural resistance" to embrace similar technologies (Niforos, Ramachandran, and Rehermann 2017, 38).

In sum, the orientation given to DLTs implementation seems to be aligned with a reasoning that evokes the logic behind Ferry's statements dating from 1885; to reinforce the concerns pointed out by Owen in 1950; and to go against the soundness of the 1970's concept of *appropriate technologies*. So, as long as local practices, needs and knowledge, progress without guiding and informing DLTs implementation and design decisions, the concept of *appropriate technologies* will be occasionally be replaced with the more suitable one of *appropriate conditions.*

5.3 Technology embedded in capital

By setting in place the legal, regulatory and social conditions for the implementation of DLTs governments are not necessarily meeting the needs of technology. The ostensibly inescapable rearrangement of local conditions to benefit from ICTs has been in fact a centerpiece to enforce deregulation and a vehicle for market expansion (Kleine and Unwin 2009, 1060–63). In this connection, this section will contend that regardless of the purpose for which they are intended, DLTs seem to be inevitably tied to the current's dynamics of capital and as such, they foster an unequitable distribution of benefits, lead to create dependency and underpin the current economic paradigm.

5.3.1 Distribution asymmetries

Chapter four concluded that the perceived benefits offered by DLTs applications are prone to be unevenly distributed among the different groups of beneficiaries. First, because the suggested implementation guidelines largely ignore the prevailing asymmetries among direct recipients. Second, because the followed approach is reluctant to acknowledge the significance of the geographical concentration of DLTs service providers.

Regarding the first, section 4.1.2.2, illustrated how DLTs are credited with great potential for agriculture as they enable the possibility to trace commodities throughout the entire supply chain. The idea is that consumers could benefit with a superior transparency about the origin and conditions in which agricultural products are cultivated and in turn, farmers would be able to increase the added value of their products (Niforos, Ramachandran, and Rehermann 2017, 45–47). Nonetheless, proposal require the use and integration of a wide range of devices and enabling technologies such as smart-meters, farming sensors and even AI and IoT (Niforos, Ramachandran, and Rehermann 2017, 47–48).

Naturally, the significant amount of investment required is in itself a major constraint to the vast majority of low-scale farmers. It is thus expected that mostly large agricultural business and a reduced number of farmers will be those who can access and fully profit from the purported benefits (see section 4.1.2.2). Consequently, DLTs would be indirectly contributing to preserve, or even to expand, current inequalities between the partakers of agriculture supply chains. As explained earlier, the foregoing is not limited to those existing between the GS and the GN, but also at national levels (see section 5.2.2).

Even though the potential of DLTs for supply chains is also examined within the context of different economic sectors like the case of the fishing and pharmaceutical industry (UNDP 2018, 22–25; Niforos, Ramachandran, and Rehermann 2017, 48–49), they all share an approach that does little to consider how the current imbalances among the different population segments will have an impact on distribution.

Concerning the second issue, it is important to underline that while some entrepreneurs in the GS are already experimenting and developing their own DLTs applications, the larger concentration of DLT companies, both in number and capital investments, is mostly located in the GN. As the IFC report acknowledges, "[new companies] are not exclusively based in developed markets, although the best funded ones are, for now, U.S.-based" (Niforos, Ramachandran, and Rehermann 2017, 32).

In 2016, at least 48 percent of all DLTs-related companies worldwide were in North America alone.[93] This unevenness is highly problematic. On the one hand, it indirectly contributes to promote adaptation instead of ground-up innovation. As it was insisted before, locally owned projects are more likely to be better informed by local knowledge and needs (see section 5.2.2) and economic gains can be better captured by communities (see section 4.1.2.1). On the other hand, it might trigger the accumulation of profits in a reduced number of companies in the GN. As the WB Note acknowledges, "many of the benefits and efficiency gains of DLT are likely to be reaped by start-ups and financial institutions in the developed world" (Natarajan, Krause, and Gradstein 2017, 23).

Against this background, it becomes clear that DLTs implementation are at a crossroad. While there might be converging interests to leverage the set of unique capabilities brought by DLTs to address socio-economic challenges in the GS (thoroughly discussed in section 2.5), those initiatives need, in order to subsist, to find the means to back their operation. While some of those initiatives could capture national or international public funds, most of them will have to find a way to collect their own economic resources.

In this sense, DLTs may contribute to reshape entire economic sectors and to bring new business models as it is widely argued, but at the same time, it is also likely that DLTs will bring –or at least contribute to consolidate– new revenue systems. Therefore, regardless of how innovative they are, DLTs will be confronted to similar market dynamics to which prior ICTs

[93] See "Distribution of blockchain companies worldwide 2016, by region" https://www.statista.com/statistics/741576/distribution-of-blockchain-companies-by-region/ Accessed on Dec 14, 2018.

initiatives were exposed. Although this might be understandable for some, this sub-section has exhibited that the unequal distribution of the potential benefits is downright unsettling.

5.3.2 Dependent development

In assessing the potential of DLT as an instrument for development, it is necessary to bear in mind the fact that most DLTs service providers are profit-oriented organizations operating in a competitive environment whose success and ultimate subsistence is contingent on their ability to effectively capture returns on their investments. In this light, this sub-section will maintain that under the protection of intellectual property rights, DLTs diffusion is likely to create dependency.

Bitcoin, the pioneer of DLTs, is a permissionless and open-source innovation.[94] This means that theoretically any person can download the program and start conducting transactions. Likewise, anyone can freely download the original code and create their own version of the program. As illustrated in chapter two, this set of characteristics allowed the creation of a large number of alternative cryptocurrencies and progressively of more complex applications (see sections 2.1.1 and 2.1.2). Nonetheless, as technology continued to grow and expand, so did the interest of companies to ensure the distinctive character of their products and services.

One commonly mentioned indication of the above is the progressive development of permissioned and private DLTs applications which, by enforcing authentication credentials, they restrict the ability of some users to access and perform changes to the ledger (see section 2.4). Nonetheless, the interest to exert control over innovations has accompanied the development of DLTs since the outset. For instance, between 2011 and 2018 the US Patent and Trademark Office alone received more than 700 DLTs-related applications (Nayak 2018). Globally, this number surpassed 2200 in 2018 (European Patent Office 2018, 7).

Not surprisingly, patent registration is also undergoing considerable concentration. The current top applicants worldwide are IBM, with 111 patents and Alibaba with 88 patents (European Patent Office 2018, 8). These companies are followed by MasterCard (US), Bank of America (US) and People's Bank of China with 80, 53 and 44 patents respectively (Vaškevičius 2018).

Although the GS could progressively develop its own applications to compete with the GN, this path does not seem to be realistic. With a handful of companies leading DLTs innovation (see

[94] "Open source refers to software in which the source code is available for all users to view and modify" (Weber and Bussell 2005, 68).

section 5.3.1) and exerting strict control over it by means of intellectual property rights, it is possible that the GS will become, as it has happened before, a profitable market of consumers for the technology industry of the GN (Pieterse 2010, 183–84). As Boas, Dunning, and Bussell annotate:

> *"It seems extremely unlikely that applications from the global South will displace a similar product from the North, particularly if the Northern product enjoys initial advantages and early acceptance among a community of users" (Boas, Dunning, and Bussell 2005, 103).*

Patent protection might be an "economic incentive for innovation" and creative work (Pretnar 2009, 841), but it has also been an effective instrument for safeguarding competitive advantages and securing capital returns via monopoly rents. It is worth to remember, that the Business Software Alliance, an advocate for the global software industry, has been particularly active in counteracting copyright infringement in the GS (Pieterse 2010, 174). In this sense, property rights application are as much as a stimulus for innovation as a sharp political instrument (Boas, Dunning, and Bussell 2005, 103).

On the other hand, the more active participation of China does not mean *per se* a reversal of the current trend. As China and other so-called emerging economies are improving their capacity to produce innovations, they are expected to become even stronger defenders of property rights (Weber and Bussell 2005, 74). So, irrespective of their geographical appurtenance or their innovative character (as it was illustrated before), DLT companies most likely will continue striving to maintain a comparative advantage over their competitors and to secure economic returns of their products and services.

In this context, the ability of the GS to benefit from DLTs in the long-run is fundamentally constrained by its disadvantaged competitive position vis-à-vis the high concentration of innovation in a few companies and regions and above all, by means of the underlying logic of accumulation in which most DLTs products and services providers operate.[95]

Almost five decades ago, the so-called Sussex Manifesto raised similar concerns.[96] By criticizing the prevailing global division of labor in innovation at the time, it deemed essential to

[95] Although in different contexts, a considerable amount of research has already explored the different ways in which technology transfer can lead to a dependency-path (see for example Castells and Laserna 1989; Coombs and Hull 1998; Fuchs and Shapira 2005).

[96] At the request of the UN Advisory Committee on Science and Technology for Development, the Sussex-Manifesto was originally intended to be an introductory chapter for the World Plan of Action for the Application of Science and Technology for

focus on improving science and technology capabilities of the GS instead of promoting the transfer of technology (Ely and Bell 2009, 4). It considered that it was only in this way that the GS would be able to enhance its own capacities to produce (Ely and Bell 2009, 4; Cherlet 2014, 15). While the idea may still be situated within an economic viewpoint, it may be at least a step closer towards self-sufficiency.

Contextualized in the current discussion, the above would translate into the need to improve the capacity of the GS to leverage on open-source DLTs to develop and advance their own tailored responses. As the UNDP report recognizes, "open-source platforms allow for greater flexibility and freedom when it comes to designing, adapting and using [DLTs]" (UNDP 2018, 7).[97] After all, DLTs originally emerged as a result of an open-source project that posed the technical possibility to dispense with intermediaries (see Nakamoto 2008).

Notwithstanding the above, all publications analyzed suggest an orientation in which the GS is provided with cautiously protected paid solutions and not with enhanced capabilities to develop their own tools. DLTs might have the technical competences to push towards self-reliance[98] but this sub-section has suggested that the challenge is as much as technical as it is political. So, until the GS is able to harness on DLTs to enhance its own capabilities instead of being perceived as mere consumers, DLTs diffusion are poised to create dependent development; one that is conditioned to capital rents on DLTs products and services and reliant on the GN's privileged competitive position.

5.3.3 Technological utopianism

DLTs may be able "to disrupt industrial sectors, commercial processes, governmental structures, or economic systems" (UNDP 2018, 2); "to address some of the economic and financial challenges that emerging markets face today" _; or "to structure solutions to development challenges in the financial sector and beyond" (Natarajan, Krause, and Gradstein 2017, x), but this possibility is inescapably constrained and enabled by political, economic and social power structures in which they are embedded (Longshore Smith 2005, 37–38).

Development first presented in 1971. Although it was integrated in the document, it was demoted to the annexes (Cherlet 2014, 14–15).

[97] After all, DLTs emerged as a result of an open-source project that posed the technical possibility to dispense with financial institutions and other intermediaries (see Nakamoto 2008).

[98] For instance, the possibility to create a decentralized system capable to regulate social interactions with an integrated and automated incentive system (see chapter two).

The deterministic visions and technological optimism that surround the examined discussion of DLTs as an instrument for development as well as a constant overestimation of their capacities vis-à-vis the overlook of their implementation hurdles (Pisa 2018, 80–81) have managed to build a parallel reality that seems to be alien to those power structures.

As it was argued earlier on this chapter, technological change does not occur in isolation, but it is instead the result of a process in which it is contested, fought over and shaped throughout an extensive network of actors. Correspondingly, the reasons that guide their DLTs orientation and motivate their implementation are also a result of this process.

Under a dominant political and economic paradigm centered around accumulation and the capitalistic logic of the market (Harvey 2007), there is no coincidence that the potential of DLTs as an instrument for development is discussed at length in terms of efficiency and that it prevails a clear propensity to prioritize the requirements of capital at the expense of local needs (see chapter four).

The intended uses and orientation given to DLTs, as well those of previous ICTs initiatives, continue to be strongly influenced by the growing demand to develop new market niches and improve productivity where the local and global interests converge. As the IFC report asserts:

> *"[DLTs] developments will be propelled by the drive to create new markets, where competition and barriers to entry are lower, or to target process efficiencies in existing operations, where current players maintain considerable market power" (Catalini and Gans 2017),* originally cited in *(Niforos, Ramachandran, and Rehermann 2017, 30).*

In light of the above, one can understand the low interest of the analyzed publications to elaborate on how the most marginalized segments of the population could benefit from DLTs initiatives. This selective approach is not the sole result of the lack of adequate conditions to implement technology; the decision can be also explained by the fact that those segments usually represent significantly lower interest for capital, due to their higher risk and low economic returns.

A quintessential example to unveil the largely overlooked power structures and different interests in the discussion of DLTs —and ICTs in general — is the seemingly philanthropic re-orientation of development interventions to assist the integration of those lower segments to access financial services, commonly referred as financial inclusion.

Around the late 2000's, financial inclusion had already constituted itself as a finance-based development standard. Nevertheless, it was only after the financial crisis in 2008 when a global network of companies, institutions and policy-makers with the declared intention to promote it became more visible (Gabor and Brooks 2017, 423–27).

One remarkable milestone was the creation of the Alliance for Financial Inclusion (AFI) in 2011 and the endorsement of its initiative known as the Maya Declaration (MD).[99] Signed by more than 90 central banks and financial institutions, the MD provided this endeavor with an organizational structure for coordinating political efforts to encourage national commitments to "unlock the economic and social potential of the 2.5 billion poorest people through greater financial inclusion" (AFI 2011, 2).

Perhaps the AFI and the MD are the most visible organized efforts, but in this endeavor converged a wide range of venture capital investors, fintech companies and start-ups, national and international development institutions who have joined —and emerged from —this extensive network. To this this seemingly benevolent aim to integrate 'the excluded' was motivated and influenced by the new possibility brought by technology to monetize financial data and to commodify digital footprints.

By making phone calls, accessing or registering on a webpage or using social media, every person creates a trace of information that is usually referred as the digital footprint. Among many others, this information can be used to estimate if that particular individual can be regarded as creditworthy (Berg et al. 2019, 2–3). This possibility gives greater certainty to financial institutions and financial services providers since it lowers the risk they need to assume when operating in markets with little or no background information about their customers.

Consequently, the interest to integrate greater portions of high-risk market segments into financial services did not emerged as a result of a selfless act, but as a consequence of the extended frontiers to capture and generate behavioral data for predicting default risk and generate new streams of revenue by selling data for marketing purposes.

As Gabor and Brooks summarize it:

[99] Information retrieved from the Alliance for Financial inclusion website, see https://www.afi-global.org/ Accessed on Nov 20, 2018.

> *"[Financial inclusion] is a market-led process that harnesses the power of technology, the better understanding of human behavior and broad political support. It is a vision that celebrates the possibilities for simultaneously achieving positive returns, philanthropy and human development (Gabor and Brooks 2017, 430)*

While DLTs did not created this finance-based development paradigm, they are being oriented to support it.[100] Although from different perspectives, the contributions of DLTs to integrate previously excluded and marginalized individuals to financial services and products is discussed as a positive impact. In doing so, DLTs discussion are being framed into the same apparently philanthropic endeavor and are removed away from their connection with power structures and network actors to appear once again, as neutral, revolutionary and suitably as possible.

5.4 Conclusion

As Wilson wrote almost two decades ago, the discussion presented in this chapter is not a negation of the potential of DLTs, but a call for rethinking the approach that has been used for determining their potential and a contestation of their connotation of newness.

By contrasting the results of the analysis presented in chapter four with critical examinations of the field of ICT4D, this chapter argued that DLTs discussion is grounded on deterministic notions reminiscent of the digital divide discourse which repetitively ignore the intricacy and entangled nature of social phenomena and the shifting causal relationship between technological and social change.

This chapter also exposed how the discourse of newness underlying DLTs narratives paradoxically contributes to the preservation of the status quo. By drawing on historical parallels of the ICT and development it showed how the orientation that is guiding DLTs implementation continue evoking the long-standing belief of the existence of a stage-like and pre-determined path of development and reinforcing the idea of a seemingly inescapable rearrangement of local conditions to benefit from technology.

[100] For instance, all three publications agree on the relevance of DLTs for promoting this "long-standing development goal" (Niforos, Ramachandran, and Rehermann 2017, 17). For instance, by assisting a broader access to the financial system by offering a reliable digital identity (UNDP 2018, 16), lessening the affordability of financial products and services (Natarajan, Krause, and Gradstein 2017, 23–27) and reducing the compliance costs of regulations triggering de-risking (Niforos, Ramachandran, and Rehermann 2017, 23–28) (see also section 4.1).

Finally, this chapter contended that the regardless of the purpose for which they are intended, DLTs are fundamentally tied to the needs and requirements of capital and their development and evolution contingent to the predominant political and economic paradigm. Although DLTs may have brought the possibility to provide technical means to assist the reorganization of social interactions this possibility is constrained and enabled by existent power structures in which DLTs unfold (Longshore Smith 2005, 37–38) and influenced by the interests of an extensive network of actors where the local, regional and global converge.

CHAPTER 6. CONCLUSIONS

Throughout this dissertation, the arguments and assumptions which advance the idea that DLTs can be considered as instruments providing opportunities for the GS's development have been consistently and systematically contested. Without denying the technical capabilities to transform entire economic sectors and reshape a wide range of social interactions this dissertation has maintained that, rather than technological, the greatest challenge for blockchain in the field of international development continues to be located at the political level.

The importance of this study lies in the fact that it offers a clearer understanding of how some of the main development organizations are evaluating the potential of DLTs to support the attainment of their goals and how their inquiries are helping to raise the general expectations. Moreover, it proposes a discussion informed by historical parallels of previous attempts to use technology for achieving similar ends taking into consideration the commonly ignored political and economic dimensions.

Thereby, this study has provided a broader framework from where expectations have been re-assessed. On the one hand, it allowed the acknowledgment of the significance of the existing social, political and economic power structures in which DLTs unfold. On the other, it emphasized that the reasons guiding DLTs orientation and motivating their implementation are a result of a process in which actors with various different interests partake.

This dissertation also exhibited the discourse of newness underlying DLTs narratives, which paradoxically contributes to the preservation of the status quo. While DLTs may be inherently innovative, this character does not extend to their application in the development field. In fact, it is shown how the orientation that is motivating their use and guiding their implementation recall —in a number of instances— contested old practices and approaches.

The similarities found between the process of growth and expansion of the DLTs with those of the Internet facilitated to draw parallels between the two technological advances. These correspondences enabled this dissertation to ascertain the following: between the temporal and spatial interstices of DLTs, and the development discourse, notions such as the digital divide and the existence of a stage-like and pre-determined path of development, continue to subsist

It was also recognized how in discussing the significance of DLTs for development, the intricacy and entangled nature of social phenomena are consistently ignored. Often times,

limited technical solutions are proposed to address complex social problems without giving due importance to the multitude of factors influencing the origin and prevalence of the perceived challenges.

The fact that DLTs are being attributed with exceptional abilities to address socio-economic problems was linked to the predominance of deterministic views which assume that technological progress is the overriding constituent impelling social change (Xinbo 2018, 206–7). The above did not imply a denial of DLTs' technical capabilities to support the attainment of socio-economic goals, but rather the insistence that this possibility is limited and enabled by existing social, political and economic power structures in which DLTs unfold (Longshore Smith 2005, 37–38).

As argued, technological change does not occur in isolation, but it is instead the result of a process in which it is contested, fought over, and shaped throughout an extensive network of actors where the local, and the global converge. Correspondingly, the reasons that guide DLTs orientation and motivate their implementation are inexorably a consequence of this process.

On the basis of this understanding, it was contested the fact that governments in the GS are repeatedly reminded of the urgent need to provide the appropriate conditions for the dissemination of DLTs. Although the suitability of local conditions is usually presented as a *sine qua non* condition for the GS to benefit from DLTs, it was asserted that similar arguments have been previously used to support the implementation of other ICTs.

In this connection, it was also pointed out that ironically, those recommendations have served at the same time as a vehicle for the expansion of global markets. Thus, DLTs' process of growth and evolution in the field of development are likely to continue being guided by the logic of improving efficiency, increasing productivity, reducing costs, and the opening of markets where political conditions are more favorable and not necessarily where they are most needed.

The discussion of DLTs as instruments for development was framed within a broader context that took into account the predominant political-economic paradigm. From this point of view, it was maintained that regardless of the purpose for which they are intended, DLTs seem to be fundamentally tied to the dynamics and requirements of capital and under that conditions, they can foster an inequitable distribution of benefits and lead to create dependency.

It was explained how DLTs applications are prone to be unevenly distributed among the different groups of beneficiaries: First, because the suggested implementation guidelines

largely ignore the prevailing asymmetries among direct recipients. Second, because the followed approach is reluctant to acknowledge the significance of the geographical concentration of DLTs service providers.

As it is widely argued, DLTs may contribute to reshape entire economic sectors and to bring new business models, but at the same time, it is also likely that DLTs will create –or at least contribute to consolidating– new revenue systems. Therefore, irrespective of how innovative they are, DLTs will be confronted with similar market dynamics to which prior ICTs initiatives were exposed.

Readers were also urged not to lose sight of the fact that many of the service providers of DLTs are profit-oriented organizations operating in a competitive environment whose success and ultimate subsistence is contingent on their ability to effectively capture returns on their investments. While patent registration has intensified in the past years, this activity has accompanied the DLTs since the very beginning when the first alternative cryptocurrencies were developed.

So, until the GS is able to leverage on DLTs to promote ground-up innovations and not only to use them simply as mere consumers to follow the indicated path, DLTs dissemination will continue to endorse a dependent development that is conditioned to capital rents on DLTs solutions and reliant upon the GN's competitive advantage as innovator and its privileged position in the control of intellectual property rights.

Once the thick and confusing haze of terminology usually surrounding DLTs is dissolved and the economic and political factors are carefully considered, the expectations about DLTs as new and promising instruments for development dwindle. Future research should be focused on how the GS could develop its technological capabilities to produce innovations and how DLTs could become true “sources of empowerment and emancipation”; tools through which this knowledge can be established and disseminated” (Schech 2002, 14).

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ABSTRACT

Blockchain has been credited with a high potential for social transformation. In recent years, an increasing number of development organizations have been examining how blockchain can support the attainment of their goals. However, the extent to which blockchain can be considered as an instrument for development remains contested. Without denying blockchain´s technical capabilities to reorganize entire economic sectors and to reshape social interactions this dissertation seeks to understand the assumptions underlying the blockchain and development discourse to provide a broader framework from where expectations can be re-assessed. It presents an analysis of relevant publications of three major international development organizations to ascertain how this discourse is formed and legitimated. The findings are then contrasted with previous attempts in which technology was used to achieve similar ends. The results suggest that the discourse of newness surrounding blockchain paradoxically contributes to the preservation of the status quo and lead to the conclusion that the greatest challenge for blockchain and development continues to be located beyond the technological scope.

In Wissenschaft, Gesellschaft und Politik schreibt man der Blockchain großes Transformationspotenzial zu. So haben Entwicklungsorganisationen in den vergangenen Jahren Perspektiven erarbeitet, die aufzeigen, wie Blockchain das Erreichen ihrer Ziele vereinfachen kann. Allerdings besteht noch Forschungsbedarf bei der Frage, inwiefern Blockchain als Entwicklungsinstrument eingesetzt werden kann. Diese Forschungsarbeit untersucht daher die Annahmen, die den Diskurs über Blockchain und Entwicklungs(arbeit) prägen. Dabei berücksichtigt sie die technischen Möglichkeiten von Blockchain, insbesondere wenn es um die Neugestaltung von ökonomischen Sektoren oder sozialer Interaktionen geht. Ziel ist es, einen Rahmen zu erarbeiten, innerhalb dessen man die gegenwärtigen Erwartungen, die an die Technologie im Zusammenhang mit Entwicklung(sarbeit) gestellt werden, neu bewerten kann. Dazu stellt die Forschungsarbeit nachfolgend die Publikationen dreier führender internationaler Entwicklungsorganisationen vor, um zu untersuchen, welche Faktoren den Diskurs in diesem Bereich bestimmen und legitimieren. Die Ergebnisse werden dann den bisherigen Implementierungsbestreben gegenübergestellt. Im Ergebnis ist festzustellen, dass der Neuigkeitsfaktor im Diskurs über Blockchain paradoxerweise dazu beiträgt, dass der Status Quo beibehalten wird. Die größte Herausforderung bei der Implementierung der Blockchain-Technologie im Entwicklungsbereich scheint also folglich jenseits der technologischen Komponente zu liegen.